10th Annual Meeting

Society for the Neurobiology of Language

AUGUST 16 - 18 **2018** QUEBEC CITY, CANADA

ABSTRACTS

www.neurolang.org

Rogue Research Inc.

A Tradition of

Innovation for Research

www.rogue-research.com
info@rogue-research.com

For almost 20 years, Rogue Research has been creating new and innovative tools that help you do your best in your research. We are proud to be one of the first sponsors of NBL and grateful for the trust you have placed in us over these years. We are continuing our drive for innovation with the resealse of our new cTMS device which provides more control over the pulse shape and opens new doors for TMS research.

Brainsight®

Brainsight® TMS

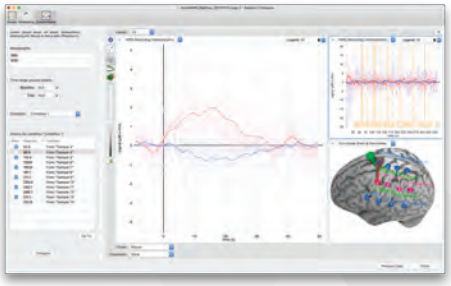
- Integrated 2-channel EMG for threshold and motor mapping
- Supports all TMS coils
- Define targets based on anatomy, MNI coordinates, functional overlay or previous coil locations
- Automatic 3D reconstruction
- Supports Axilum robot

Controllable TMS

- First new TMS design in years
- Variable pulse widths
- Controllable pulse shapes
- Unidirectional and bi-phasic rTMS
- Quadripulse
- Unidirectional theta burst
- Built-in EMG
- External control via network
- Modern touch screen UI

Brainsight® NIRS

- Brainsight controlled
- Modular design
- Up to 32 High sensitivity detectors to measure signals from the cortex
- Dedicated proximity detectors
- Up to 100 Hz sampling
- 8 aux channels with 8kHz sampling
- Low profile optodes compatible with TMS, EEG, MRI and MEG



Welcome to the Tenth Annual Meeting of the Society for the Neurobiology of Language

HAPPY ANNIVERSARY! The Society for the Neurobiology of Language has been thriving and growing since the first meeting in Chicago in 2009, and it is time to celebrate! This year we expanded the meeting to three whole days, to accommodate an amazing program, featuring four keynote lectures (**Robert Zatorre**, **Dorothee Saur**, **Morten Christiansen**, and **Julie Fiez**), talks by our Early Career (**Bharath Chandrasekaran** and **Pascale Tremblay**) and Distinguished Career (**Steven Small**) awardees, and a panel discussion about the past, present, and future of our field (moderated by **Sophie Scott**). In addition to these special events, our scientific program features three slide sessions and five poster sessions – each preceded by a poster slam where eight selected presenters highlight their findings in one minute (one clap for each!). The evening before the meeting, we are hosting a public lecture (by **Robert Laforce** and **Noémie Auclair-Ouellet**) focused on neurodegenerative disorders of language, targeting the local French-speaking people of Québec. The goal of this new initiative is to raise awareness to issues related to the neurobiology of language among the population of the host city, and to disseminate the products of research in our field to the general public.

Our keynote speakers will explore the neurobiology of language from the perspectives of language evolution, neural plasticity, recovery of the language pathways after stroke, and the reading brain. This 10th anniversary meeting is an excellent opportunity to take stock of the achievements within our field and to discuss the challenges and goals for the next 10 years – bring your questions and join the panel discussion with our past SNL chairs on Saturday morning. For all sessions, we have left plenty of room for lively discussions, and I encourage speakers and session chairs to call on junior scientists to ask the first questions.

Please join us for the opening night reception at the fabulous Musée national des beaux-arts du Québec (a lovely 15-minute walk from the Convention Centre) where you will be treated to Québec traditional music while enjoying excellent Canadian cuisine. **For student and postdoctoral researchers**, we have set up a networking opportunity for you to meet each other: Look for the "Gotta Catch 'Em All: Scientist Edition" worksheet at the welcome table and have fun (there will be prizes)! Please also join us in celebrating our 10th anniversary with Prosecco and cake at the Friday evening social hour.

I would like to thank the Program Committee for putting together an exciting scientific program: Manuel Carreiras, Jim Magnuson, Clara Martin, with special thanks to Michal Ben-Shachar as Chair of the Program Committee, and to Pascale Tremblay as Head of the local organizers. Shauney Wilson, Shawna Lampkin, and their team also deserve a round of applause for their skill in running this meeting. Thanks also to all who took time to review and provide feedback for the abstract submissions.

Finally, I am thrilled to announce that our Society will be joining with MIT Press to launch a new open access journal titled Neurobiology of Language. Please talk with Steve Small, Kate Watkins, or any board member to find out how SNL members can get involved and benefit from reduced publications costs. Come to the business meeting at the end of the conference to learn more!

Karen Emmorey
Chair, Society for the Neurobiology of Language

Review Committee

Alyson Abel
Amélie Achim
F.-Xavier Alario
Lucia Amoruso
Nicolás Araneda Hinrichs
Venu Balasubramanian
Juliana V. Baldo
Karen Banai
Shari Baum
Sara Berentsen Pillay
Anna Beres
Jonathan Berken
Tali Bitan
Louisa Bogaerts
Leonardo Bonilha
Ina Bornkessel-Schlesewsky
Heather Bortfeld
Mirjana Bozic
Jonathan Brennan
Bradley R. Buchsbaum
Adam Buchwald
Sendy Caffarra
Marco Calabria
Stefano Cappa
Velia Cardin
Joanna Chen Lee
Joao Correia
Brendan Costello
Seana Coulson
Tanya Dash
Matt Davis
Angela De Bruin
Greig de Zubicaray
Isabelle Deschamps
Michele T. Diaz
Sayako Earle
Samuel Evans
Zohar Eviatar
Li-Ying Fan
Evelina Fedorenko
Roberto A. Ferreira
Christian Fiebach
Adeen Flinker
Nadine Gaab
Carolina Gattei
Ladan Ghazi-Saidi
Laurie Glezer
Sara Guediche
Thomas C. Gunter
Ayse Gürel
Arturo Hernandez
Argye Hillis
Paul Hoffman
Andreas Højlund
Tzipi Horowitz-Kraus
Nina Hsu
Maria Ivanova
Xiaoming Jiang
Katerina Danae Kandylaki
Anne Keitel
Denise Klein
Vanja Kljajevic
Sonja Kotz
Vicky Lai
Marie Lallier
Nicole Landi
Laurie Lawyer
Chia-lin Lee
Matt Leonard
Frederique Liegeois
Mairéad MacSweeney
Simona Mancini
Alec Marantz
Karine Marcotte
William Matchin
Aya Meltzer-Asscher
Lars Meyer
Nicola Molinaro
Monika Molnar
Emily B. Myers
Nicole Neef
Caroline Niziolek
Myung-Kwan Park
Kepa Paz Alonso
Jonathan Peelle
Marc Pell
Alberto Pisoni
Christos Pliatsikas
Stephen Politzer-Ahles
Liina Pylkkänen
Ileana Quinones
Jamie Reilly
Stephanie Ries
Carlos Romero-Rivas
Daniela Sammler
Mathias Scharinger
Matthias Schlesewsky
Julie Schneider
Mohamed Seghier
Wai Ting Siok
Tineke Snijders
Christina Sotiropoulou Drosopoulou
Antje Stoehr
Kristof Strijkers
Jo Taylor
Rachel Theodore
Sukru Torun
Katherine Travis
Tae Twomey
Kenny I. Vaden
Jonathan Venezia
Jane E. Warren
Kate Watkins
Nicole Wicha
Roel M. Willems
Stephen M. Wilson
Maximiliano Agustin Wilson
Zoe Woodhead
Say Young Kim
Linmin Zhang
Elana Zion-Golumbic
Anna Zumbansen

TABLE OF CONTENTS

Directors, Committees and Founders

2018 Board of Directors

Karen Emmorey Chair
San Diego State University

James Magnuson Treasurer
University of Connecticut

Clara D. Martin Secretary
Basque Center on Cognition, Brain and Language

Michal Ben-Shachar Program Committee Chair
Bar Ilan University

Angela Grant Student/Postdoc Representative
Concordia University

Manuel Carreiras Chair-Elect
Basque Center on Cognition, Brain and Language

Mairéad MacSweeney Treasurer-Elect
University College London

Brenda Rapp Secretary-Elect
Johns Hopkins University

Marina Bedny Program Committee Chair-Elect
Johns Hopkins University

Lorraine K. Tyler Past Chair
University of Cambridge

Patti Adank Past Treasurer
University College London

Matt Davis Past Secretary
MRC Cognition and Brain Sciences Unit, Cambridge

David Corina Past Meeting Liaison
University of California, Davis

Incoming 2019 Board Members

Sonja Kotz Chair-Elect
Maastricht University

Seana Coulson Treasurer-Elect
University of California, San Diego

Jamie Reilly Secretary-Elect
Temple University

Emily Myers Program Committee Chair-Elect
University of Connecticut

2018 Program Committee

Michal Ben-Shachar Chair
Bar Ilan University

Manuel Carreiras
Basque Center on Cognition, Brain and Language

Karen Emmorey
San Diego State University

James Magnuson
University of Connecticut

Clara D. Martin
Basque Center on Cognition, Brain and Language

Pascale Tremblay Local Organizer
Université Laval, Québec

2018 Nomination Committee

Joe Devlin
University College London

Heather Bortfeld
University of California, Merced

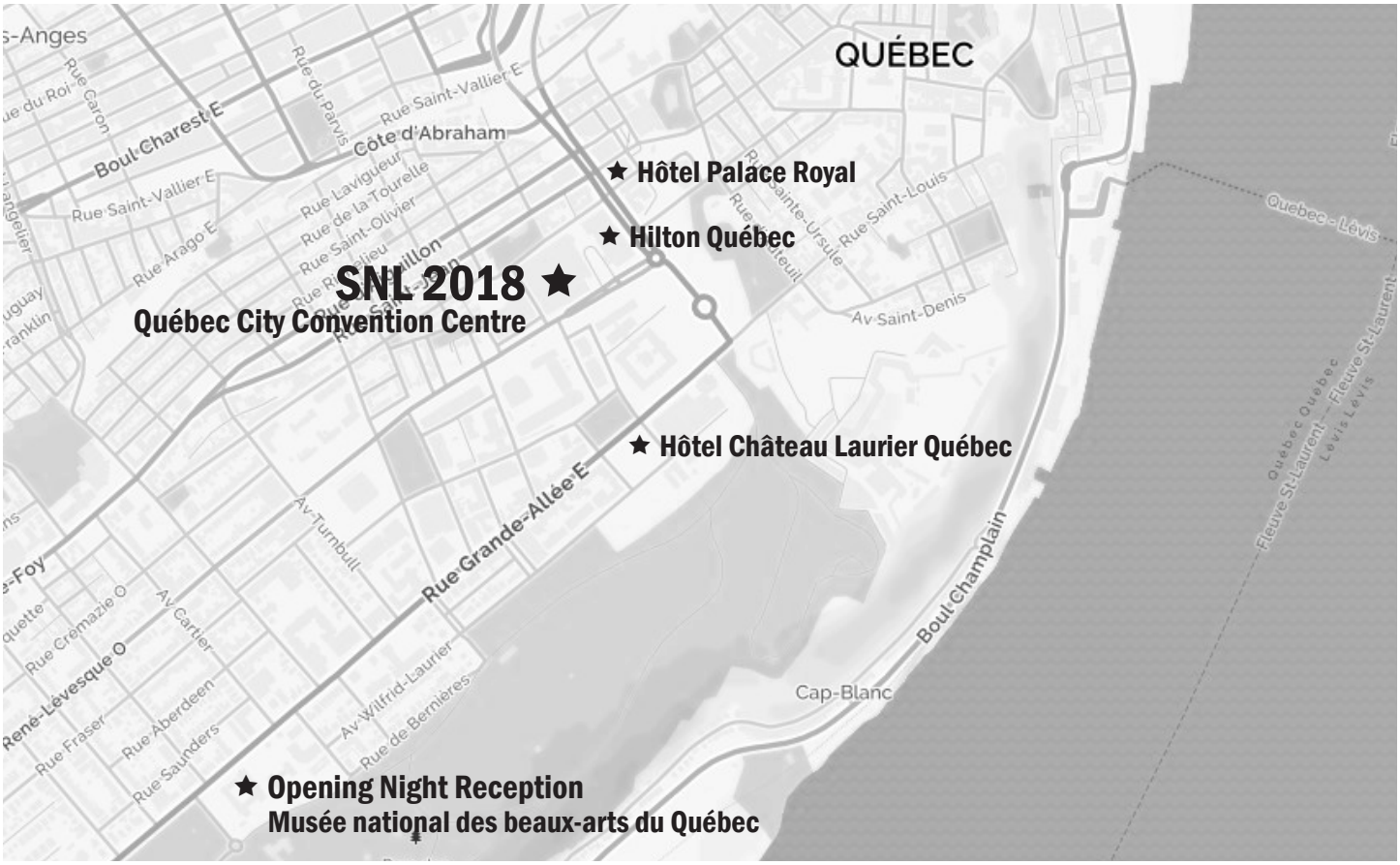
Kate Watkins
University of Oxford

SNL Founders

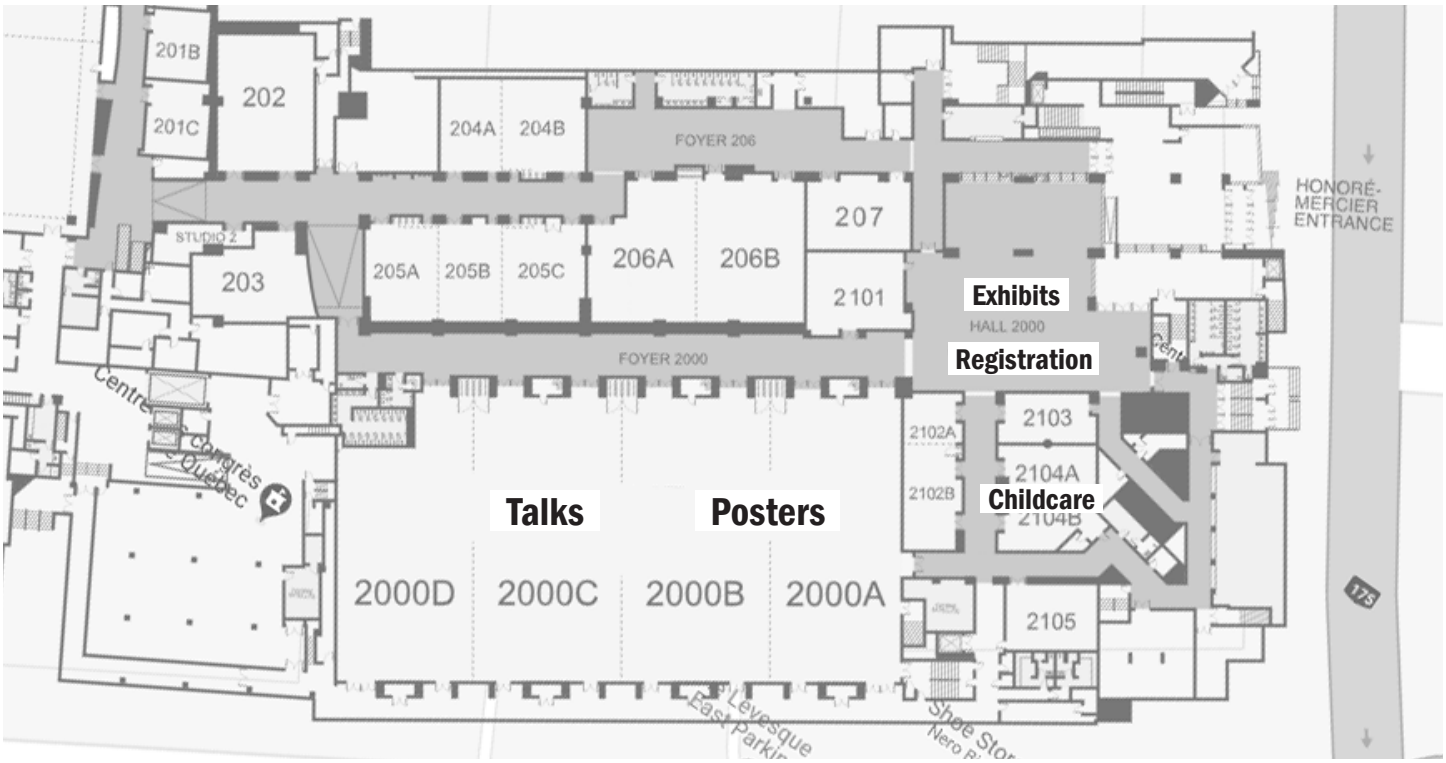
Steven L. Small
University of California, Irvine

Pascale Tremblay
Université Laval, Québec

Québec City Map



Québec City Convention Centre - Level 2



Schedule of Events

Wednesday, August 15

8:30 am – 4:30 pm	Satellite Symposium at Domaine Cataraqui *Offsite: 2141, chemin Saint-Louis*
6:30 – 7:45 pm	Public Lecture *Room 2000C*

Thursday, August 16

7:00 am – 5:45 pm	Meeting Registration *Hall 2000*
7:45 – 8:45 am	Continental Breakfast *Hall 2000*
8:00 am – 5:00 pm	Exhibits Open *Hall 2000*
8:45 – 9:00 am	Opening Remarks: Karen Emmorey *Room 2000C*
9:00 – 10:00 am	**Keynote Lecture: Robert Zatorre** Predispositions and Plasticity in Auditory-Motor Learning: Hemispheric Asymmetries *Room 2000C*
10:00– 10:15 am	Poster Slam Session A *Room 2000C*
10:15 – 10:45 am	Coffee Break *Hall 2000*
10:15 am – 12:00 pm	Poster Session A *Room 2000AB*
12:00 – 1:30 pm	Lunch (on your own)
1:30 – 2:50 pm	Slide Session A *Room 2000C*
2:50 – 3:05 pm	Poster Slam Session B *Room 2000C*
3:05 – 3:35 pm	Coffee Break *Hall 2000*
3:05 – 4:50 pm	Poster Session B *Room 2000AB*
4:50 – 5:35 pm	**Distinguished Career Award: Steven L. Small** *Room 2000C*
6:30 – 9:30 pm	**Opening Night Reception** at the Musée national des beaux-arts du Québec *Offsite: 179 Grande Allée Ouest*

Friday, August 17

7:00 am – 6:30 pm	Meeting Registration *Hall 2000*
7:30 – 8:30 am	Continental Breakfast, *Hall 2000*
8:00 am – 6:30 pm	Exhibits Open *Hall 2000*
8:30 – 9:30 am	**Keynote Lecture: Dorothee Saur** Recovery from Aphasia – Insights into Plasticity of the Language Network *Room 2000C*
9:30 – 10:15 am	**Early Career Awards: Bharath Chandrasekaran and Pascale Tremblay** *Room 2000C*
10:15 – 10:30 am	Poster Slam Session C *Room 2000C*
10:30 – 11:00 am	Coffee Break *Hall 2000*
10:30 am – 12:15 pm	Poster Session C *Room 2000AB*
12:15 – 1:40 pm	Lunch (on your own)
1:40 – 3:00 pm	Slide Session B *Room 2000C*
3:00 – 3:30 pm	Coffee Break *Hall 2000*
3:30 – 4:30 pm	**Keynote Lecture: Morten H. Christiansen** Language Evolution through the Bottleneck: From Milliseconds to Millennia *Room 2000C*
4:30 – 4:45 pm	Poster Slam Session D *Room 2000C*
4:45 – 6:30 pm	Poster Session D and Social Hour *Room 2000AB*

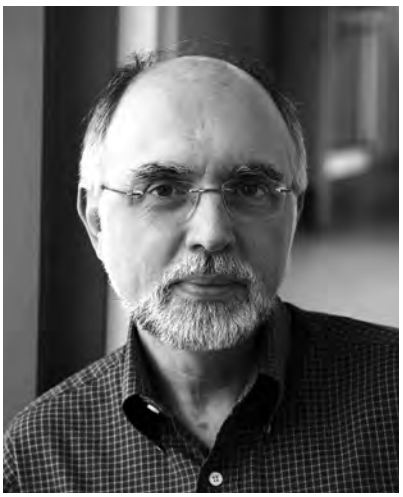
Saturday, August 18

7:30 am – 5:30 pm	Meeting Registration *Hall 2000*
7:30 – 8:30 am	Continental Breakfast *Hall 2000*
8:00 am – 3:30 pm	Exhibits Open *Hall 2000*
8:30 – 10:30 am	**Panel: Neurobiology of Language: Past, Present and Future** *Room 2000C*
10:30 – 11:00 am	Coffee Break *Hall 2000*
11:00 am – 12:20 pm	Slide Session C *Room 2000C*
12:20 – 12:30 pm	NSF Funding Opportunities: **Uri Hasson** *Room 2000C*
12:20 – 1:45 pm	Lunch (on your own)
1:45 – 2:45 pm	**Keynote Lecture: Julie Fiez** How Does the Brain Teach Itself to Read *Room 2000C*
2:45 – 3:00 pm	Poster Slam Session E *Room 2000C*
3:00 – 3:30 pm	Coffee Break *Hall 2000*
3:00 – 4:45 pm	Poster Session E *Room 2000AB*
4:45 – 5:30 pm	Business Meeting, Closing Remarks and Outlook to SNL 2019: Karen Emmorey and Manuel Carreiras *Room 2000C*

Keynote Lecture: Robert Zatorre

Robert Zatorre

Montreal Neurological Institute, McGill University



Robert Zatorre is a cognitive neuroscientist at the Montreal Neurological Institute of McGill University. His principal interests relate to the neural substrate for auditory cognition, with special emphasis on two complex and characteristically human abilities: speech and music. He and his collaborators have published over 280 scientific papers on a variety of topics including pitch perception, auditory imagery, auditory-motor integration, music and emotion, perception of auditory space, and brain plasticity in the blind and the deaf. In 2005 he was named holder of a James McGill chair in Neuroscience. In 2006 he became the founding co-director of the international laboratory for Brain, Music, and Sound research (BRAMS), a unique multi-university consortium with state-of-the art facilities dedicated to the cognitive neuroscience of music. In 2011 he was awarded the IPSEN foundation prize in neuronal plasticity, and in 2013 he won the Knowles prize in hearing research from Northwestern University. He lives in Montreal with his wife and collaborator Virginia Penhune, professor of psychology at Concordia University. He tries to keep up his baroque repertoire on the organ whenever he can get a chance.

Predispositions and Plasticity in Auditory-Motor Learning: Hemispheric Asymmetries

Thursday, August 16, 9:00 – 10:00 am, Room 2000C

Chair: Pascale Tremblay, Université Laval, Québec

Our lab has focused on music as a powerful model for understanding plasticity in a human cognitive neuroscience context. This talk will present evidence that musical training modifies auditory and motor networks, and their functional and anatomical relationships, and that important asymmetries exist across the two hemispheres in these systems. We will also discuss evidence that individual differences in learning are related to functional features that may serve as predictors of later learning success. Our goal is to develop a better model of how the large-scale organization and asymmetries of auditory-motor networks relate to the experience-dependent plasticity that underlies complex skills such as playing a musical instrument, which may also have implications for speech.

Keynote Lecture: Dorothee Saur

Dorothee Saur

University of Leipzig

Dorothee Saur serves as the Vice Chair of Neurology at the Department of Neurology, University of Leipzig. Her specialty areas are vascular and cognitive neurology. Early in her career, she started studying aphasic stroke patients with functional MRI from the acute to the chronic stage after stroke. This allowed her to identify the dynamics of language reorganisation promoting recovery from aphasia. Her research combines a broad spectrum of modern neuroimaging and non-invasive brain stimulation techniques aiming to reveal key mechanisms of brain reorganization at a systems level. As a neurologist, her dedication is to answer questions derived from her daily work with patients.

Recovery from Aphasia – Insights into Plasticity of the Language Network

Friday, August 17, 8:30 – 9:30 am, Room 2000C

Chair: Michal Ben-Shachar, Bar Ilan University

The organization of language in left-lateralized large-scale networks of closely connected and interacting brain areas in the temporal, frontal and parietal lobe allows the brain to flexibly adapt when a focal lesion hits the network. On one hand, lesions to this network may be induced by non-invasive brain stimulation such as transcranial magnetic stimulation. Although the analogy to stroke lesions is not perfect, this approach allows us to study principles of network reorganisation in a controlled lesion model in healthy subjects. On the other hand, using neuroimaging in order to map the recovery process in stroke patients with aphasia represents a unique possibility to identify mechanisms of brain repair in vivo. Synthesizing these findings in a comprehensive model of language reorganisation will, hopefully, open up new perspectives in the neurorehabilitation of stroke patients with aphasia.

Keynote Lecture: Morten H. Christiansen

Morten H. Christiansen

Cornell University, Aarhus University, Haskins Laboratories

Morten H. Christiansen is the William R. Kenan, Jr. Professor of Psychology and Co-Director of the Cognitive Science Program at Cornell University as well Senior Scientist at the Haskins Labs and Professor in Cognitive Science of Language at the School of Communication and Culture and the Interacting Minds Centre at Aarhus University, Denmark. He was the Ida Cordelia Beam Distinguished Visiting Professor at the University of Iowa (2010) and Visiting Professor at the University of Hong Kong (2012). His research focuses on the interaction of biological and environmental constraints in the evolution, acquisition and processing of language. He employs a variety of methodologies, including computational modeling, corpus analyses, statistical learning, psycholinguistic experiments, and neuroimaging. Dr. Christiansen is the author of nearly 200 scientific papers and has edited four books. His newest book, Creating language: Integrating evolution, acquisition, and processing, from MIT Press (2016), provides a comprehensive overview of his work over the past two decades. He is a Fellow of the Cognitive Science Society, the Association for Psychological Science, and the Psychonomic Society. Among his awards are a Cognitive Psychology Section Award from the British Psychological Society (2013) and a Charles A. Ryskamp Research Fellowship from the American Council of Learned Societies (2006). Dr. Christiansen delivered the 2009 Nijmegen Lectures at the Max Planck Institute for Psycholinguistics, the Netherlands, and was the inaugural keynote speaker at the Edinburgh Lectures in Language Evolution, Centre for Language Evolution, University of Edinburgh, in 2017.

Language Evolution through the Bottleneck: From Milliseconds to Millennia

Friday, August 17, 3:30 – 4:30 pm, Room 2000C

Chair: Jim Magnuson, University of Connecticut

Over the past few decades, the language sciences have seen a shift toward explaining language evolution in terms of cultural evolution rather than biological adaptation. This work has demonstrated how various nonlinguistic biases amplified by cultural transmission across generations, along with pressures from interactions between individuals within each generation, may help explain many aspects of linguistic structure observable in today's languages. Language universals, on this account, are viewed as probabilistic tendencies deriving from domain-general constraints on the nature of our thought processes, our sensori-motor apparatus, socio-pragmatic factors, and cognitive limitations on learning, memory and processing. As an illustration, I discuss the possible contribution to language evolution of a fundamental constraint on processing. During normal linguistic interaction, we are faced with an immense challenge by the combined effects of rapid input, short-lived sensory memory, and severely limited sequence memory. To overcome this Now-or-Never bottleneck, language users must learn to compress and recode language input as rapidly as possible into increasingly more abstract levels of linguistic representation. I highlight some of the key implications for theories of language acquisition and processing as well as the neurobiology of language.

Keynote Lecture: Julie Fiez

Julie A. Fiez

University of Pittsburgh

Julie A. Fiez is a Professor and Chair of Psychology, and she holds appointments in the Department of Neuroscience, Department of Communication Science and Disorders, the Learning Research and Development Center, and the Center for the Neural Basis of Cognition at the University of Pittsburgh. She received her PhD in Neuroscience from Washington University in 1992, completed a postdoctoral fellowship at the University of Iowa, and then joined the Department of Psychology at the University of Pittsburgh in 1997. Her research uses behavioral, neuropsychological, neurophysiological, and neuroimaging methods to examine the neural basis of speech, language, reading, working memory, and learning in healthy and patient populations. Dr. Fiez has received honorary awards for her research accomplishments from the Society for Human Brain Mapping and the American Psychological Association.

How does the brain teach itself to read?

Saturday, August 18, 1:45 – 2:45 pm, Room 2000C

Chair: Clara Martin, Basque Center on Cognition, Brain and Language (BCBL)

Reading is a culturally recent innovation and so it is unlikely the brain is biologically hard-wired with specialized areas devoted to this skill. This means that humans must somehow use explicit instruction and reading practice to drive neural change. For successful learners, the result is a brain in which visual word recognition occurs automatically. How does this happen? In this talk, I consider a key brain region that supports visual word recognition — the "visual word form area" — and the ways in which reading experience shapes its location and functional interactions with a broader speech and language network. I conclude by considering how the work may inform intervention efforts for struggling readers.

Panel Discussion: Neurobiology of Language: Past, Present and Future

Saturday, August 18, 2018, 8:30 – 10:30 am, Room 2000C

Moderator: Sophie Scott

Panelists: Greig de Zubicaray, Nina Dronkers, Gregory Hickok, Jeffrey Binder, Lorraine K. Tyler, Peter Hagoort, Karen Emmorey, Steven Small, Pascale Tremblay

A distinguished panel of Chairs and Founders of the Society will take a broad look at the field and its evolution over the past decade. The 10th meeting of the Society is an opportunity to take stock of what our field has achieved in the past decade and discuss the goals and aspirations for the next 10 years. Prepare your questions for the panelists and join us for this unique interactive event.

Sophie Scott
University College London

Greig de Zubicaray
Queensland University of Technology
SNL Chair 2015-2016

Nina Dronkers
VA Northern California Health Care System and University of California, Davis
SNL Chair 2014-2015

Gregory Hickok
University of California, Irvine
SNL Chair 2010-2011

Jeffrey Binder
Medical College of Wisconsin
SNL Chair 2012-2013

Lorraine K. Tyler
University of Cambridge
SNL Chair 2016-2017

Peter Hagoort
Max Planck Institute for Psycholinguistics and Radboud University, Nijmegen
SNL Chair 2013-2014

Karen Emmorey
San Diego State University
SNL Chair 2017-2018

Steven Small
University of California, Irvine
Founder of SNL
SNL Chair 2009-2010

Pascale Tremblay
CERVO Brain Research Centre, Université Laval
Founder of SNL
Meeting Organizer 2009-2010

Including a short presentation, ***SNL in Numbers***, by Svetlana Pinet and Raphaël Fargier.

Svetlana Pinet
Johns Hopkins University

Raphaël Fargier
Aix-Marseille University

Distinguished Career Award: Steven L. Small

The Society for the Neurobiology of Language is pleased to announce the 2018 Distinguished Career Award winner: Steven L. Small.

The Distinguished Career Award is generously sponsored by *Language, Cognition and Neuroscience*.

Steven L. Small

Professor of Neurology, Neurobiology & Behavior, and Cognitive Sciences, University of California, Irvine

The career of **Steven L. Small** has been fundamentally dedicated to understanding the neurobiology of language. Dr. Small completed his undergraduate training in mathematics at Dartmouth College, his Ph.D. in computer science at the University of Maryland, and his M.D. at the University of Rochester. For his dissertation, Dr. Small built a parser, reflecting an early interest in the complex rules governing human language. A neurology residency at the University of Pittsburgh developed his understanding of the brain that engenders this ability. The unique perspective afforded by this rare combination of backgrounds has caused Dr. Small to be consistently positioned at the forefront of the study of the neurobiology of language, and led to the founding of this Society, in collaboration with Dr. Pascale Tremblay.

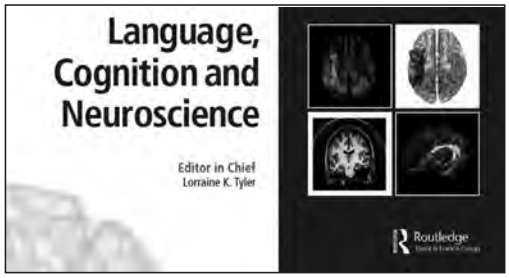
Over the past four decades, Dr. Small has made many critical scientific contributions to the neurobiology of language. These include copious work in normal language function, as well as post-stroke aphasia, and early focal brain injury. His recent work focuses on the interactions between the neural systems for controlling movement and those related to speech production and comprehension. Dr. Small's research consistently uses innovative methods to interrogate language production and processing, including multivariate structural equation models applied to observation and imitation of audiovisual speech from the level of syllables to discourse. In studies of naturalistic language comprehension, development following early stroke, and aphasia recovery, Dr. Small has used functional network analyses and graph theoretical approaches to characterize the complexity of the language system. Important advances from this work include the surprising finding of preserved network structure among language areas following pre- and peri-natal stroke. In sum, Dr. Small's scientific contributions bring us closer to understanding and modeling the neurobiology of language.

The Neurobiology of Language

Thursday, August 16, 4:50 – 5:35 pm, Room 2000C

Chair: Lorraine Tyler, University of Cambridge

The biological mechanisms of language are only beginning to be elucidated though intense interaction of behavioral and brain sciences, using advanced methods of human anatomical and physiological investigation, statistical inference, and computational modeling. This paradigm shift is not without innovation and controversy, and this talk with delve into a few examples of each.



Early Career Award: Bharath Chandrasekaran

The Society for the Neurobiology of Language is pleased to announce the 2018 Early Career Award winners: Bharath Chandrasekaran and Pascale Tremblay.

The Early Career Awards are generously sponsored by *Brain and Language*.

Bharath Chandrasekaran

Associate Professor, The University of Texas at Austin, Department of Communication Sciences & Disorders

Bharath Chandrasekaran received his Ph.D. in Integrative Neuroscience from Purdue University in 2008, and after a two-year Postdoctoral Fellowship at Northwestern University, he became an Assistant Professor in the Department of Communication Sciences and Disorders at The University of Texas at Austin, receiving tenure in 2015.

Dr. Chandrasekaran has developed two theoretical models of speech learning that are paradigm shifting. The Predictive Tuning Model argues against a corticocentric view of speech learning and proposes that top-down corticofugal connections are instrumental in selectively enhancing speech signals in challenging listening environments and during auditory learning. His dual learning systems (DLS) model proposes two dissociable cortico-striatal neural streams that are active during learning: a sound-to-rule mapping 'reflective' system, wherein processing is under conscious, deliberative control, and a sound-to-reward mapping 'reflexive' system that is not under conscious control. His most recent research examines the impact of non-invasive peripheral nerve stimulation on language learning in adults. Dr. Chandrasekaran has published 60 peer-reviewed papers (17 in the last two years), and his work was recently highlighted in Scientific American. His publications and collaborative research projects cover the entire gamut of neuroimaging approaches: EEG, fMRI, electrocorticography, neuromodulation via peripheral nerve stimulation, and near-infrared spectroscopy.

In addition to his rich research contribution, Dr. Chandrasekaran serves as the Editor-in-Chief of the Journal of Speech, Language, and Hearing Research (Speech section), and he is a standing member of the NIH Language and Communication (LCOM) panel. During his early career, Dr. Chandrasekaran has demonstrated continued excellence in research and is an exceptional academic citizen.

Corticostriatal Systems in Speech Categorization

Friday, August 17, 9:30 – 9:55 am, Room 2000C

Chair: Karen Emmorey, San Diego State University

Speech sounds are multidimensional, acoustically variable, and temporally ephemeral. Despite the enormous computational challenge, native speech perception is rapid and automatic. Over the last decade, we have made substantial progress in understanding the cortical mechanisms underlying mapping of speech onto meaning (ventral pathway) and articulation (dorsal pathway). The dorsal and ventral streams are useful points of reference to understand the processing of native speech signals. The primary goal of this talk is to elucidate mechanisms underlying how novel speech categories are acquired and represented in the mature brain. I will discuss a novel theoretical framework, the dual-learning systems (DLS) model that characterizes the neurobiology of two complementary corticostriatal streams involved in **sound-to-rule** and **sound-to-reward** mapping. I test the premise that temporal lobe circuits are trained by the dual corticostriatal circuits to incorporate dimensional rules (via the sound-to-rule stream), multidimensional integration (via the sound-to-reward stream), ultimately leading to automatic, and abstract neural representations related to categories. Our systems neuroscience approach delineates the role of multiple, functionally distinct corticostriatal loops in speech and language processing and provides a scaffolding for evaluating the impact of striatal dysfunction in individuals with communication disorders

Early Career Award: Pascale Tremblay

Pascale Tremblay

Assistant Professor, Université Laval, Québec, Canada

Pascale Tremblay received her Ph.D. in Communication Sciences and Disorders in 2009 from McGill University. The same year, with Dr. Steven Small, she co-founded the Society for the Neurobiology of Language. She organized the Society´s first two meetings in Chicago (2009) and in San Diego (2010), and later remained involved with the Society as elected Treasurer from 2013 to 2016. This year she is the local organizer for the 10th anniversary meeting.

After completing two postdoctoral periods at the University of Chicago and at the Università degli Studi di Trento in Italy, she joined the Speech-language pathology program at Université Laval in 2011 as an Assistant Professor. In 2014, she became the co-director of the CINQ, a group that promotes and facilitates brain imaging research at Université Laval through diverse scientific activities. She was promoted to Associate Professor in 2016. Dr. Tremblay has made significant contributions in the areas of speech motor control, speech perception and the "language connectome," using multimodal brain imaging and non-invasive brain stimulation. She has also made significant contributions to understanding the impact of aging on the aforementioned neurobiological processes and the neural structures with which they are associated. Dr. Tremblay's productivity has been impressive, with 50 publications including 41 peer-reviewed articles (19 of which published in the past three years). She has also been successful in obtaining research funds from foundations and several funding agencies in Canada and the United States.

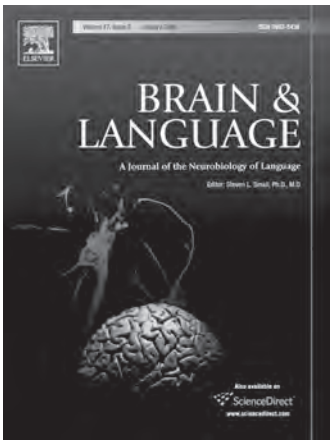
Dr. Tremblay's research interest stem from a view that speech and language are a highly evolved communicative behavior that rely on neurobiological mechanisms shared with a wide range of human behaviors. Dr. Tremblay has a strong research interest in uncovering and identifying the manner in which generalized neural functions engage specialized mechanisms associated with the flexible and complex variations that give each behavior its own identity.

Studying the Aging of Speech Functions

Friday, August 17, 9:55 – 10:15 am, Room 2000C

Chair: Karen Emmorey, San Diego State University

The ability to produce and perceive speech forms the building blocks of human communication. The complexity of the neural networks that support speech functions, and its important ties with other functional systems, is increasingly recognized in the scientific community. Yet, despite the importance of speaking, communication and social interactions, little is known about the sensorimotor and cognitive mechanisms that underlie age-related changes in speech perception and production and how they affect communication and well-being. In this talk, I will present recent work from my lab that explored the organisation of the neural speech systems, and the impact of aging on speech functions using behavioural and multimodal brain imaging techniques. I will describe the neurobiological mechanisms that underlie these changes, focusing on neuroplasticity. I will also briefly touch on our recent work on singing as a modifier of normal aging. Understanding how the speech network evolve throughout the lifespan is a timely scientific challenge that holds implications for preventive medicine and rehabilitation.



Merit Awards

The Society for the Neurobiology of Language Abstract Merit Awards are given to the students and postdocs who submitted the highest ranked abstracts.

M. Florencia Assaneo New York University, USA

Florence Bouhali University of California, San Francisco, USA

Emilie McKinnon Medical University of South Carolina, USA

Travis White-Schwoch Northwestern University, USA

Honorable Mention

Lisa Bruckert Stanford University, USA

Seyedehrezvan Farahibozorg University of Cambridge and University of Oxford, UK

Sivan Jossinger Bar-Ilan University, Israel

Han Gyol Yi University of California, San Francisco, USA

Travel Awards

This year, the Society for the Neurobiology of Language granted 23 Travel Awards. The awards, funded by the National Institutes of Health (NIH), help to cover travel and registration costs for the 2018 Society for the Neurobiology of Language Meeting in Québec City.

Through the Travel Awards, SNL aims to encourage and foster the participation of junior scientists who are members of underrepresented groups.

The 2018 Travel Award winners are:

Beatriz Barragan Arizona State University, USA

Mahsa Barzy University of Kent, UK

Jennifer Chesters Oxford University, UK

Jessica de Leon University of California, San Francisco, USA

Heather Dial The University of Texas at Austin, USA

Giulia Elli Johns Hopkins University, USA

Andrea Gajardo Vidal University College London, UK

Sandra Gisbert-Muñoz Universidad del País Vasco, Spain

Brenda Guerrero Texas A&M International University, USA

Laura Gwilliams New York University, USA

Jungna Kim CUNY, USA

Jixing Li Cornell University, USA

Diego Lorca-Puls University College London, UK

Barbara Marebwa Medical University of South Carolina, USA

Suhail Matar New York University, USA

Meghan McGarry San Diego State University, USA

Andrea Olguin University of Cambridge, UK

Lorelei Phillip University of South Carolina, USA

Alexandra Reyes Texas A&M International University, USA

Marybel Robledo Gonzalez Children's Hospital Los Angeles, USA

Zed Sevcikova Sehyr San Diego State University, USA

Neelima Wagley University of Michigan, USA

Bradley White Gallaudet University, USA

Public Lecture

Wednesday, August 15, 6:30 - 7:45 pm, Room 2000C

Chairs: Pascale Tremblay and Steven Small

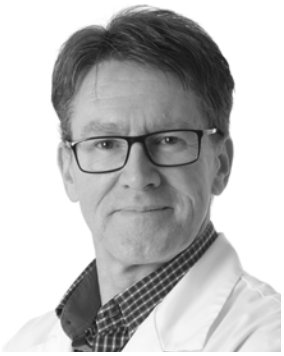
This year, for the first time, SNL will be hosting a public lecture on the neurobiology of language. The goal of this new initiative is to raise awareness to issues related to the neurobiology of language among the population of the host city, and to disseminate the products of research in our field to the general public.

This year's lecture will focus on the topic of language disorders in neurodegenerative disorders. Because this event is targeting the local population, **it will be offered in French**, the official language in Québec City. The lecture will feature two experts in neurodegenerative disorders, Dr. Robert Laforce and Dr. Joël Macoir.

Au-delà de la mémoire: Comprendre les troubles qui affectent le langage dans la démence

[Beyond memory: understanding language disorders in dementia]

Neurodegenerative disorders constitute a silent epidemic that is threatening the world's population health. Although these diseases are most often described in terms of their impact on the memory and motor systems, they are also frequently associated with speech and language disorders, a lesser known, but very important aspect of these diseases, and one that has a huge impact on the quality of life of the patients. Early screening of speech and language disorders is key to treating these symptoms, as well as raising the awareness of the patients and their families about these disorders and how to deal with them. In this lecture, the issue of language disorders in dementia will be discussed from a dual perspective, neurology and speech-language pathology, to offer a comprehensive overview of the phenomenon and related issues.



Robert Laforce, PhD, MD

Neurologist and Neuropsychologist
Associate Professor
Faculty of Medicine
Université Laval
Clinique Interdisciplinaire de Mémoire, CHU de Québec

Noémie Auclair-Ouellet, PhD

Speech-Language Pathologist, Assistant Professor, School of Communication Sciences & Disorders, McGill University, Centre for Research on Brain, Language and Music (CRBLM)

This event is organized by SNL, in collaboration with the CINQ, the CERVO Brain Research Foundation and the Québec City Convention Centre.

Fondation CERVO RECHERCHE ENSEIGNEMENT SOINS

cinq Consortium d'imagerie en neurosciences et santé mentale de Québec

CENTRE DES CONGRÈS DE QUÉBEC

Attendee Resources

ATM

There are two ATMs within the Convention Centre. They are located near the main entrance at 1000 boul. (Banque Scotia and Desjardins). The two nearest ATMs outside of the Convention Centre are a BMO, located in Hotel Palace Royal (400 m – 4 min walk), 775 Avenue Honore-Mercier, Quebec, QC G1R6A5, and an ATM at "Caisse Populaire Desjardins" (500 m – 5 min walk), 550 Rue Saint-Jean, Québec, QC G1R 3C6. In addition, there are several ATMs located in nearby financial institutions.

Abstracts

The full text of poster and slide abstracts can be found in the SNL 2018 Abstracts Book, which can be downloaded in PDF format from www.neurolang.org.

Audio-Visual

An LCD projector (e.g., for PowerPoint presentations) will be provided in Room 2000C; however, computers are NOT provided. Presenters must bring their own computers and set them up BEFORE the start of the session in which they are presenting. Presenters must arrive at Room 2000C a minimum of 30 minutes before their talk.

Business Center

The Business Center is located on Level 3 of the Québec City Convention Centre.

Business Meeting

The SNL Business Meeting is Saturday, August 18th at 4:45 pm. All SNL members are encouraged to attend. This is your opportunity to hear about SNL, ask questions, and give feedback.

Certificate of Attendance

To receive a Certificate of Attendance, please visit the Registration Desk. If you require any changes, we will be happy to email or mail a copy after the meeting (info@neurolang.org).

Childcare

Thanks to generous funding from the National Institutes of Health, SNL is pleased to offer free onsite childcare as part of the 2018 meeting! Childcare will allow you to enjoy the scientific program and time with colleagues, while the little ones create their own fun memories in Québec City.

This year, we have contracted with the highly recommended La Garderie Mobile, a Québec-based provider of professional child care services. La Garderie Mobile has a reputation for experience and professionalism. Activities will include age appropriate arts and crafts, educational activities, interactive games, and much more!

Childcare will be offered free of charge for children 0-12 years of age. Spaces are limited and will be filled on a first-come, first-served basis.

Childcare is in Room 2104. To reserve a spot, please see the Registration Desk.

Childcare Schedule

Thursday, August 16th, 8:30 am – 5:45 pm
Friday, August 17th, 8:15 am – 6:45 pm
Saturday, August 18th, 8:15 am – 5:45 pm

Code of Conduct

The Society for the Neurobiology of Language is committed to providing a safe and professional environment during our annual meeting. All attendees are expected to conduct themselves in a professional manner. It is unlawful to harass any person or employee because of that person's gender, sexual orientation or race. In addition, we require that all questions and comments to speakers and poster presenters be respectful and collegial. Verbal aggression will not be tolerated.

Contact Us

To contact us onsite, visit the Registration Desk, or send an email to info@neurolang.org. We will respond to your email at our earliest opportunity.

Copying, Printing and Office Supplies

A Business Center is located on Level 3 of the Convention Centre. The Business Center has photocopying and printing services, as well as internet workstations and cell phone charging stations. Computers are also available in the Hall 2000 Foyer.

Disclaimer

The SNL Program Committee reserves the right to make changes to the meeting program at any time without notice. This program was correct at the time of printing.

Exhibits

All Exhibits are located in Hall 2000.

Exhibit Hours

Thursday, August 16, 8:00 am – 5:00 pm
Friday, August 17, 8:00 am – 6:30 pm
Saturday, August 18, 8:00 am – 3:30 pm

Food Service

The Convention Centre is part of a complex that hosts two restaurants, Le Subtil and La Prep. In addition, light meals are available at Le Lounge restaurant and the Petit Café. A convenience store is also located in the complex. See the Restaurant section below for more information.

Complimentary food and beverage service is available to all registered attendees at the times below. All food and beverage is served in Hall 2000.

Thursday

Continental Breakfast, 7:45 – 8:45 am
Coffee Break, 10:15 – 10:45 am
Afternoon Coffee, 3:05 – 3:35 pm
Opening Night Reception, 6:30 - 9:30 pm (offsite)

Friday

Continental Breakfast, 7:30 – 8:30 am
Coffee Break, 10:30 – 11:00 am
Afternoon Coffee, 3:00 – 3:30 pm
Social Hour and Celebration, 4:45 - 6:30 pm

Saturday

Continental Breakfast, 7:30 – 8:30 am
Coffee Break, 10:30 – 11:00 am
Afternoon Coffee, 3:00 – 3:30 pm

Future Meetings

SNL 2019 will be held August 20 - 22 in Helsinki, Finland.

Guest Policy

Guests are allowed complimentary entry into one SNL session (for the purpose of seeing the poster or slide of the person they are a guest of). Guests are welcome to attend the Opening Night Reception.

Guests must register at the SNL Registration Desk upon arrival and must be accompanied by the SNL attendee. Guests must wear a badge for entrance into the session they are attending.

Interpreters

We are very pleased to provide an ASL interpreter service this year. Should you request assistance, please visit the Registration Desk.

Internet Access

Internet access is free throughout the Québec City Convention Centre. Free WiFi is also available in the Desjardins Promenade outside the Centre.

Lost & Found

Please check with the SNL Registration Desk for lost and found items.

Meeting Rooms

All general sessions (Keynotes, Award Talks, Slides, Slams, and the Panel Discussion) will be held in Room 2000C. Posters will be presented in Room 2000AB.

Messages

A bulletin board will be available for messages and job postings near the SNL Registration Desk.

Mobile Phones

Attendees are asked to silence their mobile phones when in sessions.

Musée de la Civilisation

Upon presentation of your SNL badge, receive a 15% discount from August 16th through 18th to visit the Musée de la Civilisation de Québec, 16, rue de la Barricade, Québec (QC) G1K 8W9 Canada. You can either walk to the museum or take a taxi or a city bus.

Name Badges

For security purposes, all attendees must wear their name badges to all sessions and social functions. Entrance into sessions is restricted to registered attendees only. If you misplace your name badge, please go to the Registration Desk for a replacement.

Parking

A pedestrian tunnel links the Québec City Convention Centre to four indoor parking lots. The lots are managed by Indigo and Société Parc-Auto du Québec.

Phone Charging Station

For your convenience, a phone charging station is located at the Registration Desk.

Poster Sessions

Posters are located in Room 2000AB. Poster Slam Sessions are located in Room 2000C.

Public Transportation

Get around safely and sustainably with Réseau de transport de la Capitale (RTC), Québec City's public transit system. The cost for one bus ride is $3.5 CAD. You can pay with exact change when you board the bus, or you can buy a pass that allows for unlimited travel on weekends or for five consecutive days—a very handy way to get around the city during the meeting.

There is an RTC office right across from the Convention Centre on 884 rue Saint-Joachim where you can purchase tickets and passes and gather information.

To get to the airport by bus, take Bus Route #78 offered by Réseau de transport de la Capitale (RTC), which serves the Québec City Jean Lesage International Airport, Monday through Friday (in the early morning from the terminus Les Saules and in the late afternoon to the terminus Les Saules).

Given the Convention Centre's terrific location amidst major hotels and steps away from Old Québec, walking is always a great active transportation option.

Registration

The SNL Registration Desk is located in Hall 2000 at the Québec City Convention Centre. The Registration Desk hours are:

Thursday, August 16, 7:00 am – 5:45 pm
Friday, August 17, 7:00 am – 6:30 pm
Saturday, August 18, 7:30 am – 5:30 pm

Restaurants in Québec City

Québec City is quite the foodie's paradise. The Convention Centre is just minutes away from dozens of restaurants of every kind and price range. Home to French restaurants, microbreweries, bistros, sidewalk cafés and much more, the city has earned an outstanding reputation for its innovative cuisine, fine regional products, and creative artisans and chefs.

The Convention Centre is part of a complex that has two restaurants, Le Subtil and La Prep, as well as a convenience store. In addition, light meals are available at Le Lounge restaurant and the Petit Café.

During the lunch break on Thursday, the SAGA Nomade food-truck, which is associated with the prestigious La Sagamité restaurant will be available on the Promenade Desjardins (in front of the Centre's main entrance). The food-truck features popular French Canadian cuisine, including:

- **Poutine** This popular poutine is garnished with thyme confit guinea fowl, gouda grain, onion crisp and mushroom mayonnaise.
- **Elk Burger** Served with Oka cheese, onion confit and spicy mayonnaise.
- **Deer Burrito** Garnished with mozzarella cheese, chopped salad and fresh tomatoes.
- **Bison Sandwich** Homemade smoked bison sandwich with melting Swiss cheese and truffle mayonnaise.

If you'd like to go out for lunch, but want to keep it relatively quick, we have negotiated special rates at La Scala and Café Sirocco, two popular restaurants that are within walking distance from the Convention Centre. Both are located nearby Cartier Avenue, one of the most popular streets in Québec City. Cartier Avenue is a small street with shops and restaurants that are praised by locals and visitors alike. Both La Scala and Café Sirocco have agreed to make sure that you can be in and out in an hour or less to be back in time for the meeting!

2 km from the Convention Center, Nicky Sushi is offering SNL attendees a 10% discount upon presentation of your SNL badge. Nicky Sushi is located at 311, chemin de la Canardière, Limoilou, G1L 2V1, Québec, QC.

Shipping

To ship your poster or other items home from the meeting, ask for the Concierge, located on the 3rd floor of the Québec City Convention Centre.

Sightseeing and Guided Tours of Québec City

The Concierge, located on Level 3 of the Québec City Convention Centre, can help you with making arrangements for sightseeing and guided tours, as well as recommend restaurants and shows.

Smoking

Smoking, including the use of e-cigarettes, is not permitted inside the Québec City Convention Centre. According to the provincial law, you may not smoke within nine metres of the door to a public place where smoking is usually forbidden. This rule also applies near the windows and air-intake ducts of these places.

Social Events

Opening Night Reception at the Musée national des beaux-arts du Québec

Join your colleagues on Thursday, August 16 at 6:30 pm for an elegant evening of food, drinks and stimulating conversation against the backdrop of one of Canada's premier collections of fine art. The Musée national des beaux-arts du Québec is a short, picturesque stroll from the Québec City Convention Centre.

You can walk from the Convention Centre to the Museum. The distance is 1.4 KM, about 15 minutes.

You can also take a bus to the Museum. The fastest

itinerary would be to board Bus #11 at the Convention Centre, which will take you right to the Museum.

For guests needing extra assistance in getting to the event, please contact the SNL Registration Desk.

Friday Evening Social Hour

Attendees are invited to enjoy a special Social Hour in Room 2000AB during the Friday evening poster session.

Social Media

Join the SNL discussion on Twitter!

Follow @SNLmtg for meeting information.
Follow SNL colleagues (like @kemmorey1)
Tag meeting-related tweets with #snlmtg18
Join in the conversation by searching for tweets tagged #snlmtg18

Speakers

Please report to Room 2000C at least thirty minutes before the start of your session. Upon request at the Registration Desk, a speaker ready-room with a computer will be made available for testing your presentation. See Audio-Visual.

Taxi

Taxis can be used to get around the city. The cost is the same whether you call the company or hail a cab from the street. From the YQB terminal to downtown Québec City or from downtown Québec City to YQB, a taxi ride will cost approximately $34.25 CAD (≈$28 USD, 22 Euros).

The following is a list of some of the taxi companies that serve both the airport and the city:

Taxi Coop Québec (418-525-5191)
Taxi Coop Sainte-Foy-Sillery (418-653-7777)
Taxi Laurier (418-651-2727)

Uber

Uber is available within Québec City, as well as at Québec City Jean Lesage International Airport.

National Science Foundation Funding

Saturday, August 18, 12:20 - 12:30 pm, Room 2000C

The National Science Foundation funds research related to the neurobiology of language through its Cognitive Neuroscience, Linguistics, Perception-Action-and-Cognition, Developmental Sciences and Science of Learning programs. Dr. Uri Hasson (Program Director, Cognitive Neuroscience) will present funding opportunities. Attendees are welcome to contact him in advance to arrange a meeting (uhasson@nsf.gov).

Sponsors

The Society for the Neurobiology of Language thanks the following companies for their support of our 2018 meeting. Please visit our exhibitors in the Room 2000AB.

National Institutes of Health Major Sponsor

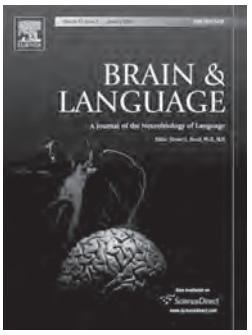
The 10th meeting of the Society for Neurobiology of Language is generously supported by the National Institutes of Health (R13 grant #DC011445). The NIH has been supporting SNL meetings by sponsoring travel grants to under-represented minorities, daycare services, sign language interpreting services and more, thus enhancing the accessibility of the meetings to various audiences. We are extremely grateful to the NIH for its generous support of SNL meetings over the years.

Rogue Research Inc. Gold Sponsor

Rogue Research, developers of the Brainsight® family of neuronavigation products, has been providing neuroscience researchers with best in class tools for over 18 years. Brainsight TMS is used in more than 500 labs and is the most popular image-guided TMS system. Our new cTMS stimulator gives you more control over the pulse shape than any other TMS device available. Our Brainsight NIRS imaging system combines our navigator with our multi-modality friendly NIRS device for combined NIRS and EEG, EMG, MRI, MEG or tDCS.

Brain & Language (Elsevier) Award Sponsor

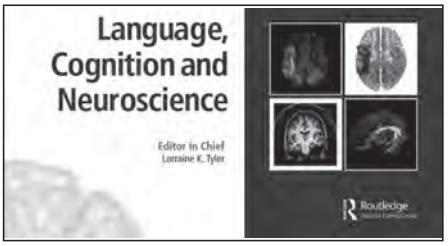
Sponsor of the SNL Early Career Awards



An interdisciplinary journal, *Brain & Language* focuses on the neurobiological mechanisms underlying human language. The journal covers the large variety of modern techniques in cognitive neuroscience, including lesion-based approaches as well as functional and structural brain imaging, electrophysiology, cellular and molecular neurobiology, genetics, and computational modeling. All articles must relate to human language and be relevant to an elaboration of its neurobiological basis. Along with an emphasis on neurobiology, journal articles are expected to take into account relevant data and theoretical perspectives from psychology and linguistics.

Language, Cognition and Neuroscience (Routledge) Award Sponsor

Sponsor of the SNL Distinguished Career Award



Language, Cognition and Neuroscience publishes high-quality papers taking an interdisciplinary approach to the study of brain and language, and promotes studies that integrate cognitive theoretical accounts of language and its neural bases. The Journal publishes both high quality, theoretically-motivated cognitive behavioural studies of language function, and papers which integrate cognitive theoretical accounts of language with its neurobiological foundations.

Local Sponsors

Québec City Business Destination

Québec City Business Destination is the city's official convention bureau. It aims to drive business tourism and facilitate North American and international conferences in Québec City. It provides support to individuals and groups interested in organizing conferences in the form of grants and consulting services. The Québec City Business Destination is in charge of the Québec City's Ambassadors' Club, founded in 1996, which offers one-stop consulting services that provide tools, resources, and financial support to local experts and industry leaders looking to organize North American and international conferences in Québec City. It brings together 150 influential and dedicated ambassadors who have organized a conference or have a viable project underway.

Quebec bio-imaging network (QBIN)

Founded in 2008, the **QBIN** is a provincial network of researchers, clinicians and students that promote and facilitate the development of high quality, innovative and collaborative research in the field of bioimaging in the province of Quebec. Funded by the "Fonds de la Recherche du Québec en Santé (FRQS)", the QBIN's mission is to support bioimaging research aimed at uncovering normal and pathological functioning in humans using human and animal models and through the development of innovative image acquisition techniques and advanced post-acquisition processing methods. The QBIN plays an important part in fostering bioimaging research in the province of Québec through various grant programs, student scholarships and support to scientific activities throughout the province including scientific talks, workshops and public lectures.

Université Laval, Office of the Vice Rector of Research and Innovation

Université Laval (UL) is the first French-language university in the Americas. Located in Québec City, UL hosts about 43,000 students each year, of which 25% are graduate students. UL is a carbon-neutral institution that is committed to sustainable development and contributing to community well-being. The UL Office of the Vice Rector of Research and Innovation bears executive responsibility for developing research and innovation activities and establishing general policies in matters of research and innovation. Finally, the Vice Rector sees to the sound management of intellectual property derived from the commercialization of university research.

Mrs. Hélène David, Minister responsible for Higher Education and for the Status of Women

Québec's parliamentary system, which is based on cooperation between the legislative body (Parliament) and the executive body (government), is modelled on the British Westminster parliamentary system. The Premier is the head of the political party with the most elected members after a general election. The Government is composed of several departments and agencies. The mission of the **Ministère de l'enseignement supérieur**, [higher education], headed by Mrs David, one of the Government's most important department, under its constituting Act, is to carry out its activities in the areas of preschool, elementary and secondary school, college and university education, research, student financial assistance, and recreation and sports. Mrs. David is a member of the Québec Liberal party.

André Drolet
Deputy for Jean-Lesage, member of the Quebec Liberal Party
Parliamentary Assistant to the Minister for Small and Medium Enterprises, Regulatory Streamlining and Regional Economic Development

Opening Night Reception

Thursday, August 16, 6:30 – 9:30 pm

Musée national des beaux-arts du Québec
179 Grande Allée Ouest
Québec (Québec) G1R 2H1, Canada

SNL invites you to our Opening Night Reception at the world-renowned Musée national des beaux-arts du Québec. Join your colleagues for an elegant evening of food, drinks and stimulating conversation against the backdrop of fine arts and Québec traditional music.

For our student and postdoctoral researchers, this year's reception will include a structured networking opportunity to develop lateral connections by meeting other students and postdocs. Look for the "Gotta Catch 'Em All: Scientist Edition" worksheet at the reception welcome table; all students and postdocs who complete it will receive a free SNL 10th anniversary notebook courtesy of the Québec Bio-Imaging Network.

Located in Québec City, a world heritage site, the Musée's four pavilions are situated in the heart of the magnificent National Battlefields Park: the Gérad Morisset pavilion (the original museum, 1933), the central pavilion (built in 1991), the Charles Baillairgé pavilion (a prison dating from 1867) and the new Pierre Lassonde pavilion, giving the Musée a street-front presence on one of the city's main arteries, the Grande Allée. Designed by OMA New York in association with Provencher_Roy, this building enabled the Musée to nearly double its floor space and to display its contemporary art, design and Inuit art collections.

The reception will be hosted in the new Pierre Lassonde pavilion, located on the marvellous Grande Allée, which is the gateway to the Musée. The building's architecture is harmoniously tiered with generous exhibition spaces: six exhibition galleries for the display of post-1960 collections, two temporary exhibition galleries and three permanent exhibition galleries (contemporary art, Inuit art and decorative arts and design).

You can walk from the Convention Centre to the Museum. The distance is 1.4 KM, this should take you about 15 minutes. You can also take a bus to the Museum. The fastest itinerary would be to take bus #11 at the convention center, which will take you right to the Museum. For guests needing extra assistance getting to the event, please contact the SNL Registration Desk.

Friday Night Social Hour and 10th Anniversary Celebration

Friday, August 17, 4:45 – 6:30 pm, Room 2000AB

Join us in the foyer for some Prosecco and cake to celebrate the 10th anniversary of our Society's annual meeting, an exciting journey than began in Chicago in 2009.

Slide Sessions

Slide Session A

Thursday, August 16, 1:30 – 2:50 pm, Room 2000C

Chair: Manuel Carreiras

Speakers: M. Florencia Assaneo, Albert Costa, Han G. Yi, Jennifer Chesters

1:30 pm

A1 Spontaneous synchronization to speech reveals neural mechanisms facilitating language learning *M. Florencia Assaneo[1], Pablo Ripolles[1], Joan Orpella[2,3,4], Ruth de Diego-Balaguer[2,3,4,5], David Poeppel[6]; [1]Department of Psychology, New York University, [2]Cognition and Brain Plasticity Unit, IDIBELL, [3]Department of Cognition, Development and Educational Psychology, University of Barcelona, [4]Institute of Neuroscience, University of Barcelona, [5]ICREA, [6]Neuroscience Department, Max-Planck Institute for Empirical Aesthetics, Frankfurt*

The ability to synchronize a motor output to an auditory input is a basic trait present in humans from birth with important cognitive implications. Infants' proficiency in following a beat, for example, is a predictor of language skills. From a phylogenetic perspective, spontaneous synchronization (i.e. without explicit training) to an external rhythm is argued to be a unique characteristic of vocal learning species, including humans. The study of this distinctive attribute has typically focused on how body movements are entrained by non-speech signals - e.g. music or a beat. Here, instead, we investigate how humans spontaneously align their speech motor output to auditory speech input. To begin with, we introduce a simple behavioral task, where individuals simultaneously perceive and produce syllables, with a remarkable outcome. The general population shows two qualitatively different behaviors: while some individuals are compelled to temporally align their utterances to the external stimulus, others show no interaction between the perceived and produced rhythms. Subsequently, we investigate the neurophysiology and brain structure features underlying the segregation. First, with a magnetoencephalography protocol we show that, when passively listening to speech, synchronizers show increased brain-to-stimulus alignment over frontal areas as well as reduced rightward asymmetry in auditory cortex. Secondly, using diffusion weighted MRI technique, we find a distinct lateralization pattern in a white matter cluster -likely part of the arcuate fasciculus, pathway connecting frontal and auditory areas- that differentiated the groups, with synchronizers showing significantly greater left lateralization. Crucially, this structural difference relates to both the auditory and frontal neurophysiological results: increased leftward lateralization in the white matter was related to higher brain-to-stimulus synchrony in left frontal regions and to more symmetrical auditory entrainment. Finally, we demonstrate that the behavioral findings on audio-motor synchronization and its neural substrate have ecologically relevant consequences: the synchronizers perform better on a word learning task. In summary, the combined behavioral, neurophysiological, and neuroanatomic results reveal a fundamental phenomenon: whereas some individuals are compelled to spontaneously align their speech output to the speech input, others remained impervious to the external rhythm. Moreover, we show a deceptively simple behavioral task capitalizing on individual differences that turns out to be diagnostic of audio-motor synchronization, neurophysiological function, brain anatomy, and performance on a word-learning task. The use of such a test can help to better characterize individual performance, leading to new discoveries related to speech processing and language learning that could have been masked by pooling together populations with substantially different neural and behavioral attributes.

1:50 pm

A2 Active bilingualism as a cognitive reserve factor against cognitive decline *Albert Costa[1,2], Marco Calabria[1], Mireia Hernández[1], Gabriele Cattaneo[1], Mariona Serra[1], Anna Suades[3], Montserrat Juncadella[3], Ramon Reñé[3], Isabel Sala[4], Alberto Lleó[4], Jordi Ortiz-Gil[5], Lidia Ugas[5], Asunción Ávila[6], Isabel Gómez Ruiz[6], César Ávila[7]; [1]Center for Brain and Cognition, Pompeu Fabra University, Barcelona, Spain, [2]Institució Catalana de Recerca i Estudis Avançats (ICREA), Barcelona, Spain, [3]Hospital Universitari de Bellvitge, L'Hospitalet de Llobregat, Barcelona, Spain, [4]Neurology Department, Hospital de la Santa Creu i Sant Pau, Barcelona, Spain, [5]Hospital General de Granollers, Barcelona, Spain, [6]Consorci Sanitari Integral, Barcelona, Spain, [7]Departamento de Psicología Básica, Clínica y Psicobiología, Universitat Jaume I, Castelló de la Plana, Spain*

Introduction. There is growing evidence that bilingualism acts as cognitive reserve (CR) factor in older adults and age-related disorders. In this study we investigated the underlying cognitive and neural mechanisms which might explain such a bilingual advantage in the context of CR. Under the hypothesis that active bilingualism may lead to an advantage on cognition, we tested the efficiency of executive control (EC), attention and episodic memory in two groups of bilinguals: a) bilinguals who actively used their two languages; b) passive bilinguals (people that understand two languages but that basically speak only one of them). Also, structural neuroimaging data was acquired and compared between these two types of bilinguals. Methods. We tested three groups of participants: healthy older adults, patients with Alzheimer's disease (AD) and patients with Mild Cognitive Impairment (MCI). 'Active' bilinguals were early and high proficient Catalan-Spanish bilinguals, they had a high frequency

of use of their L2, and they switched between languages in their everyday life. 'Passive' bilinguals were Spanish speakers with exposure to Catalan (L2) and low use of their L2. 260 participants were tested in four EC tasks and episodic memory and from 140 participants we collected neuroimaging data. Results. Three main results were observed. First, active bilingualism delays the symptoms of cognitive impairment in MCI, independently of education and other CR factors such as leisure activity and job attainment. Second, active bilinguals outperformed passive bilinguals only in tasks of conflict monitoring. Third, active bilinguals with MCI showed more atrophy on the temporal lobe than passive ones, suggesting that they have to suffer a greater amount of cerebral atrophy to have cognitive decline as compared to passive bilinguals. Conclusions. These findings add new evidence that bilingualism acts as a CR factor, also in the preclinical stage of dementia. Specifically, age of L2 acquisition and language use are crucial variables in determining such bilingual advantage. The increased EC efficiency boosted by the active use of the two languages might act as a compensatory mechanism in delaying the cognitive symptoms associated with age-related disorders.

2:10 pm

A3 Learning novel speech sounds reorganizes acoustic representations in the human superior temporal gyrus

Han G. Yi[1], Matthew K. Leonard[1], Bharath Chandrasekaran[2], Kirill V. Nourski[3], Matthew A. Howard III[3], Edward F. Chang[1]; [1]University of California, San Francisco, [2]The University of Texas at Austin, [3]The University of Iowa

Speech perception requires listeners to be sensitive to a wide range of acoustic cues for phonetic category, speaker identity, and pitch. Although these cues exist in all languages, they are often used differently, which presents challenges when listening to an unfamiliar language. For example, whereas English uses pitch primarily to signal a variety of prosodic cues, Mandarin Chinese also uses four distinct pitch patterns, called lexical tones, to change word-level meaning. Here, we ask whether learning to identify lexical tones is associated with the emergence of new neural representations, or whether existing pitch representations used for prosody are reorganized to accommodate lexical tone. To answer this question, we directly recorded cortical activity using electrocorticography in humans while they performed a multi-day training task to learn to identify tones from words produced by male and female native Mandarin Chinese speakers. We found neural populations in bilateral mid-anterior superior temporal gyrus (STG) that were highly selective for particular tones, independent of phonetic or speaker information. Crucially, behavioral performance was associated with neural clustering of tones in these populations, such that increased identification accuracy was associated with more distinct neural representations. Finally, we demonstrate that neural representation of Mandarin Chinese tones in STG reflected the same representation of relative pitch that encoded lexical stress in English sentences. Together, these results demonstrate that learning to identify unfamiliar speech sounds enhances pre-existing representations of the relevant acoustic cues, rather than generating novel encoding patterns.

2:30 pm

A4 Neural changes related to successful stutter reduction using transcranial direct current stimulation

Jennifer Chesters[1], Riikka Mottonen[2], Kate E. Watkins[1]; [1]Department of Experimental Psychology, University Oxford, [2]School of Psychology, University of Nottingham

Our recent randomized controlled trial showed that speech disfluency can be reduced by transcranial direct current stimulation (tDCS) paired with a fluency intervention. Anodal tDCS was applied over left inferior frontal cortex for 20 minutes at 1 mA while fluency was temporarily enhanced using metronome-timed speech and choral speech in five daily sessions. Disfluency was reduced one and six weeks after the intervention for the group of people who stutter receiving active tDCS (PWS-A), compared with the group receiving sham stimulation (PWS-S) (Chesters et al, 2018). Here, we investigated the neural changes related to this stutter reduction using functional MRI (fMRI). The fMRI session included three conditions where sentences were read aloud: solo reading, metronome-timed speech, and choral speech. During the baseline, participants saw a sentence in false font and were silent. Imaging data was acquired using sparse-sampling, allowing participants to speak without scanner noise and to hear clearly the metronome and choral speech. All participants were male. Twenty-five PWS with moderate-severe stutter severity were randomly assigned to the PWS-A group (N=13) and PWS-S group (N=12). They were scanned before and one week after the tDCS intervention. Fifteen participants who do not stutter were also scanned. Imaging data were analysed using the general linear model using FSL. To examine for change in activity from pre- to post-intervention, we used a region-of-interest (ROI) analysis. Control participants were fluent during all speaking conditions. PWS stuttered on some sentences during the baseline and post-intervention scans. Stuttered sentences were regressed out, so that the analysis focussed only on fluent speech. Spherical functional ROIs with 6-mm radius were defined from peak co-ordinates of previous studies showing abnormal levels of activity in PWS: in mouth motor cortex, ventral premotor cortex, midbrain, cerebellum and dorsal anterior insula bilaterally, left SMA and Heschl's gyrus, and right ventral anterior insula. Because the basal ganglia circuitry is implicated in an account of stuttering, we also included anatomical ROIs for the left and right caudate nucleus and putamen. There was activity within each of the ROIs for at least one of the three groups in the whole brain analysis of the pre-intervention scan. We compared the differences in percent signal change in these ROIs from pre- to post-intervention for the PWS-A and PWS-S groups. The PWS-A group

showed significant increases in activity across all ROIs, and all speaking conditions, compared with the PWS-S group (main effect of tDCS group F 1,23 = 5.61, p = .027, no significant interaction between group and ROI, or speaking condition). Our results indicate that the stutter reduction following the combined application of anodal tDCS with temporary fluency techniques is associated with increased activity across the speech network. This increase includes regions previously shown to be under-active in PWS during speaking, but also regions where over-activation has been identified.

Slide Session B

Friday, August 17, 1:40 – 3:00 pm, Room 2000C

Chair: Brenda Rapp

Speakers: Mante Nieuwland, Seyedehrezvan Farahibozorg, Laura Gwilliams, Beth Jefferies

1:40 pm

B1 Dissociable effects of prediction and integration during language comprehension: Evidence from a large-scale study using brain potentials *Mante Nieuwland[1,2], Dale J. Barr[3], Federica Bartolozzi[1,2], Simon Busch-Moreno[4], Emily Darley[5], David I. Donaldson[6], Heather J. Ferguson[7], Xiao Fu[4], Evelien Heyselaar[1,8], Falk Huettig[1], E. Matthew Husband[9], Aine Ito[2,9], Nina Kazanina[5], Vita Kogan[2], Zdenko Kohút[10], Eugenia Kulakova[11], Diane Mézière[2], Stephen Politzer-Ahles[9,12], Guillaume Rousselet[3], Shirley-Ann Rueschemeyer[10], Katrien Segaert[8], Jyrki Tuomainen[4], Sarah Von Grebmer Zu Wolfsthurn[5]; [1]Max Planck Institute for Psycholinguistics, Nijmegen, the Netherlands, [2]School of Philosophy, Psychology and Language Sciences, University of Edinburgh, UK, [3]Institute of Neuroscience and Psychology, University of Glasgow, UK, [4]Division of Psychology and Language Sciences, University College London, UK, [5]School of Experimental Psychology, University of Bristol, UK, [6]Psychology, Faculty of Natural Sciences, University of Stirling, UK, [7]School of Psychology, University of Kent, Canterbury, UK, [8]School of Psychology, University of Birmingham, UK, [9]Faculty of Linguistics, Philology & Phonetics; University of Oxford, UK, [10]Department of Psychology, University of York, UK, [11]Institute of Cognitive Neuroscience, University College London, UK, [12]Department of Chinese and Bilingual Studies, the Hong Kong Polytechnic University, Kowloon, Hong Kong*

Predictable words are easier to process than unpredictable words: 'bicycle' is easier to process than 'elephant' in "You never forget how to ride a bicycle/an elephant once you've learned". For example, predictable words are read and recognized faster than unpredictable words (e.g., Clifton, Staub & Rayner, 2007). Predictable words also elicit reduced N400 amplitude (Kutas & Hillyard, 1984). However, it remains unclear whether such N400-indexed facilitation is driven by actual prediction (i.e., predictable words are activated before they appear), by integration (i.e., predictable words are semantically more plausible and therefore easier to integrate into sentence context than unpredictable words after they have appeared), or by both. The integration-access debate has long engrossed the psychology and neuroscience of language (for reviews, see Kutas & Federmeier, 2011; Lau, Phillips & Poeppel, 2008; Van Berkum, 2009), but it has yet to reach a conclusion, and there is support for both views. Supporting the access-view, numerous studies show that people can predict the meaning of upcoming words during sentence comprehension, and some studies suggest that N400 amplitude is not a function of sentence plausibility. Supporting the integration view, however, several studies report N400 modulations by semantic or pragmatic plausibility that are not easily explained in terms of prediction alone (e.g., Rueschemeyer, Gardner & Stoner, 2015). The mixed evidence has led some researchers to question the viability of an access-only or integration-only view of the N400, and to propose a hybrid, 'multiple-process' account (Baggio & Hagoort, 2011). This account views N400 activity as reflecting cascading access- and integration-processes. Effects of prediction and of integration are therefore both visible in N400 activity, but effects of prediction would precede and be functionally distinct from those of integration. We investigated this issue by exploring modulation of the N400 (Kutas & Hillyard, 1980), an event-related potential (ERP) component commonly considered the brain's index of semantic processing (Kutas & Federmeier, 2011), using a temporally fine-grained analysis of data from a large-scale (N=334) replication study (Nieuwland et al., 2018, which attempted to replicate DeLong, Urbach & Kutas, 2005). We investigated whether prediction and integration have dissociable effects on N400 amplitude, and how these effects unfold over time. Improving on previously used methods, we simultaneously modelled variance associated with predictability and plausibility, while also controlling for semantic similarity (LSA). We modelled activity at each EEG channel and time-point within an extended time window (e.g., Hauk, Davis, Ford, Pulvermüller, & Marslen-Wilson, 2006), we examined the time-course and spatial distribution of the effect of predictability while appropriately controlling for plausibility and vice versa. We observed overlapping effects of predictability and plausibility on the N400, albeit with distinct spatiotemporal profiles. Our results challenge the view that semantic facilitation of predictable words reflects the effects of either prediction or integration, and suggest that facilitation arises from a cascade of processes that access and integrate word meaning with context into a sentence-level meaning.

2:00 pm

B2 Processor Hub Versus Integrator Hubs: Distinct Roles for Anterior Temporal Lobe and Angular Gyrus in Semantic Processing *Seyedehrezvan Farahibozorg[1,2], Richard Henson[1], Anna Woollams[3], Elisa Cooper[1], Gemma Evans[4], Yuanyuan Chen[1], Karalyn Patterson[1], Olaf Hauk[1]; [1]MRC Cognition and Brain Sciences Unit, University of Cambridge, [2]Wellcome Centre For Integrative Neuroimaging, Nuffield Department of Clinical*

Neurosciences, University of Oxford, [3]Neuroscience and Aphasia Research Unit, School of Psychological Sciences, University of Manchester, [4]Department of Psychology, University of Chester

Brain imaging research to date has not reached a consensus as to whether distributed semantic networks are organised around one central hub or consist of several heteromodal convergence zones (Lambon-Ralph et al. 2016; Binder 2016; Pulvermüller 2013). In this study, we addressed this question by drawing a distinction between two possible roles of a semantic hub, namely higher-level amodal processing and modality-specific cross-modal integration (Woollams & Patterson 2018), at different stages of visual word processing. Consequently, we hypothesised neural activity inside processor hub(s) and connectivity of integrator hub(s) to heteromodal and unimodal semantic areas to be modulated by semantic variables (i.e. amplitude versus connectivity modulation). In order to test these hypotheses, we utilised the spatio-temporal resolution of source-estimated concurrent Electro-/Magnetoencephalography (EEG/MEG) and: (i) monitored the time course of semantic modulation in a data-driven manner from whole-brain evoked responses in order to identify the processor hub(s); (ii) computed functional connectivity (Coherence) among candidate hub regions (left Anterior Temporal Lobe (ATL), Angular Gyrus (AG), Middle Temporal Gyrus (MTG) and Inferior Frontal Gyrus (IFG)) and the whole-brain in order to identify the integrator hub(s) through differential modulations of connections to the sensory-motor-limbic systems; (iii) compared network models of evoked responses among the candidate hub regions (with visual Word Form Area as the input region) using effective connectivity (Dynamic Causal Modelling (DCM)) in order to identify the integrator hub(s) within the heteromodal subnetwork of semantics. For this purpose, we recruited 17 healthy native English speakers (age 18-40) who performed a concreteness decision task in a visual word recognition paradigm while EEG and MEG (70 and 306 channels) were recorded simultaneously (Elekta Neuromag). Preprocessing included Maxfilter, band-pass filtering (1-48Hz), ICA artefact rejection and epoching. Forward modelling and source estimation were performed on combined EEG/MEG data and based on individual MRIs using boundary element models and L2 minimum norm estimation. Firstly, in order to identify the processor hub(s), source-reconstructed evoked responses were compared between concrete and abstract words using whole-brain cluster-based permutation tests. Left ATL was revealed as a processor hub as early as 100ms peri-stimulus, persisting into later stages of semantic word processing at ~400ms when the effects spread to the bilateral ATLs and anterior IFGs. Secondly, among the tested candidate hubs, whole-brain seed-based connectivity analyses highlighted only ATL and AG as potential integrator hubs through differential modulations of their coherence to the unimodal semantic areas. More specifically, while ATL showed higher connectivity to the right orbitofrontal cortices for the abstract words, AG showed higher connectivity to the somatosensory cortices for the concrete words. Thirdly, the DCM analysis showed that a single hub model provided the highest evidence for connectivity among the left-hemispheric heteromodal subnetwork of semantics, in which ATL acted as the integrator hub during the earliest time window (within 250ms), while AG played this role during later time windows (within 450ms). Therefore, our results suggest that distinct brain systems underlie processing and integration hubness in dynamic semantic networks and that these cortices overlap in the ATL.

2:20 pm

B3 Parsing continuous speech into linguistic representations

Laura Gwilliams[1,2], Jean-Rémi King[1,3], David Poeppel[1,4]; [1]New York University, [2]NYUAD Institute, [3]Frankfurt Institute for Advanced Studies, [4]Max-Planck-Institute

INTRODUCTION. Language comprises multiple levels of representation, from phonemes (e.g. /b/ /p/) to lexical items (e.g. bear, pear) to syntactic structures (e.g. bears [SUBJECT] eat [VERB] pears [OBJECT]). Here we address two research questions that arise in online processing of naturalistic speech: 1) which representational states are encoded in neural activity; 2) what overarching algorithm orchestrates these representations to ultimately derive meaning? METHODS. Eighteen participants listened to four narratives that were fully annotated - from speech sounds to syntactic structures - such that each level could be correlated with brain activity. Two ~1 hour sessions were recorded from each participant. This naturalistic but controlled setup allowed us to decode, localise and track phonological, lexical and syntactic operations from magnetoencephalography recordings (MEG) using machine learning approaches. RESULTS. First, acoustic-phonetic features (e.g. voicing, manner, place of articulation) could be successfully discriminated from a sequence of neural responses unfolding between ~100 ms to ~400 ms after phoneme onset. Second, part of speech (e.g. verb, noun, adjective), indicative of lexical processing, was decodable between ~150 ms and ~800 ms after word onset. Third, we could decode and track proxies of both syntactic operations (e.g. number of closing nodes) and syntactic states (e.g. depth of tree). Interestingly, some of these syntactic representations were clearly present several hundreds of ms before word onset, whereas others maximally peaked ~300 ms later. CONCLUSION. These sustained and evoked MEG responses suggest that the human brain encodes each level of representation as proposed by linguistic theories. Importantly, the corresponding neural assemblies overlap in space and time, likely facilitating concurrent access across these low-to-high-level representations, in line with a cascade architecture. Put another way, the brain does not discard the representation of a lower-level linguistic property (e.g. phonetic content) once a higher-level feature has been derived (e.g. part of speech). Finally, our study demonstrates how the combination of machine learning

and traditional statistics can bridge the gap between spatiotemporally-resolved neuroimaging data and rich but tractable naturalistic stimuli.

2:40 pm

B4 Individual differences in default mode connectivity relate to perceptually-coupled and decoupled modes of semantic retrieval: Functional consequences for comprehension and mind-wandering *Beth Jefferies[1], Meichao Zhang[1], Nicola Savill[2], Daniel Margulies[3], Jonathan Smallwood[1]; [1]University of York, UK, [2]York St John University, UK, [3]CNRS, Institut du cerveau et de la moelle épinière (ICM), Paris*

A contemporary puzzle in cognitive neuroscience concerns how regions of the default mode network (DMN) support opposing mental states. This network is activated in tasks tapping comprehension, memory retrieval, imagination and creativity. However, DMN activity is also associated with poor task performance and mind-wandering. A potential solution to this puzzle is offered by the observation that regions linked to heteromodal mental representations, such as ventral and lateral portions of the anterior temporal lobes (ATL), show a pattern of intrinsic connectivity to both DMN and visual cortex. This gives rise to the possibility that ATL supports comprehension at the end of the ventral visual stream, yet also contributes to off-task self-generated thought when this region is perceptually decoupled. We examined the association between these patterns of connectivity and individual differences in comprehension and mind-wandering during reading. Behaviourally, there was a strong negative correlation between these measures: people who mind-wander more often during reading comprehend the text less well. In Study 1, we found people with good comprehension showed stronger activation in middle temporal gyrus (MTG) for meaningless orthographic inputs. Much of this activation fell within the DMN in a region of the temporal lobe associated with heteromodal conceptual processing. In Study 2, we then examined individual differences in the intrinsic connectivity of this DMN region at rest and related these patterns of connectivity to behavioural performance measured outside the scanner. We found that participants reported more frequent mind-wandering during reading when MTG had a pattern of relatively weak connectivity with visual regions. Conversely, better comprehension was associated with greater functional connectivity between MTG and another region of the DMN within the anterior cingulate cortex. These findings show that DMN connectivity is associated with good as well as poor comprehension, and that relatively-low level visual processes contribute to higher-order cognitive states. Our individual differences analysis complements task-based studies of comprehension in the ventral visual stream by showing that activation in heteromodal semantic regions is necessary but not sufficient for good comprehension. In people with strong connectivity between MTG and visual cortex, semantic cognition tends to be perceptually-coupled, while perceptually-decoupled semantic retrieval is associated with poor comprehension. Thus, the opposing roles of DMN in different mental states may reflect connectivity to task-relevant or irrelevant information.

Slide Session C

Saturday, August 18, 11:00 am – 12:20 pm, Room 2000C

Chair: Marina Bedny

Speakers: Florence Bouhali, Emilie McKinnon, Katherine Travis, Travis White-Schwoch

11:00 am

C1 Distinct areas for the processing of graphemes and words in the left occipitotemporal cortex *Florence Bouhali[1,2,3,4,5], Zoé Bézagu[1,2,3,4], Stanislas Dehaene[6,7], Laurent Cohen[1,2,3,4,8]; [1]Inserm, U 1127, F-75013, Paris, France, [2]CNRS, UMR 7225, F-75013, Paris, France, [3]Sorbonne Universités, UPMC Univ Paris 06, UMR S 1127, F-75013, Paris, France., [4]Institut du Cerveau et de la Moelle épinière, ICM, F-75013, Paris, France., [5]University of California San Francisco (UCSF), San Francisco, CA 94143, [6]Cognitive Neuroimaging Unit, CEA DRF/I2BM, INSERM, Université Paris-Sud, Université Paris-Saclay, NeuroSpin center, 91191 Gif/Yvette, France, [7]Collège de France, 11 Place Marcelin Berthelot, 75005 Paris, France, [8]AP-HP, Hôpital de la Pitié Salpêtrière, Féderation de Neurologie, F-75013, Paris, France*

Word reading in alphabetical scripts can be achieved either by print-to-sound mapping, or by direct lexical access. While the lexico-semantic route can operate on coarse orthographic units like non-contiguous subsets of letters, phonological decoding is based on the exact identification of graphemes and of their order to support their conversion into phonemes. At the neural level, the visual word form area (VWFA), within the left occipito-temporal cortex, has been extensively implicated in the extraction of orthographic information. Yet, it is unclear how the VWFA extracts information for access to both phonology and to the lexicon, as these two orthographic codes strongly differ in nature. In order to identify regions potentially implicated in grapheme encoding for grapheme-to-phoneme mapping, the current study manipulated the perception of multi-letter graphemes (e.g., AI in chair), crucial for phonological decoding but not for lexical access. Twenty adults performed both lexical decision and naming tasks in French in the MRI, on words and pseudo-words containing a high proportion of multi-letter graphemes. The perception of multi-letter graphemes was encouraged or disrupted visually using both font color alternation and spacing, either located between graphemes (ch-ai-r), or in the middle of graphemes (c-ha-ir). Behaviorally, we observed that the perceptual disruption of multi-letter graphemes impaired reading, especially when naming pseudo-words – the condition that relied most on the phonological reading route. Within the left occipito-temporal cortex, the manipulation of graphemes affected

the activity of a region near the mid-fusiform sulcus in opposite directions, depending on whether stimulus and task demands required either a lexical or a phonological strategy. A separate contrast revealed that this same region was also overall more activated in participants whose response times were most affected by the manipulation of graphemes. Interestingly, this "grapheme region" was more medial than the typical VWFA identified separately, and significantly differed from the VWFA on several aspects. The medial "grapheme region" was more sensitive to string length, and its connectivity during task to the intra-parietal sulcus, known for its integral role in letter-by-letter reading, was modulated by phonological demands. In contrast, the VWFA showed large effects of word frequency and of lexicality. Our results hence suggest a partial dissociation within the left ventral stream of orthographic regions implicated in orthographic processing: medial fusiform regions would encode orthographic information at a fine-grained graphemic level (sublexical processing), while the typical VWFA – located laterally within the occipito-temporal sulcus – may participate more in direct lexical access. This view is compatible with reports of more medial activations for reading in children – who rely more on phonological decoding than adults, or in Braille readers – who are constrained by the serial nature of the sensory input. These two regions would collaborate in particular in conditions requiring phonological processing, as suggested by our connectivity analyses, with the VWFA as a primary output of the visual system towards the reading network.

11:20 am

C2 Synergism between cortical damage and white matter disconnection contributes to aphasia severity

Emilie McKinnon[1], Barbara Marebwa[1], Chris Rorden[2], Alexandra Basilakos[2], Ezequiel Gleichgerrcht[1], Julius Fridriksson[2], Leonardo Bonilha[1]; [1]Medical University of South Carolina, [2]University of South Carolina

Language impairments are common after a dominant hemisphere stroke, although the relative contribution of damage to cortical areas and white matter pathways to aphasia severity remains poorly understood. In this study, we assessed if our understanding of aphasia severity and linguistic skills could be improved by quantifying damage to both gray and white matter areas often implicated in language. Specifically, we hypothesized that cortical disconnection aids in the explanation of critical differences in language function particularly when cortical areas are largely intact. We recruited 90 right handed participants (age 58.8 ± 12.1 years, 34 females; 42.8 ± 50 months post stroke) with a single left hemisphere stroke that underwent MRI imaging (T1-w, T2-w and DTI (b=0, 1000 s/mm2) and the Western Aphasia Battery-Revised (mean 63 ± 28). In addition, we scanned 60 older self-reported cognitively normal participants (47 females, age 55.1 ± 8.6 years). T1-weighted images were segmented into probabilistic gray and white matter maps using either SPM12's unified segmentation-normalization or enantiomorphic normalization. The probabilistic gray matter map was divided into JHU anatomical regions, and white and gray matter parcellation maps were registered into diffusion imaging space where pairwise probabilistic DTI fiber tracking was computed. Weighted connectomes were constructed based on the number of streamlines corrected by distance traveled and by the total gray matter volume. Lesions were drawn on T2-weighted images and proportional damage to ROIs was determined by the intersection of lesion drawings and JHU ROIs. ROIs were considered disconnected when the number of connections was less than 2 standard deviations away from the mean number of connections in the non-brain damaged cohort. Our results focused on a language specific subnetwork consisting of Broca's area, supramarginal gyrus (SG), angular gyrus (AG), superior temporal gyrus (STG), middle temporal gyrus (MTG), inferior temporal gyrus (ITG) and the posterior parts of the STG (pSTG) and MTG (pMTG). Disconnection within this subnetwork significantly aided in the explanation of aphasia severity (WAB-AQ) when cortical areas suffered between 21 – 91 % damage. Outside of this range, disconnection did not significantly help explain the variability in aphasia quotient. In an additional ROI-based analyses, damage to the left superior longitudinal fasciculus explained an extra 31% of variance ($r=-0.56$, $p<0.05$) in WAB-fluency scores in addition to 29% variance explained by damage to Broca's area alone. Likewise, individual auditory comprehension scores were explained by the quantification of damage to the inferior longitudinal fasciculus ($r=-0.23$, $p<0.05$) in addition to quantified damage to Wernicke's area. In conclusion, quantifying damage to white matter pathways can help explain individual language impairments in subjects with chronic aphasia. Our results suggest that this benefit is largest in areas with average cortical damage.

11:40 am

C3 More than Myelin: Interrogating white matter tissue properties underlying receptive and expressive language abilities in 8 year old children

Katherine Travis[1], Lisa Brucket[1], Aviv A. Mezer[2], Michal Ben-Shachar[3], Heidi M. Feldman[1]; [1]Stanford University, [2]The Hebrew University of Jerusalem, [3]Bar Ilan University

Background: Language abilities in children and adults rely on multiple white matter tracts, including both dorsal and ventral pathways. Prior studies using diffusion MRI (dMRI) have shown that structural properties of these pathways vary in association with age-related changes in development and aging, and with individual differences in receptive and expressive language abilities in both adults and children. In children, it is often assumed that structure-function associations are driven by on-going myelination. However, dMRI metrics, such as fractional anisotropy (FA), are sensitive to multiple tissue properties including myelin content and axonal properties, specifically crossing fibers, axonal diameter and axonal density. Clarifying the contributions of myelin to individual variations in

language abilities in children requires additional MRI techniques with increased sensitivity for myelin content, such as quantitative T1 MRI (qT1). R1 from qT1 is a measure of the longitudinal relaxation rate of water and is directly associated with myelin content (R1 = 1/T1). Here, we combined metrics from dMRI (FA) with qT1 (R1) to interrogate the contributions of myelin content and axonal properties to individual variations in children's receptive and expressive language abilities. Methods: We obtained 30 direction dMRI (b = 1,000 s/mm) and qT1 data in 8-year old children (N=24). Children further underwent behavioral testing of expressive and receptive language using the Clinical Evaluation of Language Fundamentals (CELF4). qT1 scans were acquired using a spoiled gradient echo sequence (flip angles 4°, 10°, 20°, 30°) corrected for inhomogeneity with spin-echo, inversion-recovery sequence, with multiple inversion times (TI = 400, 1200, 2400ms). Whole-brain deterministic tractography and automated tract quantification were used to segment dorsal and ventral language-related pathways. We quantified fractional anisotropy (FA) and R1 (R1 = 1/T1) values along the trajectory of each tract. Associations between FA or R1 and standard scores for receptive and expressive language skills were examined using Pearson correlations. Results: In the right inferior fronto-occipital fasciculus both FA and R1 were significantly and positively associated with language scores. In the left and right inferior longitudinal fasciculus, only R1 was significantly correlated with language scores. In the left inferior fronto-occipital fasciculus and right uncinate fasciculus, only FA was significantly correlated with language scores. No significant correlations were detected between language scores and either white matter metric in dorsal stream tracts. Conclusions: The current evidence suggests that multiple tissue properties, including both myelin content and axonal properties, account for individual variations in children's language abilities at school age. The present findings also demonstrate that R1 may be sensitive to structure-function associations not otherwise captured by FA alone. Future analyses will focus on clarifying which specific linguistic processes (e.g., lexico-semantic) broadly captured by the current language measure account for patterns of associations within ventral but not dorsal pathways. Overall, the present study emphasizes the importance of combining MRI techniques to advance understandings of how white matter properties contribute to language abilities in children. Specifically, we demonstrate that the neurobiological underpinnings of language abilities in children are not limited to myelin.

12:00 pm

C4 Pre-school auditory processing predicts school-age reading achievement: A 4-year longitudinal study

Travis White-Schwoch[1], Elaine C. Thompson[1], Silvia Bonacina[1], Jennifer Krizman[1], Trent Nicol[1], Ann R. Bradlow[1], Steven G. Zecker[1], Nina Kraus[1]; [1]Northwestern University

Several prominent theories of developmental dyslexia propose that poor auditory processing is a risk factor for reading impairment. A crucial prediction of this hypothesis is that auditory processing is faulty before children begin learning to read. The frequency-following response (FFR) is a scalp-recorded electrophysiological response that relies on synchronous neural firing along the auditory pathway. The FFR is not dependent on any attention or task compliance, and is appropriate across the lifespan, making it an excellent approach for longitudinal studies in children. We previously reported that, in preschoolers (ages 3-4 years), frequency-following responses (FFRs) to consonants in noise strongly predicted early literacy skills such as phonological awareness and rapid automatized naming, and also their performance on early literacy tests one year later (White-Schwoch et al., 2015, PLOS Biol). However, given how young those children were at the time, we could not evaluate their reading achievement. Here we report a longitudinal follow-up to that project, where we followed the same children for an additional 4 years, evaluating their reading performance at school age. We show that FFRs to consonants in noise measured in preschoolers (ages 3-4) predict their reading skills 4 years later (ages 7-8), including silent and oral reading fluency, phonological processing, and rapid naming. These results show that individual differences in reading achievement in school-aged children can be predicted from a pre-literacy index of auditory processing (the FFR). These results support auditory processing models of reading development and specifically identify poor auditory processing in noise as a potential source of reading impairment. FFRs in preschoolers may provide a clinical tool to identify children at risk for future reading impairment. Supported by NIH (DC01510) and the Knowles Hearing Center.

Poster Slam Schedule

Poster Slams provide a fast-paced and entertaining showcase for posters. Forty presenters have been invited to provide one-minute, one-slide overviews of their posters. Poster Slams take place just prior to the beginning of each poster session. Participants will present their Slam on the main stage (Room 2000C), ensuring effective exposure to the entire SNL audience. We envision that presenters will address an exciting or provocative finding, challenge current dogma, or highlight how their data or technique addresses current issues in the Neurobiology of Language. We encourage participants to think outside the box and use their one-minute, one-slide presentation in a novel and creative way to communicate their science.

Session	Date	Mandatory Briefing	Line-Up Time	Session Begins
Session A	Thursday, August 16	8:30 am	9:55 am	10:00 am
Session B	Thursday, August 16	1:15 pm	2:45 pm	2:50 pm
Session C	Friday, August 17	8:15 am	10:10 am	10:15 am
Session D	Friday, August 17	3:15 pm	4:25 pm	4:30 pm
Session E	Saturday, August 18	1:15 pm	2:40 pm	2:45 pm

Information for Slam Presenters

You must arrive at the main lecture hall (Room 2000C) for a short Mandatory Briefing at the designated time for your Slam Session (see above). At the Mandatory Briefing, SNL staff will meet you at the podium and explain the logistics of Slam sessions, including where to line up, use of the microphone, timing and so on. This is critical for the success of this fast-paced micro-session. Slam presenters will line up according to their presentation order at Line-Up Time (see above).

Poster Slam Sessions

For poster details, see "Poster Sessions" on page 34.

Poster Slam Session A

Thursday, August 16, 10:00 – 10:15 am, Room 2000C

Chair: Matt Davis

A5 Self-monitoring in L1 and L2 speech production: an MEG study *Sarah Bakst*

A21 How are visual words represented? Insights from EEG-based image reconstruction during reading *Shouyu Ling*

A26 Hierarchical syntactic structures modulate brain activity during morphological processing *Yohei Oseki*

A29 Inter-individual differences in predictive coding during language processing: the role of individual alpha frequency and idea density *Ina Bornkessel-Schlesewsky*

A49 Automatic speech analysis technology yields reproducible dysprosodic markers in Primary progressive aphasia *Naomi Nevler*

A57 Brain activation for spoken and sign language in infancy: Impact of experience in unimodal and bimodal bilinguals *Evelyne Mercure*

A63 The impoverished comprehension of non-native speech in noise *Esti Blanco-Elorrieta*

A64 Neurodevelopmental impact of early bilingual acquisition on children's syntactic processing *Neelima Wagley*

Poster Slam Session B

Thursday, August 16, 2:50 – 3:05 pm, Room 2000C

Chair: David Corina

B4 Syllable sequencing into words: A computational model of speech production *Meropi Topalidou*

B7 Neural representation of phonemic categories in tonotopic auditory cortex *Deborah F. Levy*

B14 Neural oscillations track changes in speech rate shown by MEG adaptation and perceptual after-effects *Matthew H Davis*

B22 fMRI evidence for binding theory during anaphora resolution in naturalistic listening *Jixing Li*

B27 Spatial attention and perceptual-motor representations of demonstratives: a fast fMRI study using naturalistic auditory stimuli *Roberta Rocca*

B51 Neural plasticity of speech and reading networks associated with language learning *Kshipra Gurunandan*

B59 Picture naming in American Sign Language: an ERP study of the effects of iconicity and alignment *Meghan McGarry*

Poster Slam Session C

Friday, August 17, 10:15 – 10:30 am, Room 2000C

Chair: Mairéad MacSweeney

C3 The Role of Primary Motor Cortex in Second Language Word Recognition *Beatriz Barragan*

C4 Cortico-striatal tractography: Structural connectivity of the left inferior frontal gyrus along the rostrocaudal length of the putamen *Simone Renée Roberts*

C8 Brain activity predicts future learning potential in intensive second language listening training *Mayumi Kajiura*

C14 The neurobiology of Braille reading beyond the VWFA *Judy Sein Kim*

C36 Using local neural heterogeneity to both predict and track in language recovery *Jeremy Purcell*

C39 Neuromodulatory effects of individualized tDCS on MEG dynamics in chronic post-stroke aphasia *Priyanka Shah-Basak*

C40 Syntactic and thematic mechanisms of subject-verb integration in aphasia and typical sentence comprehension *Jennifer Mack*

C48 Reading efficiency is associated with fractional anisotropy, but not with myelin content, in the superior cerebellar peduncles. *Lisa Bruckert*

C61 Worse than useless: traditional ERP baseline correction reduces power through self-contradiction *Phillip M. Alday*

Poster Slam Session D

Friday, August 17, 4:30 – 4:45 pm, Room 2000C

Chair: Angela Grant

D5 Speech rate is associated with cerebellar white matter in persistent developmental stuttering *Sivan Jossinger*

D6 Ageing does not affect excitability of articulatory motor cortex during speech perception *Helen E Nuttall*

D7 Sensorimotor adaptation in speech is sensitive to vowel targets of altered feedback *Hardik Kothare*

D11 Electrophysiological Effects of Bilingualism and Aging on Working Memory *Cassandra Morrison*

D15 Impaired Incidental Phonetic Learning in People with Aphasia *Christopher Heffner*

D16 Lexical tone classification in frontal and posterior regions using fNIRS *Benjamin Zinszer*

D20 Measuring the N400 during naturalistic conversation: An EEG hyperscanning study *Caitriona Douglas*

D23 Examining plasticity of the reading network: insights from deaf readers of Chinese *Junfei Liu*

Poster Slam Session E

Saturday, August 18, 2:45 – 3:00 pm, Room 2000C

Chair: Patti Adank

E15 Human cortical encoding of a discrete temporal landmark for processing syllables in continuous speech *Yulia Oganian*

E16 Structural connectivity across stimulation-defined critical language areas *Brian H. Silverstein*

E25 Interaction of morphological and long-distance dependency processing: MEG evidence *Suhail Matar*

E41 Classification of fMRI Data in Aphasia Based on Task, Time Point, and Subject *E. Susan Duncan*

E43 Aphasia therapy results in differential changes in functional connectivity depending on treatment response *Jeffrey P. Johnson*

E44 Continuous theta burst stimulation over right pars triangularis facilitates naming abilities in chronic post-stroke aphasia by enhancing phonological access *Denise Y. Harvey*

E45 Neural Correlates of Impaired Emotional Prosody Recognition in Acute Right Hemisphere Stroke *Shannon M. Sheppard*

E46 Bilingualism delays age of symptom onset in the language variant but not the amnestic variant of Alzheimer's dementia *Jessica de Leon*

Poster Schedule

Poster sessions are scheduled from Thursday, August 16 through Saturday, August 18. Poster sessions are one hour and forty-five minutes long. Presenting authors are expected to be at their poster during the entire session. Posters are located in Room 2000AB. You may post your materials on your assigned board at the scheduled "Setup Begins" time shown below. Please note that any posters not removed by the "Teardown Complete" time will be discarded. Do not leave personal items in the poster room.

Date & Time	Posters	Topics
Poster Session A Thursday, August 16 10:15 am – 12:00 pm *Room 2000AB* Setup Begins: 8:00 am Teardown Complete: 1:00 pm	A1 - A4	Control, Selection, and Executive Processes
	A5 - A10	Speech Motor Control and Sensorimotor Integration
	A11 - A13	Phonology and Phonological Working Memory
	A14 - A19	Perception: Speech Perception and Audiovisual Integration
	A20	Writing and Spelling
	A21 - A25	Perception: Orthographic and Other Visual Processes
	A26 - A28	Grammar: Morphology
	A29 - A34	Grammar: Syntax
	A35 - A41	Meaning: Lexical Semantics
	A42 - A46	Meaning: Discourse and Pragmatics
	A47 - A48	Language Therapy
	A49 - A56	Language Disorders
	A57 - A61	Language Development
	A63 - A70	Multilingualism
Poster Session B Thursday, August 16 3:05 – 4:50 pm *Room 2000AB* Setup Begins: 1:00 pm Teardown Complete: 5:30 pm	B1 - B3	Control, Selection, and Executive Processes
	B4 - B6	Speech Motor Control and Sensorimotor Integration
	B7 - B13	Perception: Speech Perception and Audiovisual Integration
	B14 - B17	Perception: Auditory
	B18 - B21	Perception: Orthographic and Other Visual Processes
	B22 - B26	Grammar: Syntax
	B27 - B34	Meaning: Lexical Semantics
	B35 - B36	Language Therapy
	B37 - B45	Language Disorders
	B46 - B50	Language Development
	B51 - B57	Multilingualism
	B59 - B62	Signed Language and Gesture
	B63 - B66	Methods
	B67 - B70	Computational Approaches
Poster Session C Friday, August 17 10:30 am – 12:15 pm *Room 2000AB* Setup Begins: 8:00 am Teardown Complete: 1:00 pm	C1 - C2	Control, Selection, and Executive Processes
	C3 - C4	Speech Motor Control and Sensorimotor Integration
	C5 - C7	Phonology and Phonological Working Memory
	C8 - C13	Perception: Speech Perception and Audiovisual Integration
	C14 - C17	Perception: Orthographic and Other Visual Processes
	C18 - C24	Grammar: Syntax
	C25 - C31	Meaning: Lexical Semantics
	C32 - C35	Meaning: Prosody, Social and Emotional Processes
	C36 - C38	Language Therapy
	C39 - C47	Language Disorders
	C48 - C52	Language Development
	C53 - C60	Multilingualism
	C61 - C65	Methods
	C66 - C67	Computational Approaches

Poster Session D Friday, August 17 4:45 – 6:30 pm *Room 2000AB* Setup Begins: 1:00 pm Teardown Complete: 7:00 pm	D1 - D4	Control, Selection, and Executive Processes
	D5 - D10	Speech Motor Control and Sensorimotor Integration
	D11 - D14	Phonology and Phonological Working Memory
	D15 - D19	Perception: Speech Perception and Audiovisual Integration
	D20 - D22	Perception: Auditory
	D23 - D24	Writing and Spelling
	D25 - D27	Grammar: Morphology
	D28 - D32	Grammar: Syntax
	D33 - D41	Meaning: Lexical Semantics
	D42 - D43	Meaning: Combinatorial Semantics
	D44 - D47	Meaning: Discourse and Pragmatics
	D48	Language Therapy
	D49 - D56	Language Disorders
	D57 - D64	Multilingualism
	D65 - D67	Signed Language and Gesture
	D68 - D70	Computational Approaches
Poster Session E Saturday, August 18 3:00 – 4:45 pm *Room 2000AB* Setup Begins: 8:00 am Teardown Complete: 5:30 pm	E1 - E4	Control, Selection, and Executive Processes
	E5 - E7	Phonology and Phonological Working Memory
	E8 - E14	Perception: Speech Perception and Audiovisual Integration
	E15 - E19	Perception: Auditory
	E20 - E24	Perception: Orthographic and Other Visual Processes
	E25 - E27	Grammar: Syntax
	E28 - E34	Meaning: Lexical Semantics
	E35 - E36	Meaning: Combinatorial Semantics
	E37 - E40	Meaning: Discourse and Pragmatics
	E41 - E42	Language Therapy
	E43 - E51	Language Disorders
	E52 - E55	Language Development
	E57 - E64	Multilingualism
	E65	History of the Neurobiology of Language

Satellite Symposium

The Bilingual Brain - A lifelong perspective

Wednesday, August 15, 8:00 am – 4:00 pm, Reception Following
Domaine Cataraqui, 2141, chemin Saint-Louis, Québec City, QC., G1T 1 P9

This first SNL official symposium reflects on language learning across the lifespan and how our experience with language and multiple language learning informs questions of brain plasticity and organization. The symposium is organized by the Center for Research on Brain, Language, and Music (CRBLM) and by the Québec Brain Imaging Consortium (CINQ). For more information, please go to http://www.cinq.ulaval.ca/Bilingual-Brain.

Poster Sessions

Poster Session A

Thursday, August 16, 10:15 am – 12:00 pm, Room 2000AB

Control, Selection, and Executive Processes

A1 Assessment of Bilingual Language Context on Cognitive Aging *Angelique M. Blackburn[1], Nayeli Rojas[1], Nayeli Rivas[1], Alejandra Santos[1], Alexandra Reyes[1], Brenda Guerrero[1]; [1]Texas A&M International University*

The bilingual advantage, that bilinguals demonstrate enhanced cognitive control to adapt to task demands compared to monolinguals, has been heavily attacked due to replication failure. One possibility for this failure is that only bilinguals who use their languages in contexts that require heavy language control will selectively strengthen aspects of cognitive control required to navigate their language use. We have used the Assessment of Code Switching Experience Survey to categorize Spanish-English bilinguals as dense code switchers, who frequently code switch between two languages within a conversation, or as dual-language bilinguals, who switch frequently between languages throughout the day but rarely within a conversation. We observed the N2 effect, an event-related potential (ERP) related to interference suppression ability, while these bilinguals performed the Simon and Flanker interference suppression tasks. To determine if the effect requires a lifetime of residing in a specific context, we are comparing the effect in an older bilingual population (ages 50+) to that previously obtained in young adults (ages 18-30). Preliminary results suggest that bilinguals residing in the dual-language context, in which greater language control is needed, exhibit enhanced neural responses related to interference suppression compared to those who reside in a dense code switching context. To test whether interference suppression is strengthened via a dopaminergic pathway, we will be determining if the effect is mediated by dopamine receptor expression linked to the A1 allele. These results clarify the long-term effects of residing in different bilingual contexts and elucidate a possible mechanism of the bilingual advantage in older adults.

A2 Early Detection of Alzheimer's Disease: Combining EEG and Pupillometry to Assess Automatic and Controlled Language Processing Dynamics *Nicole Amichetti[1], Elena Festa[1], William Heindel[1]; [1]Brown University*

The ability to detect presymptomatic individuals who are at greatest risk for progressing to Alzheimer's disease (AD) is critical for the effective application of therapeutic strategies. However, biological markers alone are insufficient to identify at-risk individuals given the presence of AD pathology in a large number of cognitively healthy elderly. Standard neuropsychological assessments also fail to detect the earliest cognitive changes as compensatory processes moderate the relationship between pathology and cognitive performance. That is, two individuals can display similar levels of performance despite substantial differences in the pathological burden placed on neural systems. The transition from healthy aging to AD can be viewed as a breakdown of homeostasis due to the combined presence of two AD-related pathological changes: A breakdown in bottom-up integration processes within perceptual and memory representation systems due to a disruption of functional connectivity among posterior cortical regions, leading to greater reliance on top-down compensatory processes; and a disruption within frontotemporal white matter pathways mediating these top-down compensatory control processes. Given this view, the simultaneous assessment of the efficiency of bottom-up perceptual processes and integrity of recruited counteracting top-down control systems can provide insight into the homeostatic health of the aging brain and will allow for the identification of at-risk yet currently asymptomatic elderly. Language impairment is observed frequently AD, often early in disease progression. Also, language impairment signals greater risk for developing AD in prodromal individuals. Therefore, we employ concurrent electrophysiological (EEG) and pupillometry measures to systematically assess the dynamics of automatic and controlled language processing in patients with prodromal AD and cognitively healthy elderly with high or low biomarker risk of AD. This study employs an 'anomalous sentence paradigm' to systematically vary task difficulty and measure underlying effort required in real-time. Of interest is the N400 component which reflects automatic and controlled semantic integration and its amplitude is modulated by the degree of integration difficulty as determined by the sentence context. For example, the sentence "The dog came inside and drank the water" elicits a small N400 amplitude, whereas, "The dog came inside and drank the mustache" with its anomalous, ending word elicits a larger amplitude. Sentences are presented in an auditory manner, counterbalanced across three conditions: 1) sentences which are highly contextually constrained and contain a highly probable final word (as predicted by the preceding context); 2) moderately contextually constrained sentences with a low-moderately probable final word; 3) sentences which are highly contextually constrained and contain an anomalous or highly improbable final word. Neural activity is simultaneously recorded with pupil dilation, as task-evoked cognitive effort recruited to compensate for either increasing task difficulty or diminished cognitive ability can be measured via pupil dilation, an indirect marker of LC-NE activity. Results are discussed in terms of neural activity patterns and cognitive effort required for semantic integration and compared across cognitively healthy, impaired, and at-risk elderly. Also discussed is the relationship between frontal theta oscillations and

pupil dilation across task conditions differing in required allocation of cognitive effort, a topic yet unexplored in at risk individuals.

A3 How attention relates to consecutive interpreting performance: the importance of processing rather than storage

Junyan Wei[1,2], Yulei Gao[1], Shuyi Liu[1], Chuanbin Ni[1]; [1]Nanjing Normal University, [2]McGill University

Consecutive interpreting is a process of transferring meaning from one language to another. During consecutive interpreting, interpreter listens to the speaker and takes notes. When the speaker pauses, the interpreter then convey the meaning of his talk into the target language to the listeners. Since there are so many tasks but the time is limited, it is important for interpreters to filter the most crucial messages into information processing procedure, focuse on it, but at the same time allocate their energy among different tasks. Therefore, consecutive interpreters need good attention abilities. The interdisciplinary topic of the role of attention in interpreting has been studied since the 1960s. Attention has by far been considered a well-established predictor for individual variation in consecutive interpreting performance. However, there are different aspects of attention, namely, processing of attention (which can be subdivided into focused and divided attention) and storage of attention. How these different aspects of attention relate to consecutive interpreting is still unclear. In the current study, the contribution of focused attention, divided attention and attention span to the performance of consecutive interpreting were investigated. 40 students majored in English/Chinese translation and interpretation took part in the experiment. Two groups of tests were conducted. The first group was the attention test, which included focused attention, divided attention and attention span tests. The second group was the English-Chinese(E-C) and Chinese-English(C-E) consecutive interpreting test. For attention test, focused and divided attention were measured by a dichotic listening program. Attention span was measured by a visual attention span test. For consecutive interpreting test, participants were asked to interpret two articles from Chinese to English, and two from English to Chinese. Their speeches were recorded and graded. The total score of interpretation performance was combined by three aspects, accuracy of information, fluency of speech, and pragmatic correctness. Correlation, ANOVA and regression were applied for data analysis. Results showed that (1) Focused attention had a close relationship with both E-C and C-E consecutive interpreting, especially the fluency of interpreters' speech. Interpreters who were better at focusing attention could be more fluent in consecutive interpreting. (2) Divided attention was not correlated to either E-C or C-E consecutive interpreting. Interpreters who had better ability to divide attention among tasks did not necessarily perform better in consecutive interpreting. (3) Attention span and consecutive interpreting was not correlated either. During consecutive interpreting, broader attention span might not help interpreters achieve better performance. Based on the results, it can thus be concluded that not all aspect of attention plays equal important roles in consecutive interpreting. Processing aspect of attention, especially the ability of quickly focusing on crucial information, is more important than the storage of attention in predicting the performance of consecutive interpreting.

A4 Lexical access and cognitive control in healthy bilinguals and bilinguals with aphasia: Evidence from the category generation task

Leela A Rao[1], Claudia Penaloza[1], Swathi Kiran[1]; [1]Boston University

Cognitive control plays a crucial role in lexical access in bilinguals by allowing them to switch between languages in a seemingly effortless manner (Friedman & Miyake, 2004; Green et al., 1998). However, the relationship between lexical access and varying degrees of cognitive control demand in the context of speech production remains unclear, especially in individuals with aphasia. The two constructs are frequently assessed together in tasks of semantic category or phonemic letter fluency, but the relative contribution of each to performance on the task is not well understood. In the present study, we investigated the relationship between lexical access and cognitive control in 17 Spanish-English speaking healthy bilingual adults (HB) and 10 Spanish-English speaking bilingual adults with aphasia (BAA) using a battery of language assessments and a semantic category generation task. The category generation task was modified to include three conditions requiring varying degrees of cognitive control: No Switch (NS), or word generation in just one language; Self-Switch (SS), or word generation by switching between languages at will; and Forced Switch (FS), or word generation by switching between languages across items. All participants were given one minute per condition to generate a word list. There were four categories (animals, food, clothing, and transportation), and condition-category pairings were counterbalanced across participants. Total number of items produced, proportion of accurate items to total items, error types, and proportion of direct translations to total number of accurate responses were calculated. Results demonstrated that HB produced significantly more accurate items in both languages than BAA across all conditions, though the number of errors made did not differ significantly across groups. HB also had a greater proportion of accurate responses to total responses across all conditions when compared to the BAA, indicating that HB produced more items with greater accuracy than BAA. Additionally, within-group trends demonstrated that both HB and BAA performed more accurately in the NS and SS conditions compared to the FS condition. However only BAA had a greater proportion of accurate responses on the SS condition ($\bar{x}$ = .764, SD = .343) compared to the NS condition ($\bar{x}$ = .666, SD = .363). Our findings suggest that lexical access in HB may become impaired with increasing cognitive control demands on lexical selection, reflecting a language-switching cost.

However, lexical access in HB may not be more facilitated in contexts of unconstrained language selection (e.g. the SS condition) when compared to single-language contexts (e.g. the NS condition). In contrast, lexical access in BAA may be facilitated in unconstrained language contexts (e.g. SS condition) while also becoming impaired with increasing cognitive control demands. These results provide greater insight into the relative contributions of lexical access and cognitive control in verbal fluency performance of HB and BAA.

Speech Motor Control and Sensorimotor Integration

A5 Self-monitoring in L1 and L2 speech production: an MEG study

Sarah Bakst[1], Caroline A. Niziolek[1]; [1]University of Wisconsin–Madison

We listen to ourselves while talking, comparing our acoustic output to an internal auditory representation of how our speech should sound. Because these representations of speech targets are weaker in a second language (L2), self-monitoring may be less successful, resulting in more varied, less native-like speech. In the current study, participants were recorded producing monosyllabic words in L1 (English) and L2 (French) during a magnetoencephalography (MEG) scan. The vowels tested were English {i, □, æ} (“Eve”, “eff”, “add”) and French {i, □, œ} (“Yves”, “hais”, “oeuf”). Previous work (Niziolek et al. 2013) has shown that native speakers will use their auditory feedback to help them correct their speech in real time. Because speakers are sensitive to the natural acoustic variability in their productions, they can steer deviant productions towards their auditory targets while speaking. This corrective behavior is evident in the magnitude and direction of the trajectories of vowel formants over the course of an utterance. The speakers in the present study showed such corrective behavior while speaking L1, but not in L2: there was both increased acoustic variability and reduced corrective behavior for utterances in French. Further, the most variability and least corrective behavior was found for [œ], the only vowel which can not be mapped onto an English category. Unlike in L1, where increased acoustic variability is associated with increased corrective behavior, the increased acoustic variability in L2 vowels did not result in increased corrective behavior. These results indicate weakened auditory representations of speech targets in L2 and suggest that these weak representations impair the ability to self-correct one’s own productions. Learning a second language is also associated with structural differences in the brain; beginners show increased structural connectivity between hemispheres compared with monolinguals and more proficient bilinguals (Xiang et al. 2015). Here, we investigated functional differences while speaking and listening in L1 and L2. Neuroimaging studies have previously shown that the auditory cortical response to hearing one’s own speech during L1 production is suppressed in comparison with silent listening to those same productions (Houde et al. 2002; Niziolek et al. 2013). During MEG recording, the production task described above alternated with a listening task in which participants heard acoustically-matched productions played over headphones. Preliminary analyses of MEG data show left auditory cortical suppression in both L1 and L2, providing evidence of self-monitoring in both languages. However, there was a reliable difference in laterality: while the cortical response to self-produced speech in L1 was highly left-lateralized, in L2 there was less lateralization in both speaking and listening. Our findings suggest that greater recruitment of right hemisphere occurs during both speaking and listening in adult L2 learners, which may be related to observed structural changes accompanying language learning.

A6 Neuroanatomical Correlates of Foreign Speech Production in Musician and Non-Musician Bilinguals

Paul-Noel Rousseau[1,4], Lucía Vaquero[2,3], Virginia Penhune[2,4], Denise Klein[1,4]; [1]McGill University, [2]Concordia University, [3]University of Barcelona, [4]CRBLM - The Centre for Research on Brain, Language and Music

Music and language have been shown to share a similar neural architecture, and there is evidence of transfer from musical training to different aspects of language ability. Using a combination of behavioural testing and structural neuroimaging we sought to tease apart this relationship and evaluate the neuroanatomical correlates of foreign language ability in a group of musician and non-musician bilinguals. 61 subjects (31 musicians, 30 non-musicians) were recruited and administered a battery of behavioural tests consisting of cognitive, music, and foreign language tasks. The language tasks were comprised of a perception task involving the discrimination of Hindi dental/retroflex phonemes, production of Hindi words, and production of syllables and words including the Farsi voiced uvular stop. We also collected T1 structural imaging, and performed a cortical thickness analysis in order to assess the anatomical correlates foreign language abilities. Behaviourally, we observed no differences between the musician and non-musician groups on any of the foreign language tasks. Musicians, did however, outperform non-musicians on a range of cognitive tests. In the cortical thickness analysis, we found performance on the Hindi production task be to be correlated with cortical thickness in the left inferior frontal gyrus, left somatosensory cortex, left medial temporal lobe, and right supramarginal gyrus and somatosensory cortex. Performance on the Farsi production task was correlated with cortical thickness in the left inferior frontal gyrus and medial temporal lobe as well as right posterior superior temporal gyrus and bilateral middle temporal gyri. We did not observe any significant differences in cortical thickness between groups, nor did we observe any relationship between structure and performance on the discrimination task. We found no evidence of transfer from the musical domain to language, however musical training was related to better

performance on a range of cognitive tests. The anatomical correlates of the foreign language production tasks did not differ between the groups, suggesting a shared architecture underlying their performance. While both the Hindi and Farsi tasks were related to cortical thickness in the left IFG, the former showed a greater contribution the somatosensory cortices and the later the middle temporal gyri. This implies that the different language tasks may involve different underlying abilities and consequently different parts of the brain. The lack of transfer effects may be due to a similar advantage in foreign language perception and production from bilingualism, to which music experience may not add a substantial advantage. However, only the comparison with monolingual musicians or non-musicians would help us shed light on this issue in future studies.

A7 Intracranial Neurophysiology of Auditory Feedback Control During Speech Production

Muge Ozker Sertel[1], Margaret A McAlister[1], Patricia Dugan[1], Daniel Friedman[1], Werner Doyle[2], Orrin Devinsky[1], Adeen Flinker[1]; [1]Department of Neurology, New York University School of Medicine, [2]Department of Neurosurgery, New York University School of Medicine

Accurate and fluent production of speech critically depends on hearing one's self. The auditory system continuously monitors self-generated vocal sounds to detect vocalization errors, which allows for the online adjustment of motor actions to achieve intended vocalization. When auditory feedback is disrupted, vocalization is altered to compensate for the disruption (e.g. speaking loudly when listening to music over headphones). To study auditory feedback control during speech production, we used a delayed auditory feedback (DAF) paradigm, which strongly disrupts speech fluency by causing stutter-like speech, characterized by syllable repetitions, prolonged words and longer pauses. While delaying speech in real time is a common therapeutic approach in stutterers, where it interestingly improves speech fluency, the underlying neural mechanism remains understudied and poorly understood. Here, we employed rare neurosurgical electrocorticography (ECoG) recordings directly from cortex. Subjects were visually presented with 3-syllable words and 8-word sentences in separate sessions. As they read aloud the presented stimuli, their voice was recorded by a microphone and played back to them with 0, 50,100 or 200 millisecond delays through earphones. Behaviorally, articulation duration increased significantly with increasing amount of delays for both word reading (For 0, 50, 100 and 200 ms delay: 0.72, 0.75, 0.78, 0.81; $F = 38.4$, $p = 10\text{-}9$) and sentence reading (2.77, 3, 3.49, 3.82; $F = 111$, $p = 10\text{-}16$). Neural responses in the high-gamma broadband frequencies (70-150 Hz) were used as the primary measure of neural activity. Auditory electrodes over the superior temporal gyrus showed increased neural responses as delays increased both for word reading ($F = 98$, $p = 10\text{-}16$) and for sentence reading ($F = 123$, $p = 10\text{-}16$). Motor electrodes showed increased neural responses for increasing delays only for sentence reading ($F = 37$, $p = 10\text{-}9$) but not for word reading ($F = 3.6$, $p = 0.06$). This represents one of the first reports of delayed auditory feedback in human electrophysiology. The data suggests that while auditory cortex encodes mismatches between intended and produced speech, motor cortex is preferentially engaged only when articulation demand increases during production of longer, more complex speech segments.

A8 Quantification and parcellation of posterior inferior frontal cortex connections to auditory association and supplementary motor area targets

Vatche Baboyan[1], Gregory Hickok[1], Nitin Tandon[2,3]; [1]Department of Cognitive Sciences, University of California, Irvine, [2]Vivan L Smith Department of Neurosurgery, University of Texas Medical School at Houston, [3]Memorial Hermann Hospital, Texas Medical Center, Houston

Diffusion imaging studies over the past decade suggest that a variety of intra- and inter-lobar association fibers important for language terminate near the posterior inferior frontal cortex (pIFC). These studies rarely examine the asymmetry of the connections to posterior temporal and superior frontal cortex pathways and their inter-relationship to language dominance. Here, we sought to quantify the structural connections of the pIFC, bilaterally, to well-known targets in auditory and motor association cortex within a set of neurosurgical patients having undergone the Intracarotid Amytal (Wada) Test for language lateralization. We tested whether left-right asymmetries exist among pIFC connections to the supplementary motor Area (preSMA/SMA), supramarginal gyrus, and posterior temporal cortex (STG/MTG). To infer a relationship between structural asymmetry and language laterality, only unilateral left-hemisphere language dominant subjects were enrolled in this study. Anatomical regions of interest were generated for the pIFC (comprising BA45, BA44, and ventral BA6), the supplementary (SMA proper) and pre-supplementary motor cortex (preSMA), the supramarginal gyrus (SMG), and posterior temporal cortex (STG/MTG). Probabilistic fiber tracking was implemented from each pIFC subregion to each of the target regions and inter-hemispheric differences in seed-to-target connectivity was compared. In addition, we performed a pIFC parcellation at the individual subject level by clustering seed-to-target connectivity computed from the pIFC as a whole. The resulting cluster areas were also statistically compared to determine whether the pIFC shows inter-hemispheric differences in it's preferred cortico-cortical connections. We found that BA45 showed a leftward asymmetry to the SMA and a rightward asymmetry to the SMG and pSTG. BA44 showed a significant leftward asymmetry of connections to the posterior MTG and rightward asymmetry of connections to the SMG. vBA6 showed a leftward asymmetry to both the pSTG and

pMTG. These findings demonstrate that the anterior portion of Broca's area (specifically, BA45) has a leftward asymmetry of connections to the supplementary motor area while posterior portions (BA44/vBA6) have leftward asymmetries of connections to posterior temporal cortex. Consistent with prior research, the present work implicates the significance of a left-dominant structural network of both pIFC to SMA and pIFC to MTG/STG connections for language function while a right-dominant network of pIFC to SMG network likely contributes to lateralized visuospatial function. This work also indicates that, similar to studies of the thalamus, a so-called "hard parcellation" of the pIFC on the basis of its structural connections may present a clinically useful imaging biomarker to lateralize speech and language function.

A9 What can we learn about reading from a lollipop? Exploring the role of sensorimotor feedback on the speed of reading in adults and children

Jacqueline Cummine[1], Angela Cullum[1], Daniel Aalto[1,2], Cassidy Fleming[1], Alesha Reed[1], Amber Ostevik[1], William Hodgetts[1,2]; [1]Communication Sciences and Disorders, Faculty of Rehabilitation Medicine, University of Alberta, [2]Institute for Reconstructive Science in Medicine

There is compelling evidence to indicate that reading is closely tied to speech production (i.e. the universal print-to-speech network). In this model, skilled and accurate reading relies on feedforward (i.e., motor representations) and feedback (i.e., auditory and somatosensory) processes. While the impact of altered auditory feedback has been studied extensively, little is known about the effects of somatosensory feedback on reading performance. Here we altered somatosensory feedback, via a large lollipop in the mouth, in three tasks that varied in the reliance on the feedback system: 1) a picture categorization (PIC task: no feedback needed: press '1' if the stimulus is an animal; press '2' if it is not an animal), 2) an orthographic lexical decision task (OLDT: minimal feedback needed: press '1' if the letter string spells a real word; press '2' if it does not spell a real word) and 3) a phonological lexical decision task (PLDT: feedback necessary: press '1' if the letter string sounds like a real word; press '2' if it does not sound like a real word). Participants (Adults N = 61; Children N = 24) completed each of the three decision tasks two times: once with a lollipop in their mouth and once without a lollipop. Four types of stimuli were used in each of the OLDT and PLDT reading tasks: regular words (e.g., brain), exception words (e.g., pint), nonwords (e.g., bint), and pseudohomophones (e.g., brane). A series of paired samples t-tests was used to test the impact of altered somatosensory feedback on response times (i.e., the button press), for each word type, in each of the tasks. Results showed that the presence/absence of the lollipop did not impact response times in the picture categorization task for either adults or children. However, pseudohomophones were identified faster in the OLDT for adults (34ms) and children (164ms), with the lollipop compared to no lollipop. In contrast, during the PLDT, regular words were identified slower for adults (44ms), but faster for children (164ms), with the lollipop as compared to no lollipop. The presence/absence of the lollipop had little, to no effect, on response times for exception words and nonwords in either task, for both adults and children. The implications of these results and the role of somatosensory feedback to the reading process will be discussed.

A10 Effects of HD-tDCS Current Intensity on Vocal Pitch Motor Control

Dirk B. Den Ouden[1], Danielle Fahey[1], Taylor McDonald[1], Janelle Rocktashel[1], Roozbeh Behroozmand[1]; [1]University of South Carolina

Introduction: High-Definition transcranial Direct-Current Stimulation (HD-tDCS) is a relatively recent innovation to the tDCS technique, by which the focality of cortical stimulation is improved through the use of multiple electrodes. This may increase the potential for tDCS to enhance treatment outcome for neurogenic disorders. However, with a method that allows greater control over stimulation parameters comes an increase in associated configurational choices. To a large extent, the different settings currently used in experimental studies are based on what is known from traditional tDCS, even though modeling studies show that the regional direction and intensity of electric field potentials in HD-tDCS are very different. Traditional tDCS studies have typically applied intensities of 1 and 1.5mA, but accepted safety practices allow HD-tDCS current intensities up to 2mA. It is unclear to what extent this should lead to increased effects, or rather whether there may be an upper effective intensity threshold, or even the possibility to 'overstimulate', yielding decreased behavioral effects beyond a certain threshold. In a previous study by our group, HD-tDCS of the left ventral motor cortex modulated the magnitude of compensatory vocal responses to pitch-shift stimuli in speech auditory feedback, particularly with cathodal stimulation for downward pitch shifts. This finding suggested that HD-tDCS can modulate the underlying neural mechanisms of vocal pitch motor control, and that the magnitude of behavioral compensation provides a sensitive outcome measure. Here we have used this outcome measure to test the effects of current intensity in a partial replication of our previous experiment. Methods: Twenty right-handed participants (19 females; mean age 23, range 18-28) received either 1mA or 2mA of cathodal HD-tDCS on left ventral motor cortex. Before, during and after stimulation, participants maintained steady vowel vocalizations and received randomized upward (+100 cents) and downward (-100 cents) pitch shift stimuli in their auditory feedback. We recorded participants' vocalizations and measured the magnitude of pitch shifts in response to feedback pitch alterations. Results: A main effect of time point on the amount of pitch shift in response to altered auditory feedback was present for downward ($F(1.371, 24.7)=4.941$, $p<.05$), but not for upward pitch-shift stimuli ($F(1, 18)=.821$, ns). This main effect

was driven by a significant reduction in the magnitude of vocal compensation between the pre-stimulation and the post-stimulation time points (pairwise t-test: p<.05). For neither of the two pitch-shift directions was there a main effect of intensity, nor an interaction between time point and intensity. Conclusion: Results replicate our earlier findings, in that cathodal HD-tDCS reduced the magnitude of compensatory responses to downward pitch shifts in the auditory feedback. No effect of stimulation current intensity was present. At this point, therefore, we conclude that 2mA of HD-tDCS does not increase (nor reduce) behavioral effect sizes of HD-tDCS. This is in line with the idea that there is an upper threshold of stimulation intensity beyond which no added benefits may be generated. Practically, for our purposes, it also means we may increase the lifetime of HD-tDCS electrodes, by limiting their use to 1mA.

Phonology and Phonological Working Memory

A11 Adaptive paradigms for mapping phonological regions in individual participants

Melodie Yen[1], Andrew T. DeMarco[2], Stephen M. Wilson[1]; [1]Vanderbilt University Medical Center, [2]Georgetown University

Phonological encoding depends on left-lateralized regions in the supramarginal gyrus and the ventral precentral gyrus. Localizing these phonological regions in individual participants is important in several research and clinical contexts. These applications include presurgical language mapping, studying functional reorganization in recovery from aphasia, and as functional localizers for ROI-based analyses. Existing language mapping paradigms do not consistently localize these phonological regions in individual participants. To address this challenge, we designed two tasks that load on speech sound knowledge: a rhyme judgment task and a syllable counting task. In the rhyme task, participants decided whether or not two pseudowords rhymed. In the syllables task, they decided whether or not two pseudowords had the same number of syllables. Critically, both tasks used an adaptive staircase design to ensure that each individual found each task similarly challenging. The baseline was an adaptive perceptual judgment task. The goal of this study was to assess the validity of the two paradigms, in terms of their ability to produce left-lateralized activations within the supramarginal gyrus and ventral precentral gyrus in neurologically normal individuals with presumptively normal language organization. Sixteen healthy participants were scanned with fMRI as they performed the rhyme judgment paradigm, the syllable counting paradigm, and an adaptive semantic matching paradigm we have described previously, which reliably activates inferior frontal and posterior temporal language regions. We included this semantic paradigm to investigate the extent to which the phonological paradigms could successfully identify regions specific to phonological encoding and not just language processing in general. We found that the rhyme and syllable paradigms both activated supramarginal and ventral precentral regions in the majority of participants (supramarginal: 13/16 for both; precentral: 14/16 for rhyme and 15/16 for syllables). In contrast, these regions were almost never activated by the semantic matching paradigm (never more than 3/16), suggesting that these activations are driven by phonological encoding and not by generic language processing. The extent of supramarginal and precentral activation was greater for both phonological paradigms than the semantic paradigm (all pairwise t-tests $p < 0.0001$), while the phonological paradigms did not differ from one another. These activations were strongly left-lateralized, suggesting they reflect linguistic rather than domain-general cognitive processes. The mean lateralization index in the supramarginal gyrus was greater for the rhyming task (LI = 0.99 ± 0.03) than the syllables task (LI = 0.71 ± 0.38, $p = 0.02$), while both paradigms showed similar lateralization in the precentral gyrus (rhyme: LI = 0.84 ± 0.24; syllables: LI = 0.74 ± 0.32; $p = 0.18$). Because of its greater ability to reveal lateralized parietal activation, we advocate using the rhyme paradigm in future applications. In sum, our findings show that the proposed adaptive rhyme judgment paradigm robustly identifies phonological encoding regions in individual participants. In conjunction with the semantic matching paradigm, it can be used to derive multifaceted individual language maps whereby regions are distinguished in terms of specific language domains, going beyond the concept of undifferentiated "eloquent cortex".

A12 The impact of alphabetic script acquisition on Cantonese phoneme judgement: a combined behavioral and ERP study

Yubin Zhang[1], Jessica Ka Yui Leung[1], Chotiga Pattamadilok[2], Dustin Kai Yan Lau[1], Mehdi Bakhtiar[1], Caicai Zhang[1,3]; [1]The Hong Kong Polytechnic University, [2]Laboratoire Parole et Langage, CNRS, [3]Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences

Acquisition of an alphabetic script induces remarkable behavioral and cerebral changes in speech processing. For example, it can lead to enhanced phonological awareness — the ability to segment the spoken language into smaller sound units. However, only a few studies have examined the extent that these changes also occur in logographic readers, like Chinese readers, who have learned a Romanization system of their native language during adulthood. In this study, we focused on the impact of learning Jyutping, a Romanization system of spoken Cantonese, on explicit phoneme judgement and its underlying neural activities in native Cantonese speakers. A GROUP (Jyutping + Chinese vs. Chinese) × STIMULUS (speech vs. pure tone) × LIST (global vs. segmental) design was adopted. Fourteen native Cantonese speakers with both logographic Chinese and Jyutping proficiency (Jyutping + Chinese group) and 12 matched controls only literate in Chinese (Chinese group) were tested on a

Cantonese initial phoneme judgement task (speech) and pure tone judgement task (pure tone). The two groups were matched on their English proficiency. On the initial phoneme judgement task, participants judged whether pairs of Cantonese CV(C) pseudowords had the same initial, while on the pure tone judgement task, they judged whether pairs of tone-triplets shared the same initial tone. The pure tone task served as a control condition, as the impact of Jyutping acquisition was not expected to generalize to other auditory discrimination tasks. The test materials for both tasks were further divided into two lists – global and segmental. The global list included pairs of pseudowords with the same rimes (e.g., paa2 and faa2) and pairs of tone-triplets with the same non-initial tones (e.g., 200Hz1600Hz800Hz – 200Hz1600Hz800Hz), whereas the segmental list contained materials with more irrelevant variations, namely different rhymes (e.g., paa2 and paai2) or different non-initial tones (e.g., 200Hz1600Hz800Hz – 200Hz1400Hz1800Hz). These variations could interfere with the judgement of the initial sound, pushing listeners to adopt a 'segmentation' strategy, especially in the speech-segmental condition. Both behavioral (RT and accuracy) and EEG data were collected for analysis. Accuracy results showed that both groups performed significantly worse in the speech-segmental condition than in other conditions. As for RT, a marginally significant three-way interaction indicated that the group difference in RT on correct trials was largest in the speech-segmental condition, where the Chinese group performed much slower than the Jyutping + Chinese group. Electrophysiologically, compared with the Chinese group, the Jyutping + Chinese group exhibited a prolonged negativity in the 200-300 time-window (N200) and the following 300-400 ms time-window (P300), while processing the second syllable in the speech condition. This group difference might be attributed to their different phonological processing abilities, namely, phonological awareness and working memory. Enhanced phonological processing skills were found in Cantonese native speakers who had learnt Jyutping, at both the behavioral and neural levels. This finding suggests that speech processing, especially explicit phoneme judgement, can be changed even for logographic readers who have acquired an alphabetic script late in adulthood. This underscores the plasticity of the human brain even in adulthood.

A13 Fast phonotopic mapping with oscillation-based fMRI – Proof of concept

Mikkel Wallentin[1,2], Torben Ellegaard Lund[2], Camilla M. Andersen[1], Roberta Rocca[1]; [1]Department of Linguistics, Cognitive Science and Semiotics, Aarhus University, [2]Center of Functionally Integrated Neuroscience, Aarhus University Hospital

INTRODUCTION: The auditory cortices contain tonotopic representations of sound frequency (e.g. Saenz and Langers, 2014), but how about functional organization of speech sounds? Previous experiments have hinted at a phonotopic map (e.g. Formisano et al., 2008), but the temporal and spatial resolution of neuroimaging has made it difficult to construct protocols for mapping phonemes in the brain. Here, we describe a novel oscillation-based method, using a fast fMRI protocol, building on findings that the BOLD signal having higher temporal fidelity than hitherto imagined (Lewis et al., 2016). METHODS: Stimuli consisted of pairs of phonemes making up syllables. Two conditions (9v5c and 9c5v) combined 9 Danish vowels/consonants with 5 consonants/vowels to create a total of 45 syllables per condition. In each condition, consonants and vowels were repeated in a fixed order, i.e. in condition 9v5c, a vowel would be repeated on every 9th trial, and the consonant would be repeated every 5th trial, making every combination new for the 45 trials, but at the same time creating two highly predictable rhythms for vowels and consonants. Sessions consisted of 6x4 blocks: [6x9v5c, 6x9c5v, 6x9v5c, 6x9c5v], lasting 18 minutes. Three sessions were acquired in a single participant (female, 25 years) for this preliminary study, yielding a total of 72 blocks. fMRI data was acquired at 3T using a whole-brain fast acquisition sequence (TR = 371ms, multi-band EPI acquisition) to capture signal changes at syllable resolution. Data were modelled using sine and cosine waves at the presentation rate for vowels and consonants, i.e. either 1/9 Hz or 1/5 Hz. Fitted sine and cosine waves were used to generate a phase map for each 45 s block. Phase is indicative of the delay in a voxel's responsiveness to a repetitive stimulus, thus here suggesting differences in phoneme responsivity. Phase maps from each block were used to perform a multivariate classification test. The phase maps for the 72 blocks were divided into two. The first half was used to conduct a search-light analysis (using the nilearn-package in Python) in order to select the 500 most predictive voxels. These voxels were used in a subsequent pattern classification test on the 2nd half of the phase maps. Both steps involved a Gaussian naïve-bayes classifier. Cross-validation and permutation tests were used to determine significance. RESULTS: Univariate SPM-analysis across all data showed a significant difference ($P<0.05$, FWE-corrected) between consonants and vowels in the left auditory cortex. The same areas also differentiated between phonemes oscillating at 1/5 Hz and 1/9 Hz, regardless of phoneme type. Classification tests were able to classify 45 second phase maps from the 9s condition into consonants and vowels with 77% accuracy ($p<0.03$) and 5s condition with 75% accuracy ($p<0.02$). CONCLUSION: This protocol provides the first step towards mapping a phonotopic "fingerprint" across multiple phonemes simultaneously at the individual participant level. This map may be used to predict native language, foreign language exposure as well as literacy. It is also the first step towards making use of fMRI signal for decoding at near speech rate temporal resolution.

Perception: Speech Perception and Audiovisual Integration

A14 Articulatory suppression enhances visual discrimination of speech

Matthew Masapollo[1], Frank Guenther[1,2]; [1]Department of Speech, Language, & Hearing Sciences, Boston University, [2]Department of Biomedical Engineering, Boston University

It is well established that somatosensory signals from the vocal tract play an important role in speech production and motor control (see Perkell, 2012; Guenther, 2016, for reviews). Recently, studies have provided evidence that orofacial somatosensory inputs also influence the perception of speech sounds in both adult speakers (Ito et al., 2009; Ito & Ostry, 2012) and pre-babbling infants (Yeung & Werker, 2013; Bruderer et al., 2015). Whereas these and other psychophysical experiments have demonstrated complex somatosensory-auditory interactions during speech processing at a behavioral level, neuroimaging studies indicate that visual speech cues in talking faces influence activity in somatosensory cortex above and beyond its response to auditory speech cues alone (e.g., Skipper, Nusbaum & Small, 2005; Matchin, Groulx & Hickok, 2014). Thus, understanding the contribution of potential somatosensory-visual interactions during speech processing may yield additional key insights into perception-action linkages for speech. Toward this end, we examined whether there are effects of articulator suppression on visual speech perception by measuring viseme discriminability while participants held a bite block or lip tube in their mouths. Visual stimuli were natural productions of vowels from within the same phonemic category (/u/) or from two different phonemic categories (/□-æ/). We chose vowels whose corresponding visemes are optically distinct. For the within-category contrast, the variants of /u/ were produced with different degrees of visible lip compression and protrusion. For the between-category contrast, /æ/ was produced with a lower mandibular position than /□/. Multiple tokens of each vowel were video recorded by a female speaker. To create the visual-only discrimination pairings, the audio track was removed from the AV recordings of the model speakers' productions. Thirty-eight monolingual English speakers were tested using a traditional same-different (AX) discrimination task. For the baseline group, the AX task was conducted with no oral-motor manipulation. For the experimental group, the AX task was conducted with either a tube between the lips or a bite block between the upper and lower teeth. Subjects were assigned randomly to one of the two conditions. On each trial, subjects watched silent video sequences of the model speaker articulating the vocalic gestures, and then judged whether they were the same or different. We employed a signal detection theory analysis to assess perceptual sensitivity; the dependent measure was a-prime. Results showed that when proprioceptive information from subjects' own vocal tracts was constrained, their overall discrimination performance was significantly better compared to baseline ($p = .058$). There was also a trend such that discrimination of the within-category (/u/) pairings was highest for the subjects with a tube inserted between their lips, whereas discrimination of the between-category pairings (/□-æ/) was highest for the subjects with the bite block between their teeth. There is not sufficient statistical power to compare performance across the two perturbation types, thus further research is still needed to assess whether this pattern interacts with vowel contrast. Nevertheless, these findings raise the intriguing possibility that suppression of an articulator (lips or jaw) may heighten attention to visible movements of that articulator during concurrent speech perception.

A15 Audiovisual speech integration in cochlear implant users: A behavioral and optical neuroimaging study

Iliza Butera[1], Rene Gifford[1], Mark Wallace[1]; [1]Vanderbilt University

Cochlear implants (CIs)—widely considered the most successful neuroprosthetic devices—afford over half a million users worldwide access to sound following severe-to-profound hearing loss. However, visual cues remain vitally important for many CI users to interpret the impoverished auditory information that an implant conveys. While auditory-only speech understanding is well characterized in clinical outcome measures, relatively little is known about audiovisual (AV) speech comprehension in this cohort. The aim of this study is to characterize AV integration of speech in CI users compared to normal-hearing controls using both behavioral and neuroimaging approaches. We reasoned that CI users' high proficiency with visual-only oral communication (i.e, lip reading) may contribute to enhanced audiovisual processing following implantation. To-date, we have recruited 18 adults with CIs who have completed monosyllabic word recognition testing using 224 words arranged into 9 lists of 40 words each. Using these stimuli, we tested word recognition in three modalities (A, V, AV) and three auditory signal-to-noise ratios (SNRs). Because the components of a multisensory stimulus are more effectively integrated when the salience of the components is relatively weak (i.e., greater gain is seen), we conducted this behavioral testing in quiet and in two levels of multi-talker babble that partially masked the target speaker's voice presented at 60 dB SPL. We sought to measure AV gain at individualized noise levels that approached identification of 20% of words in the auditory-only condition as well as a moderate noise level targeting 50% identification. The resulting SNRs across all subjects ranged from +15 to -5 dB, and we quantified audiovisual integration using the formula: (AV - max(A,V)) / max(A,V) x 100%. Preliminary analyses indicate that the CI cohort experiences AV gain both with and without background noise. However, multisensory-mediated gain measured in quiet (median= 29%) was not significantly different than gain at a moderate noise level (median= 63%; Mann-Whitney U= 80, n1 = 18, n2 = 13,

p = 0.1 two tailed). In comparison, AV gain measured in high noise SNRs (median 106%) was significantly greater than the moderate SNRs (Mann-Whitney U= 41, n1 = 17, n2 = 13, p = 0.003 two tailed). Ongoing recruitment of an age-matched, normal-hearing control group will allow us to perform a between-groups comparison to test whether this AV gain in CI users is greater than controls, particularly at the highest noise level. Additionally, we have collected optical neuroimaging data using functional near-infrared spectroscopy (fNIRS) in CI users (n = 15) to further test whether greater recruitment of multisensory areas like the superior temporal sulcus (STS) is also evident in a between-groups comparison. The overall goal of this work is to better understand audiovisual integration and how it relates to speech comprehension of CI users. This knowledge is essential for our understanding of proficiency with a CI and, most importantly, for how users can best utilize all sensory information to enhance speech intelligibility and improve quality of life.

A16 Audiovisual facilitation in speech depends on musical background – An ERP study. *Marzieh Sorati[1], Dawn Marie Behne[1]; [1]Norwegian University of Science and Technology (NTNU)*

Audiovisual information facilitates perception in comparison to an audio-only condition. Visual information accompanying sound, such as corresponding mouth movements while articulating a syllable, adds an anticipatory effect which can facilitate audiovisual perception. Although this audiovisual facilitation has been tested in groups with different ages, emotions, languages and with different speech and non-speech stimuli, yet unclear is whether musical training enhances audiovisual facilitation. While extensive experience through musical training can increase neural plasticity and improve auditory perception, an unattended question is whether this improvement is specific to unimodal auditory perception or transfers to audiovisual perception. The current study addresses differences between musicians and non-musicians in audiovisual facilitation in speech due to the addition of visual information. ERP data were collected from 12 participants (six musicians and six non-musicians) in response to the syllable /ba/ in audio-only (AO), audiovisual (AV) and video-only (VO) conditions. In the audio-only condition, analyses of N1-P2 latencies and amplitudes showed that musicians have an improved N1 latency compared to non-musicians. These results are consistent with previous ERP research indicating that musicians have improved auditory perception. Next, to isolate the anticipatory effect of visible mouth movements, the ERP waveform from the video-only condition was subtracted from the audiovisual condition (AV-VO) and compared to the corresponding audio-only ERP waves. An analysis of variance with musical background and condition (AV-VO vs. AO) as factors showed a tendency for an interaction with a large effect size for N1 latency; the difference between AV-VO and AO was therefore further analyzed for each group. Consistent with other recent studies, non-musicians showed facilitation in N1 latency. Notably, musicians showed no significant difference in N1 latency when comparing the AV-VO difference wave and AO condition. These findings imply that AV facilitation is affected by the musical background of the participants. The expected finding, also observed here for non-musicians, is for greater facilitation for the AV-VO than AO condition. However, this was not found for musicians, for whom N1 latencies were already short relative to the non-musicians and were not further reduced in the AV-VO difference wave. Whereas non-musicians, who have relatively late unimodal N1 latencies have AV facilitation, the unimodal audio facilitation that comes with a musical background is not further facilitated for audiovisual speech, suggesting that the extent to which N1 latency for audio perception is facilitated may have limitations.

A17 Aging diminishes auditory activation for single spoken words: evidence from fMRI *Chad Rogers[1], Michael S. Jones[1], Sarah M. McConkey[1], Brent Spehar[1], Nichole Runge[1], Kristin J. Van Engen[1], Mitchell S. Sommers[1], Jonathan E. Peelle[1]; [1]Washington University in St. Louis*

Normal aging is associated with changes in not only cognitive functioning, but sensory ability. Hearing loss is one of the most common complaints in adults aged 60 and over, and is the third most chronic medical condition aside from arthritis and hypertension. Despite the relative prevalence of hearing loss, older adults' language processing is generally quite good, with age-related declines in performance typically observed only in situations presenting enhanced perceptual or cognitive challenge (Wingfield & Stine-Morrow, 2000). A central question is how older adults are able to maintain such good performance despite significant changes in cortical anatomy and related changes in cognitive ability. Although it is widely accepted that understanding spoken words relies on bilateral temporal cortex in young adults (e.g., Lee et al., 2016; Hearing Res), relatively few studies have directly investigated age-related changes in the processing of spoken words. In the current study, we examined age-related changes in neural recruitment for spoken word processing. Using sparse functional magnetic resonance imaging (fMRI), brain activity patterns were compared between samples of young (N=32) and older adults (N=32), who performed two speech perception tasks: repetition of spoken words and passive listening of spoken words. Words were presented in the clear, with no additional noise masking. While older adults were less successful than young adults while identifying words in the scanner (Young M = 0.93, SD = 0.03; Older M = 0.73, SD = 0.17), both young and older adults showed significant speech-related activation in bilateral superior temporal gyrus (STG). Comparisons between the young and older adult groups suggested that young adults had stronger and wider speech-related activation of regions in bilateral STG than older adults. Comparisons of word repetition

vs. passive listening revealed that young adults produced stronger activation in bilateral motor areas when repeating words than passive listening compared to older adults. The current study thus provides preliminary evidence that even under conditions of minimal linguistic and acoustic challenge (i.e. when listening to spoken words in quiet conditions), older adults with normal hearing for their age activate auditory processing regions less robustly than young adults (see also Vaden et al., 2016; Exp Aging Res). This pattern also held for motor-related activations when participants repeated words aloud. Future directions and potential relationships between patterns of observed activation and subthreshold hearing loss will be discussed.

A18 The role of left vs. right superior temporal gyrus in speech perception: An fMRI-guided TMS study

Aurora I Ramos Nunez[1], Qiuhai Yue[2], Siavash Pasalar[2], Randi C Martin[2]; [1]College of Coastal Georgia, [2]Rice University

A large body of neuroimaging research has implicated the superior temporal gyrus (STG) in speech perception. Price et al.'s (2012) review found that while some studies showed activity only in the left STG for speech stimuli, others showed activity in bilateral STG. However, activity is generally greater on the left and debate continues regarding the necessary role of right STG regions (Turkletaub & Coslett, 2010). The present study employed transcranial magnetic stimulation (TMS) applied to regions activated for speech vs. nonspeech stimuli to directly assess whether both left and right STG regions are causally involved in speech perception. Twenty healthy Rice University students (7 males, 13 females) between the ages of 18 and 22 participated in this fMRI-guided TMS experiment. Participants performed speech and nonspeech discrimination tasks (during the fMRI session) and a speech perception task only (during the TMS session). FMRI was used to detect activity in the STG of each participant which showed greater activation for speech than nonspeech, serving as the landmarks for the Brainsight neuronavigation system for the TMS session. During the fMRI session subjects heard pairs of one-syllable speech sounds and pairs of musical tones and were instructed to make a same or different decision. One anatomical and two functional scans were acquired. During the TMS session, subjects heard pairs of syllables differing in one distinctive feature (one spoken in a male voice and one in a female voice). During the speech discrimination task, three target regions (left anterior and posterior STG and right STG) and one control region (the occipital (V1) cortex) were stimulated via three pulses very 100msec. at onset of the first sound. FMRI analyses were performed on a subject-by-subject basis and were FDR-corrected for multiple comparisons (p level of .001). Consistent with the literature, all 20 subjects showed greater activity in bilateral STG during speech relative to nonspeech perception, but not in the control region (V1). The effects of TMS were analyzed by calculating accuracy difference on speech discrimination between TMS and No TMS in the target and control areas during the speech perception task. There was a 24% accuracy difference between TMS and No TMS in the left anterior STG, which was significantly greater than the 11% difference in the control region; t (1,19) = 2.631, p = 0.016. Neither the accuracy difference in the left posterior STG (15%) nor in the right STG (13%) was significantly different from that in the control region (11%), t (1,19) = .70, p = .49, and t (1,19) = .47, p = .65, respectively. The present study demonstrated a causal relationship between the left anterior STG and speech perception in that TMS disrupted this process. This was not seen in any of the other target areas and suggests that the left anterior STG plays a greater role in speech perception than the right STG. To our knowledge, this is the first study to demonstrate such direct relationship. However, the left posterior STG did not show a TMS effect, thus more research is needed.

A19 Neural orienting response does not differ between hearing own and other names in autistic individuals with language impairments

Sophie Schwartz[1], Le Wang[1], Barbara Shinn-Cunningham[1], Helen Tager-Flusberg[1]; [1]Boston University

When you hear your name, you quickly turn towards its source. That's because your name is salient and elicits a strong orienting response, even in 12-month-old infants. However, core deficits in autism disrupt automatic orienting to own name and is an early sign of the disorder. This begs the question of what other salient speech might they be missing and how this might affect language development and everyday communication. Research has found that children and adults show a positive event-related potential response (ERP) to their own name but not other peoples' names over parietal-occipital channels around 300 milliseconds post-stimulus (i.e., a P3), in attentive and inattentive states, and even in sleep and comatose states. Moreover, recent evidence suggests that adults with autism have a smaller P3 to own name when compared to typically developing (TD) adults (Nijhof et al., 2018). Prior work has also highlighted that there may be a strong relationship between the ability to segregate streams and extract salient speech from noise and the integrity of language skills in autism. Our work expanded on prior findings by investigating ERPs to names in both quiet and multispeaker noise background, in TD listeners and autistic listeners with a wide range of language skills. We presented subjects, ages 13-23, with audio-recordings of their own and two other subjects' names in a passive ERP paradigm while the subjects were watching a silent movie. We presented 162 trials of each name across six condition blocks, alternating between quiet and noise conditions. Names were spoken by a familiar female voice, while overlaid multispeaker babble was composed of six male speakers. In the quiet condition, TD subjects showed a stronger P3 to their own name relative to other names during the first 30 presentations of each name (p=0.05), replicating prior studies that only presented this many trials. However, after 162 presentations of each name, topography of response changed. With more

trials, TD subjects showed a habituated frontal channel ERP to their own name around 250-300 milliseconds relative to other names ($p<0.05$). When the names were presented in the noise condition, response to own name was significantly larger than to other names, lasting from 300 to 700 milliseconds, along parietal-occipital channels (i.e., a prolonged P3) ($p<0.05$). In contrast, subjects with autism showed no significant difference in response to their own and other names in either quiet or multispeaker noise conditions. Preliminary findings suggest that reduced differentiation between own name and other names is more pronounced in autistic subjects with more severe language impairments. This study is the first to investigate cortical response to names in multispeaker noise, not only in autism, but also in typical development. Future work will expand on these findings by considering within-subject variability as it relates to neural response and language profile. Findings may have strong implications for interventions that target sound processing in those with autism who are at heightened risk for language disorders.

Writing and Spelling

A20 Word-Level Spelling Performance in Patients with Parietal versus Temporal-Frontal Lobe Lesions: Implications for the Dual Lexica Model

Venugopal Balasuramanian[1,2], Maureen Costello-Yacano[3], Maha Alders[4], Judith Koebli[1]; [1]School of Health and Medical Sciences, Seton Hall University, South Orange, New Jersey, [2]SCORE Lab, Johns Hopkins School of Medicine, [3]LaSalle University, Philadelphia, PA, USA, [4]King Faisal Specialist Hospital and Research Center, Riyadh, Saudi Arabia

Hickok and Poeppel (2004; 2016) proposed their dual (dorsal and ventral) stream model to account for the neural underpinnings of speech and language processing from auditory input and, it is evident that it gave a new impetus to research in the field of neurobiology of language/speech. Based on this model, Gow (2012) proposed a dual lexica model: Dorsal and ventral lexica. The two lexica, according to Gow, will facilitate different processes in the dual streams. Gow localizes the dorsal lexicon (DL) in the inferior parietal lobe, including the supramarginal gyrus. The DL provides interface between the articulatory and phonetic representations. The ventral lexicon (VL), neurologically rooted in the superior posterior temporal sulcus and mid-temporal gyrus, provides interface between word and meaning. The present study aimed at using the dual lexica model of spoken language processing (Gow, 2012) to discuss the performance of two persons with aphasia on a few lexical tasks, in particular, spelling to dictation and reading tasks. If the dorsal lexicon is impaired due to parietal lobe lesions, one would expect phonological paraphasias in reading and phonologically-related substitutions in spelling. If the ventral lexicon is implicated due to temporal lobe lesions, one would expect semantic paraphasias/deep dyslexias in oral reading and deep dysgraphia in spelling to dictation. Method. Subjects. LK, a 45 year-old male with a stroke induced lesion in temporal region extending up to a portion of the frontal lobe and the basal ganglia of the LH. CBH is a 59-year-old female aphasic with bilateral parietal lobe lesion. Procedures. Clinical testing (BDAE, BNT), Experimental Testing:1) Johns Hopkins University Dysgraphaia Battery, 2) Psycholinguistic Assessment of Language Performance of Aphasics (reading and writing sub-tests). Using the performance profiles, the cognitive components implicated in the subjects' performance were identified. Results and Discussion. Lk's reading is less severely affected, compared to his writing, such a disparity in performance is expected because writing is a harder task. He has symptoms of deep dyslexia without the symptoms of deep dysgraphia. Semantic errors (9% of all reading errors) were found only in reading. If the interface between semantic representations and the auditory input (dictation) is interrupted, then the errors will include semantically related ones. At this point in time, the VL's relation to orthographic representation of words is not specified. CBH's writing performance revealed impaired lexical-semantic component, whereas her reading performance fails to show a matching deficit. This finding does not accord well with the prediction about the phonologic/articulatory relationship in spelling errors. Thus the DL in Gow's model is underspecified to account for semantic nature of the error pattern in CBH. The role of the supramarginal gyrus in semantics is attested in clinical literature as evidenced in Luria's category of semantic aphasia. A recent meta-analysis of fMRI studies of semantic processing (Binder, Desai, Graves and Conant, 2009) identified three cortical systems for semantic processing, including the posterior multimodal and heteromodal association areas. To account for language processing in reading and writing, both the dual stream and dual lexica models will require further extension.

Perception: Orthographic and Other Visual Processes

A21 How are visual words represented? Insights from EEG-based image reconstruction during reading

Shouyu Ling[1], Andy C.H. Lee[1,2], Blair C. Armstrong[1,3], Adrian Nestor[1]; [1]University of Toronto Scarborough, [2]Rotman Research Institute, [3]BCBL. Basque Center on Cognition, Brain, and Language

Investigations into the neural basis of orthographic processing have made considerable progress by exploiting the spatial structure of functional magnetic resonance imaging (fMRI) data. For instance, fMRI patterns in high-level visual cortex have been recently used to decode the visually word forms presented to participants , providing insights into "what" and "where" orthographic information is stored. However, such investigations tell us relatively little about "what" and "when" specific properties of a word are represented over time. Here, we capitalize on the spatiotemporal structure of electroencephalography (EEG) data to examine the neural signature of visual word

processing, its representational content as well as its spatial and temporal profile. Specifically, we investigated whether EEG patterns can serve for decoding and reconstructing visually presented words in neurotypical young adults. To this end, data were collected from 14 participants who performed a one-back repetition detection task on 80 three-letter high-frequency nouns with a consonant-vowel-consonant structure. EEG pattern analyses were conducted across time-domain and frequency-domain features for 64 recording channels for the purpose of word decoding (i.e., classifying which word was presented) and reconstructing the visual image. The decoded EEG patterns and the recovered visual images of the words were estimated using a neural-based image reconstruction algorithm. Our results show that: (i) word classification accuracy was well above chance across participants (range: 69-78% versus 50% chance level); (ii) word decoding and image reconstruction was achieved at a similar level of accuracy, providing an important means of visualizing an answer to the "what" question; (iii) relatedly, letters in all positions were reconstructed above chance, though we also note a marked advantage for the nucleus (i.e., the vowel); (iv) regarding the "when" question, the time course of classification/reconstruction accuracy peaks in the proximity of the N170 component, and (v) the relevant structure of the EEG signal across occipitotemporal electrodes was correlated with processing in the left visual word form area as suggested by additional fMRI data. Further, we found that reconstruction results are well explained by objective orthographic similarity and image similarity across word stimuli. Last, we noted individual differences in the representational orthographic structure across participants. These differences may relate to different reading strategies. Thus, our results establish the feasibility of using EEG signals to support decoding and image reconstruction as applied to orthographic stimuli. Moreover, they shed light on the temporal dynamics of orthographic processing and they take steps toward accounting for the representational structure of EEG signals in terms of their fMRI counterpart. The parallels between our findings and analogous work in face processing also illustrate the domain generality of our approach. More generally, the current findings provide a new window into visual word recognition in terms of the underlying features, the spatiotemporal dynamics, and the neurocomputational principles governing visual recognition.

A22 The left lateralization of print-specific negativity depends on visual attention in competitive stimuli.

Tomoki Uno[1,2], Takashi Katakura[3], Tetuko Kasai[4]; [1]Graduate School of Education, Hokkaido University, [2]Japan Society for Promotion of Science Research Fellow, [3]School of Education, Hokkaido University, [4]Faculty of Education, Hokkaido University

INTRODUCTION: Fluent reading requires to implicitly decode the phonological information from logographic scripts. Previous studies using event-related potentials (ERPs) showed that such implicit grapheme-to-phoneme conversion was reflected by the print-specific N170, which was typically distributed over left occipito-temporal areas (Bentin et al., 1999; Maurer & McCandliss, 2007). Although early print processing may highly be automatized, recent studies have suggested that the leftward asymmetry of the N170 depends on visual attention based on observations in separate experiments (Okumura et al., 2014, 2015). The present study tested this notion, by directly manipulating visual attention for letter/symbol strings that were spatially overlapped with random-dot fields. We asked participants to attend either the strings or dots, so that the amount of attention available for letter strings were varied. METHODS: Twelve native Japanese speakers (6 females, 21-27 years) participated in this experiment. Hiragana words, nonwords and symbols strings (107 stimuli each) were spatially overlapped with the random-dot field (1° by 4.1°) and presented for 100 ms with interstimulus intervals of 300-600 ms (50 ms/step). In the attend-string condition, participants were required to detect navy letter/symbol strings (i.e., target) and to ignore navy-dot field (i.e., nontarget), while the targets and nontargets were reversed in the attend-dot condition. Each block contained 279 standard stimuli (both strings and dots were black), and 21 targets and 21 nontargets in both conditions. RESULTS: RTs were faster and Hit rates were higher in the attend-string task compared to the attend-dot task ($ps<.01$), and FA rates were higher in the attend-dot condition ($p=.009$). These behavioral results indicate that attending to strings was easier than attending to dots and that letter/symbol strings were more salient objects. In ERP results during 150-200 ms poststimulus, hiragana words induced a more negative deflection compared to the other stimuli ($p=.006$), which did not differ across the attention conditions ($p=.26$). Importantly, a left-lateralized negative enhancement for prints was observed only in the attend-string condition during 200-300 ms ($p=.03$). DISCUSSIONS: In the present study we observed a pattern of results similar to that in previous studies during C1/P1 and N170 latencies (e.g., Okumra et al., 2015; Proverbio & Adorni, 2009). However, interestingly, the letter-string/word effects were generally delayed, which may be due to additional time required for segregating letter strings from visual noise (i.e., dots). As the earliest effect, we found a word-specific negativity during 150-200 ms regardless of the attention conditions. Such insensitivity to attention suggests that word representations in early stages of the cortical hierarchy can be activated basically in an automatic fashion. Most importantly, attending to letters did elicit a left-lateralized negativity during 200-300 ms, which may be a correlate of the typical print-specific N170. Given that the left-lateralization of print-specific negativity reflects phonological mapping (Maurer & McCandliss, 2007), it is suggested that attentional resources are necessary for activating phonological information from prints.

A23 White matter tract of orthographic recognition and its functional plasticity: Evidence from patients and congenital blinds *Ke Wang[1], Xiaonan Li[1], Ruiwang Huang[2], Junhua Ding[1], Luping Song[3], Zaizhu Han[1]; [1]State Key Laboratory of Cognitive Neuroscience and Learning, Beijing Normal University, [2]School of Psychology, South China Normal University, Guangzhou, China, [3]College and China Rehabilitation Research Center, Capital Medical University, Beijing, China*

Orthographic recognition, a pivotal stage during word reading, has been found to be supported by a neuroanatomical network. However, the white-matter connectivity in this network remains unclear because prior findings might be confounded by impure behavioral measures, potential brain structural reorganization, or limited samples of subjects and white-matter tracts. It is also unclear which part of the connectivity is inherent and which part is determined by postnatal visual experience. To address these issues, we separately investigated the relationship between the integrity of 20 major tracts in the whole brain and the pure orthographic index across 70 patients with short-term brain damage and across 31 congenitally blind readers. The integrity of the tracts was evaluated using the mean fractional anisotropy value (for patients and blind readers) and the lesion volume percentage (for patients). The orthographic index was measured by the residual of accuracies in the orthographic tasks, regressing out accuracies in the corresponding non-orthographic tasks. The observed effects of orthographic tracts were further validated by ruling out the influence of numerous potential confounding variables. We found that the left inferior longitudinal fasciculus (ILF) was the only orthographic tract whose integrity values were significantly correlated with orthographic scores in the patients. Moreover, when the tract was split into the anterior and posterior branches along the visual word fusiform area (VWFA), both branches contributed to orthographic recognition in the patients. More importantly, the visual deprivation forced only the posterior but not the anterior branch of the tract to engage in orthographic processing, since the integrity values of the posterior rather than the anterior branch were significantly correlated with the performance of orthographic recognition in the congenitally blind subjects. Furthermore, the observed effects could not be accounted for by the potential confounding factors. These findings strengthen the vital role of the left ILF in orthographic processing and reveal the functional neuroplasticity of this tract in response to visual experience deprivation.

A24 Neural oscillations as a brain signature of statistical learning? *Louisa Bogaerts[1], Ayelet N. Landau[1], Craig G. Richter[2], Ram Frost[1,2,3]; [1]The Hebrew University of Jerusalem, Israel, [2]Basque center on Cognition, Brain and Language, [3]Haskins Laboratories*

Statistical learning (SL), the ability to extract distributional properties of sensory input across time and space, is taken to be the main mechanism by which cognitive systems discover the underlying regularities of the environment. Since the seminal demonstration of Saffran and colleagues (1996) that infants are able to segment speech on the basis of transitional probabilities, a large number of studies have demonstrated that people often display a remarkable sensitivity to the co-occurrence of stimuli in an input stream. This was shown across a range of stimuli, for newborns as well as adults, and across sensory modalities. By highlighting experience-based principles for detecting regularities SL research has offered a new perspective on how language regularities are acquired. Recent neuroimaging studies have associated SL with domain-general regions responsible for binding temporal and spatial contingencies in different modalities (hippocampus, medial temporal lobe), as well as with domain-specific visual and auditory cortical networks. Here we aim to go beyond the neurobiological "where" of SL and use electro-encephalography (EEG), which can reveal oscillatory activity. Neuronal oscillations reflect rhythmic fluctuations in the inhibition/excitation balance of neuronal populations and have been proposed to be instrumental in accounting for sensory processing, attentional selection and memory formation. We present data (n=36) from a classical visual SL task. This task consists of a familiarization phase in which participants are repeatedly exposed (3 blocks of 18 repetitions each) to 8 triplets of shapes, embedded in a continuous stream. Subsequently, learning is assessed behaviorally through a set of two-alternative-forced-choice questions. The intriguing possibility we explore is that pre-stimulus neural oscillations in the Delta and/or Alpha-Beta range may provide a brain signature of the anticipation of the predictable stimuli in a sequence, and hence of regularity learning. Our behavioral results indicate that 65% of the tested participants had significant above-chance performance at the individual level. For those "learners" we found 1) increased Delta activity (2-4Hz) over frontal and centro-parietal electrodes in the 400ms to 100ms time window before the presentation of predictable shapes relative to unpredictable shapes and 2) a similar modulation of centro-parietal activity in the 11-14Hz frequency range, in the 150ms prior to stimulus onset. Importantly, looking at the entire sample, the relative difference in Delta power measured in the last learning block was highly correlated with behavioral learning outcomes. These findings will be discussed in the context of the believed functional relevance of neural oscillations in regularity learning and predictive processing. Revealing a spectral signature of learning holds the promise of offering an online learning measure providing critical insights regarding the mechanisms of SL.

A25 Masked identity priming survives the rotation of individual letters within words: An ERP investigation

Marta Vergara-Martinez[1], Maria Fernandez-Lopez[1], Ana Marcet[1], Manuel Perea[1]; [1]Universitat de València

The process of visual word recognition is quite resilient to visual degradation (e.g., readers can automatically process CAPTCHAs; see Hannagan, Ktori, Chanceaux, & Grainger, 2012). A leading neural model of visual word recognition (Local Combination Detectors [LCD] model, Dehaene, Cohen, Sigman, Vinckier, 2005) makes a direct prediction with respect to a visual degradation manipulation: letter rotation. In the LCD model, the detectors of abstract letter units should be hindered by letter rotation beyond 40 degrees. To examine the impact of letter rotation during visual word recognition, we designed a masked priming ERP experiment with the lexical decision task in which we manipulated two factors: 1) prime-target relatedness (identity, unrelated); and 2) the rotation of individual letters in the primes (0-degree rotation [i.e. the standard format], 45-degree rotation, 90-degree rotation). The targets were always in lowercase with the standard (horizontal) format, whereas the primes were presented in uppercase with a smaller font size. If letter rotation slows down orthographic processing, one would expect small (or negligible) masked identity priming effects for those primes composed of rotated letters. For word targets, the behavioural results showed significant effects of letter rotation and identity priming in the response times: 1) letter rotation slowed down the processing of both identity and unrelated priming conditions; and 2) the magnitude of masked identity priming was sizeable for the three formats. More important, the ERP results showed a very early effect of letter rotation (N/P150 component: 0-degree rotation <> 45- and 90-degree rotation), along with a general latency delay of the N250 and N400 components for the rotated conditions. Interestingly, the identity priming manipulation had an impact on both the standard and the rotated formats (i.e., larger N400 amplitude for the unrelated priming condition). Taken together, the masked identity priming effects obtained when the individual letters of the primes were rotated reveal that, despite the dramatic changes induced by letter rotation, the cognitive system is able to encode orthographic information in the very early stages of visual processing.

Grammar: Morphology

A26 Hierarchical syntactic structures modulate brain activity during morphological processing

Yohei Oseki[1,2], Alec Marantz[2]; [1]Waseda University, [2]New York University

A single-route "full decomposition" model of morphological processing (Taft, 1979, 2004; Taft & Forster, 1975) has proposed that there are three functionally different stages of morphological processing: morphological decomposition, lexical access, and morphological composition. In the recent literature on the neurobiology of language, these three stages have been associated with spatiotemporally dissociable evoked response components (Fruchter & Marantz, 2015): morphological decomposition around 170 ms in the inferior temporal/anterior fusiform cortex (i.e. M170), lexical access around 350 ms in the middle temporal cortex (i.e. M350), and morphological composition around 500 ms in the orbitofrontal cortex. However, given the theoretical agreement on hierarchical syntactic structures within words, what stage of morphological processing tracks hierarchical syntactic structures of words during morphological processing? In order to address this question, this paper conducts an magnetoencephalography (MEG) visual lexical decision experiment, where computational models proposed in natural language processing are employed to predict brain activity localized to Visual Word Form Area (VWFA), with special focus on the first stage of morphological decomposition indexed by the MEG evoked response component called the M170 (Gwilliams et al., 2016). The participants were 20 native English speakers. The stimuli were 800 novel morphologically complex trimorphemic words and nonwords with linear (root + suffix + suffix) and nested (prefix + root + suffix) syntactic structures. Two "amorphous" and three "morphous" computational models were investigated on the assumption that morphological processing proceeds incrementally from left to right. Specifically, the "amorphous" models, Letter Bigram Model and Syllable Bigram Model, estimate probabilities of morphologically complex words from bigram transition probabilities among letters and syllables, respectively, without reference to morphemes. The "morphous" models, Markov Model, Hidden Markov Model, and Probabilistic Context-Free Grammar, estimate probabilities of morphologically complex words from bigram transition probabilities among morphemes, linear syntactic structures, and hierarchical syntactic structures, respectively. The probability estimates were then transformed into surprisal (Hale, 2001; Levy, 2008), which was in turn employed as a predictor in regression analyses. Statistical analyses were based on two regions of interest (ROIs): anatomically-defined inferior temporal ROI and functionally-defined anterior fusiform ROI based on lemma frequency previously proposed to localize the M170 component. There are three primary results. First, all "morphous", but not "amorphous", models were statistically significant. Second, Probabilistic Context-Free Grammar, a computational model that estimates probabilities of morphologically complex words from hierarchical syntactic structures, most accurately predicted brain activity in the M170 evoked response component. Third, inspection of residual errors indicated that Probabilistic Context-Free Grammar explains nested words better than linear ones, while the opposite was the case for Markov Model and Hidden Markov Model. These results strongly suggest that the first stage of morphological decomposition indexed by the MEG evoked response component called the M170 not only reflects

the decomposition of morphologically complex words into morphemes, but also the parsing of those complex words into hierarchical syntactic structures. Furthermore, morphological processing seems to track morphemes incrementally from left to right, contradicting "amorphous" models of morphological processing (Baayen et al., 2011). Consequently, morphological processing is sentence processing within words.

A27 Perception of Morphologically Complex Words Using Single-Trial EEG

Laurie Lawyer[1]; [1]University of Essex

Introduction. Within models of speech perception involving morphologically complex words (eg. Taft (1994), Schreuder & Baayen (1995), Stockall & Marantz (2006), Marslen-Wilson and Tyler (2007)) there is disagreement over whether complex words must be decomposed into their constituent parts during online processing, or whether they may be accessed as whole forms. This study presents a novel approach, using single-trial EEG data to investigate the processing of real words and mispronounced morphologically complex words. Methods. In an ERP experiment, subjects (N=28) were presented 40 complex words and 80 non-words and asked to identify correctly pronounced words. Non-words were created by substituting a single segment in the prefix of an existing complex word with a segment that differed by one to three major phonological features (place, voice, or manner). A linear mixed-effects model was estimated at every time point (-200 to 1400msec) using the single-trial EEG data. The input to the model for each time point contained the amplitude at each electrode site, for each word, for each subject. Predictors were word frequency (from CELEX (Baayen et al., 1995)), and residualised prefix frequency and root frequencies. For modified nonwords, the original frequency values were used. Subject, item, and electrode site were included as random effects. All z-values exceeding 1.96 (estimating $p < .05$) were considered significant at a given time point. Results. Subject performance showed good discrimination, with 94% of real words correctly labeled, and 87% of mispronounced words correctly identified. In correctly labeled word responses, EEG signal amplitudes were predicted to increase significantly as prefix frequency increased between 260 - 320msec. Word frequency significantly predicted increases EEG amplitude in a later window, from 580 - 1040msec. Root frequency did not achieve statistical significance in any time window. In correctly identified nonwords, EEG signal was predicted to decrease significantly as prefix frequency increased, from 180 - 200msec. Further, root frequency significantly predicted increases in EEG amplitude from 330 - 550msec, and word frequency from 750 - 950msec. Conclusions. The analysis of factors influencing single-trial EEG data show a cascading effect of lexical access. In real words, prefix, root, and word frequencies predict EEG signal amplitude sequentially in separable effects. In cases of prefix mispronunciation, prefix frequency negatively predicted signal amplitude, while root frequency had a similar effect observed in real word processing. This suggests subjects may have used the un-altered roots to bootstrap successful recognition of the mispronounced words, evidenced by the significant word frequency effects. Taken together, this data provides evidence for mutli-staged decompositional parsing of morphologically complex words. The data suggests sub-elements of complex words, such as prefixes, are accessed individually, prior to the fully composed word, which is separately subsequently accessed. This supports the idea that morphologically complex elements are obligatorily decomposed during processing, while also suggesting a different approach to dual-route models where whole-word processing of complex words occurs in a secondary stage of processing.

A28 Morpheme-based word production is associated with ventral-stream white matter pathways

Maya Yablonski[1], Benjamin Menashe[1], Michal Ben-Shachar[1]; [1]Bar-Ilan University

Language users possess extensive knowledge about the internal structure of words and their constituent morphemes. Although ample behavioral evidence has shown that morphology is an important factor in skilled reading, the white matter underpinnings of morphological skills remain largely unknown. In a recent study, we found that implicit morphological knowledge is associated with microstructural properties in bilateral ventral-stream pathways of adult English readers. Here, we examine white matter associations with morpheme-based word production in adult Hebrew readers. This extends our measurements to a non-linear, morphologically rich language, using a task that requires morpheme abstraction, lexical search and access, in response to an orally presented word. To assess root-based fluency, participants were requested to generate within 30s as many Hebrew words as possible derived from a common root (e.g., upon hearing the target miSGeRet, frame, participants orally generated words like SaGuR, is closed, maSGeR, a welder, and so on, all derived from the same triconsonantal root, SGR). Similarly, in a pattern-based fluency task, participants had to generate words derived from a common morphological pattern (e.g., upon hearing the word maGReSa, a shredder, participants generated maMTeRa, a sprinkler, maVReGa, a screwdriver, etc.). In accordance with the dual-stream model of speech processing (Hickok & Poeppel, 2007), we hypothesized that root-based fluency would be associated with the bilateral ventral-stream tracts, which support semantic processing and lexical access. We further hypothesized that pattern-based fluency would be associated with the left dorsal stream, due to the phonological regularities introduced by the morphological pattern in Hebrew words. Participants were 45 adult native Hebrew-speakers (29 females). They all completed both fluency tasks (as well as other cognitive tests) and underwent an MRI scan (3T Siemens scanner, 64 diffusion directions at b=1000 s/mm2, 3 volumes at

b=0; isotropic voxel size: 1.7*1.7*1.7mm3). Dorsal and ventral tracts of interest were identified bilaterally in each participant's native space, using deterministic tractography and automatic tract segmentation (Yeatman et al., 2012). Spearman's correlations were calculated between each fluency measure and two diffusivity parameters, fractional anisotropy (FA) and mean diffusivity (MD), averaged across the length of the tract. The results show that root-based fluency is positively correlated with the mean FA of the inferior fronto-occipital fasciculus (IFOF) bilaterally, and with the left arcuate fasciculus (AF). In addition, negative correlations were found between root-based fluency and mean MD of the bilateral IFOF, bilateral inferior longitudinal fasciculus, left uncinate fasciculus and left AF. Pattern-based fluency was not significantly correlated with any of the tracts tested. In sum, root-based fluency was correlated with ventral-stream tracts, bilaterally, as well as with the left AF, a dorsal-stream tract. Importantly, partial correlations controlling for phonemic or semantic fluency eliminated the effects in the left AF, but maintained significance in the bilateral ventral pathways. These results suggest that the left AF contributes to verbal fluency tasks broadly, and not specifically to morpheme-based fluency. Taken together, our findings point to the involvement of bilateral ventral-stream pathways in morphological processing, across stimulus and response modality, cross-linguistically, and across morphological systems.

Grammar: Syntax

A29 Inter-individual differences in predictive coding during language processing: the role of individual alpha frequency and idea density

Ina Bornkessel-Schlesewsky[1], Caitlin Howlett[1], Isabella Sharrad[1], Erica Wilkinson[1], Matthias Schlesewsky[1]; [1]University of South Australia

Predictive coding constitutes a possible unifying theory of information processing in the human brain (e.g. Friston, 2005), including language processing (e.g. Pickering & Garrod, 2007). It is also a highly promising framework for examining the neurobiology of language, given the level of neurobiological detail proposed as part of hierarchical cortical predictive coding architectures (Bastos et al., 2012). However, little is known about whether and how predictive coding differs between individuals (see Moran et al., 2014, for lifespan changes). Here, we examined inter-individual differences in predictive coding during language processing in young, healthy adults, using individual alpha frequency (IAF) and idea density (ID) as predictors. IAF, the peak frequency of the EEG alpha band, correlates with processing speed, memory and intelligence (Klimesch, 1999; Grandy et al., 2013). High-IAF individuals also tend to have more fine-grained perceptual representations (Samaha & Postle, 2015; Cecere et al., 2015). ID measures the number of ideas expressed relative to the number of words used and thus provides a measure of linguistic information encoding efficiency (Kemper et al., 2001). Low ID in young adulthood has been associated with poor cognitive function in older adulthood (Snowdon et al., 1996). In the present study, native speakers of English (n=42; 28 women; mean age:22.8, SD:3.7) listened to 150 passages (4-5 sentences) while their EEG was recorded. Ninety passages contained 2 two-adjective noun phrases (e.g. "huge grey elephant") at varying positions. In 50% of cases, adjective order was non-canonical ("grey huge"; not examined here). We examined N400 responses and pre-stimulus alpha power at IAF at two positions: passage-initial words (low predictability; only the 35 passages starting with proper nouns were used for this analysis) and nouns in the two-adjective NPs (high category predictability due to preceding adjectives). While pre-stimulus alpha power is thought to reflect the precision of predictions (e.g. Bauer et al., 2014), we assume that N400 amplitude indexes predictive model updating. IAF was estimated from eyes-closed resting EEG and ID was calculated from a text sample written in the lab. Data were analysed using linear mixed-effects models, with IAF and ID as continuous predictors. Across both positions, ID-related N400 differences emerged across the course of the experiment. N400 amplitude was inversely correlated with ID, particularly at the end of the experiment and for participants with a low IAF. High ID participants also showed lower pre-stimulus alpha power than low ID participants, again particularly at low IAF. These results indicate that high ID individuals are better able to adapt their predictive linguistic models to the current input, as they show neurophysiological correlates of higher predictive precision and less model updating during later stages of the experiment. High ID may thus be indicative of a more adaptable language model. Intriguingly, ID differences were particularly pronounced for low IAF. We conclude that the quality and flexibility of an individual's language model (ID) as well as biological constraints on the resolution of one's perceptual input (IAF) jointly determine inter-individual differences in the efficiency of predictive coding during language comprehension.

A30 Improving pre-operative mapping of language in clinical fMRI using assessment of grammar

Monika Polczynska[1], Kevin Japardi[1], Susan Curtiss[1], Teena Moody[1], Christopher Benjamin[2], Andrew Cho[1], Celia Vigil[1], Taylor Kuhn[1], Michael Jones[1], Susan Bookheimer[1]; [1]University of California, Los Angeles, [2]Yale University

Introduction: In spite of using pre- and intra-operative language mapping techniques, surgical interventions are still challenging, particularly in the language dominant hemisphere. When the risk to new language deficits is too high, patients are frequently not recommended to undergo surgery. Standard protocols for mapping language function seem to be relatively good at predicting location of language at a group level, however, at an individual level they remain sub-optimal. The standard tests typically evaluate lexico-semantic language aspects only. The tests do not properly reflect the complexity of

language production or comprehension at a sentence level. In a group of patients with left hemisphere dominance for language (as indicated by the standard fMRI language tests and/or the Wada test) we examined which tests best activate language areas in the brain. Methods: Twenty-five (13 females) candidates for brain surgery participated in the study. Mean age of the participants was 38.8 years (± 11.7). There were nine patients with epilepsy and 16 patients with a brain tumor. Eighteen patients had lesions in the left hemisphere and seven – in the right hemisphere. We compared tests of grammar with standard language tests using pre-operative fMRI. In the grammar component we applied seven tasks from the CYCLE-N. The test is an adaptation of a well-validated clinical instrument for assessment of grammar, the CYCLE (Curtiss and Yamada 2004). The CYCLE-N examines grammar aspects that have been shown to be especially vulnerable to brain damage: relativized subject and object clauses, word order in active and passive sentences, past tense marking and wh-subject and object questions. The standard tests included three tasks: object naming, auditory responsive naming and visual responsive naming. We selected nine regions of interest (ROI) in each hemisphere: four anterior ROI (the anterior superior temporal gyrus, BA 44, 45 and 47) and five posterior ROI (the angular gyrus, anterior and posterior supramarginal gyrus, posterior superior temporal gyrus and posterior middle temporal gyrus). We compared fMRI activations in both protocols at the group level and in individual patients. All tumors were masked. Results: The CYCLE-N produced more activity in the left hemisphere (the angular gyrus, anterior/posterior superior temporal gyrus). The tests helped identify additional language areas that were not detected by the standard tests (e.g., the left posterior middle temporal gyrus). The standard tests elicited more volume of activation only in left BA 47. Ten subjects showed more volume of activation in the left hemisphere during the CYCLE-N and two subjects – during the standard tests. However, after we excluded individual cases with extensive tumors in the posterior ROI (we did not record any activity in masked tumor areas), we found that no patients had significantly more activity in the standard tests than the CYCLE-N. The CYCLE-N also generated considerable activations in the right hemisphere. Thus, the tests were superior at detecting contributions to language processing both in the right and left hemisphere. Conclusion: We suggest that the grammar tests may be a valuable addition to the standard language testing conducted pre-operatively.

A31 Experimental L2 Semantics/Pragmatics of Scalar Implicature: An ERP Study

Euiyon Cho[1], Wonil Chung[1], Myung-Kwan Park[1]; [1]Dongguk University

There have been a few studies investigating the processing of scalar implicature using ERPs. Noveck and Posada (2003) measured ERPs while participants read and judged underinformative sentences such as "Some cats have ears", which is correct under a semantic interpretation but incorrect under a pragmatic interpretation. At the critical word such as 'ears', a reduced N400 was elicited relative to the control condition. Niewland et al. (2010) reported that participants with high pragmatic ability showed a greater N400 for the underinformative relative to the informative critical word. The present study examined Korean English L2ers' comprehension of scalar implicature of English 'some' and 'no' to investigate whether they make a distinction between semantic and pragmatic interpretations. Nineteen Korean L2 learners with a high level of English proficiency participated in our experiment. In our experiment we adopted a picture-sentence verification design (modelled after Politzer-Ahles et al. (2012)) to compare the neural responses to scalar quantifiers such as some and no. On each trial the participants were presented with a picture, followed by a sentence that correctly or incorrectly describes it. In the experiment 1 we manipulated picture type, particularly, Some-type picture and constructed the four types of picture, such as (i) some apples in the basket, (ii) no apple in the basket, (iii) all apples in the basket, and (iv) some pineapples in the basket. The quantifier some was used in the experimental condition such as In the picture, being thrown into the basket by the boy was some candies. Likewise, in the experiment 2 we manipulated No-type picture and constructed the four types of picture, such as (i) no apple in the basket, (ii) some apples in the basket, (iii) all apples in the basket, or (iv) no banana in the basket. The quantifier no was used in the sentence such as In the picture, being thrown into the basket by the boy was no candy. ERPs were measured at the critical phrase (e.g., some candies or no candy). EXP 1 showed (i) a significant anterior P600 in No (semantic violation: SV) condition, (ii) a significant P200 in All (pragmatic violation: PV) condition, and (iii) a significant N400 in lexical violation (like 'some pineapples' in the picture) condition, relative to Some condition, respectively. EXP 2 showed (i) a significant N400 in Some (SV) condition, (ii) a marginal P700 in All (PV) condition, and (iii) a significant N400 in lexical violation (like 'no banana' in the picture) condition, relative to correct No condition, respectively. Our results make the following points. The lexical violation conditions with both 'some' and 'no' elicited the same response: a significant N400. However, the two quantifiers in question diverge: P600 for 'some' and N400 for 'no' in semantic violation, and P200 for 'some' and a marginal P700 in pragmatic violation. These findings suggest that semantic/pragmatic aspects of meaning are processed using different mechanisms than lexical aspects of meaning, and that different quantifiers may make a distinct contribution in semantics/pragmatics.

A32 Dissociating prediction and constituent-structure during sentence-structure building

Murielle Fabre[1], Shohini Bhattasali[1], John Hale[1], Christophe Pallier[2]; [1]Cornell University, [2]INSERM-CEA Cognitive Neuro-imaging Unit

Introduction: Sentence processing is more than decoding linear strings of words. Hierarchical relations between words which impact language comprehension are formalized through tree-like structures, and their complexity has been consistently shown to correlate with activity in core brain areas in the language network (Ben-Shachar et al. 2004; Shetreet and Friedman 2014; Pallier et al. 2011). Along with such structural complexity, different computational parsing strategies can be used to investigate the neural correlates of syntactic structure-building. Modelling how sentence structure can be parsed can reveal different components of sentence processing. Thus, the interest in comparing the fMRI activation patterns to Bottom-Up (BU) and Top-Down (TD) parsing strategies (Fig.1) lies in decomposing the cognitive process of sentence-structure building into different sub-processes. BU can instantiate constituent-structure building as it builds and collects sub-parses towards the end of the phrase/sentence. The rules of a grammar are applied at each incoming word, as seen through the parser action counts (Fig.2). Alternatively, TD better approximates expectation-driven structural processing, as rules are applied predictively, in advance of each word, thus assigning higher scores at the beginning of sentences. Methods: Participants (n=51, 32 female) listened to The Little Prince's audiobook for 1 hour and 38 minutes. Participants' comprehension was confirmed through multiple-choice questions (90% accuracy, SD = 3.7%). Functional scans were acquired using multi-echo planar imaging sequence (ME-EPI) (TR=2000ms; TE's=12.8, 27.5, 43ms; FA=77 degrees; FOV=240.0mm X 240.0mm; 2X image acceleration; 33 axial slices, voxel-size 3.75 x 3.75 x 3.8mm). Preprocessing was done with AFNI16 and ME-ICA v3.2 (Kundu et al., 2011). The number of parser actions required, word-by-word, to build the correct syntactic tree as determined by the Stanford parser was computed according to two parsing strategies, described above and illustrated by a sentence from the auditory stimuli (Fig.2). Along with these syntactic structure building regressors, we entered four regressors of non-interest into the GLM analysis (SPM12): word-offset, word frequency, pitch, intensity. The regressors were not orthogonalized. The whole-brain main effects were FWE-corrected (T-score>5.3). Results: Regression analyses localized the activation patterns for BU and TD to different areas in the brain. BU showed bilateral clusters. The peak activation was observed in right TP within a main cluster extending to STG through MTG, while ATL involvement was bilateral. Increased activation of LIFG and RIFG stretching over Pars Orbitalis and Triangularis and extending to the anterior Insula and Putamen was observed together with the clusters reported in Fig. 3. For TD, two bilateral clusters were observed along STG extending from its posterior portion to MTG, reaching TP in the right hemisphere (Fig.3). Conclusion: Predictive syntactic processes modeled by TD evoke a pattern of activation that is spatially-dissociable from compositional structure-building modeled by BU. This result replicates findings about surprisal (Willems et al. 2015). Consistent with previous work (Nelson et al. 2017; Brennan et al. 2016), these findings underline that different parts of the language network functionally contribute to different dimension of sentence-structure building during natural language comprehension.

A33 Neural Correlates of Sentence Processing in Acute Stroke Patients

Sigfus Kristinsson[1], Brielle Stark[1], Grigori Yourganov[1], Alexandra Basilakos[1], Helga Thors[1], Julious Fridriksson[1]; [1]Center for the Study of Aphasia Recovery at the University of South Carolina

Introduction Syntactic processing is a fundamental aspect of language and is often compromised in aphasia. The ventral inferior frontal gyrus has long been suggested as an important area for sentence processing, particularly Broca's area.1-7 Other areas commonly implicated in syntactic processing include the posterior temporal areas,8-10 and anterior superior and middle temporal gyrus.11-13 Contrasting previous studies, recent voxel-based lesion-symptom (VLSM) studies have consistently implicated a temporo-parietal area, including the posterior middle temporal gyrus (pMTG), as being important for sentence processing.13-18 The current study examined the association between left hemisphere stroke and sentence processing in persons with acute aphasia. We hypothesized that damage to the pMTG, and not to Broca's area, would predict performance on the syntactic processing task. Method This was a prospective study. A total of 56 participants were recruited from Iceland and 56 from a local hospital. All participants had incurred a single stroke to the left hemisphere (Table 1). Participants completed a 45-item sentence-picture-matching task which includes nine types of sentence structures (Table 2).19 Performance on sentences with canonical word order (C: Types 1, 4, and 8) was compared to that on non-canonical sentence types (NC: 2, 5, and 9). All participants underwent MRI scanning. Brain lesions were demarcated on DWI images by a trained neurologist. Our main analysis was a stepwise regression analysis using proportional damage in all predefined language ROIs within The Dual Stream Model of speech/language processing20-21 as independent variables and total score (TS), C scores and NC scores as dependent variables, in three separate analyses. Lesion volume was controlled for in all analyses. Results Participants' mean TS was 35.8 points (SD=9.1, range: 12-45). Mean score on C sentences was 13.0 points (SD=2.96, range: 4-15), and mean score on NC sentences was 11.3 points (SD=3.6, range: 3-15). Patients scored significantly higher on C sentence types than NC on average ($t=7.44$, $p<.001$; Figure 1). Ceiling effects were significantly greater on C sentence types than NC sentence types (52 vs. 31, $X2=7.24$, $p=.007$). Figure 2 shows a lesion overlay map. Region-wise analysis revealed that impaired SP was best predicted by proportional damage to pMTG, angular gyrus (AG) and the inferior frontal gyrus pars triangularis ($F=31.0$, $R2=.482$, $p<.001$; Table 3). Performance on C sentence types was best

predicted by damage to AG, the middle temporal gyrus (MTG) and the superior temporal gyrus (STG) (F=21.6, R2=.393, p<.001). Damage to pMTG, AG and the inferior frontal gyrus pars opercularis predicted performance on NC sentences (F=31.4, R2=.485, p<.001). Conclusion These results indicate that damage to temporo-parietal cortex predicts performance on an auditory-visual sentence processing task in acute stroke patients. Damage to the pMTG is the strongest predictor of TS and NC scores, explaining 33.7% and 37.1% of the variance in scores, respectively. Damage to a temporo-parietal area predicted C scores as well. These results suggest that the pMTG may play a crucial role in complex sentence processing. Importantly, the results furthermore show that Broca's area does not seem to be critically involved. These aspects will be studied further.

A34 Differentiating three different types of double subjects/Nominatives in Korean: An ERP-based study

Kiyong Choi[1], Daeho Chung[2], Wonil Chung[3], Say Young Kim[2], Bum-Sik Park[3], Myung-Kwan Park[3]; [1]Kwangwoon University, [2]Hanyang University, [3]Dongguk University

Building on Lee's (2014), Kim's (2015), Kim, Kim, and Yoon's (2015) offline judgment tests of double Nominative-Case-marked subject (DNS) constructions in Korean, we performed an online ERP (event-related potential)-based examination of processing three different types of DNSs by Korean native speakers. In particular, the target word in these three constructions is the second Nominative Case-marked subject NP. The experimental materials consisted of 180 sets of 3x2 factorial design with 3 types (Property-type, Family Relation-type, and Adjunct-type DNSs) and 2 Case (Nom and Gen/Loc), constructed on the model of KKY (2015). They, however, were composed of double Nominative subjects situated in right dislocation contexts, schematically represented below. Conditions (i)-(ii): Property—Genitive/Nominative: kwake-ey yeypp-ess-e, yengi-uy/-ka maum-i. past-in kind-Pst-Informal, Yengi-Gen/Nom heart-Nom 'It was kind in the past, Yengi's heart.' (iii)-(iv): Family Relation—Genitive/Nominative: kwake-ey yeypp-ess-e, yengi-uy/-i tongsayng-i. past-in pretty-Pst-Informal Yengi-Gen/-Nom sister-Nom 'She was pretty in the past, Yengi's sister.' (v)-(vi): Adjunct—Locative/Nominative: kwake-ey cekes-se, sewul-ey/-i chatul-i. past-in a few-Informal Seoul-Locative/-Nom cars-Nom 'There were a few in the past, Seoul's cars.' Eighteen (male: 12) native Korean undergraduate students participated in the experiment. The descriptive data of the offline 4-scale (1: not at all acceptable, 4: definitely acceptable) acceptability task for the 6 conditions are as follows: (Condition (i)): (P)roperty SSs (single subject) - 3.7; (ii): P-type DNSs - 2.4; (iii): Family Relation (FR) SSs - 3.6; (iv) FR-type DNSs – 1.5; (v): (A)djunct SSs - 3.4; (vi): A-type DNSs – 2.2. The ANOVA results of the offline task showed significant effects of factors such as type (F(2,34)=12.26,p<0.001), Case (F(1,17)=178.27,p<0.001), and type*Case interaction (F(2,34)=12.11,p=0.001). Korean speakers rated the acceptability of P-type DNSs higher than that of A-type DNSs, and the acceptability of P-type DNSs higher than that of FR-type DNSs. ERPs were measured at the second subject NP in DNS conditions and the post-Genitive/Locative subject NP in single subject conditions. In Property-type condition there was an LAN effect in the 400-500 ms interval. In contrast, in Family Relation-type condition there was a P600 effect at the posterior in the 600-700 ms. Furthermore, in Adjunct type condition there was a marginal P600 effect at the posterior in the 600-700 ms. The results indicated that the LAN effect in Property-type condition is an index of difficulty in carrying out theta-identification between the double Nominative subjects based on the same Nominative Case marking (Yoon 1990). The second Nominative subject in this type of DNS enters into 'agreement' relation via theta-identification with the first one. The P600 effect in Family Relation-type condition is a signal of syntactic revision/reanalysis that has been reported to arise in sentences involving garden path. The second Nominative NP in this type of DNS is reanalyzed as a subject after the first one has been. Likewise, the P600 effect in Adjunct-type condition also reflects syntactic revision/reanalysis, notwithstanding a marginal P600. The second subject in this type of DNS is not in sharp contrast to its counterpart after the Locative particle –ey 'in'.

Meaning: Lexical Semantics

A35 The neural correlates of the interaction between phonological and semantic processing in Reading Chinese characters

Min Dang[1], Rui Zhang[1], Xiangyang Zhang[1], Xiaojuan Wang[1]; [1]Shaanxi Normal University

A general agreement of the contemporary models of visual word reading is that there exists an interaction between phonological and semantic processing. The logographic property of Chinese writing system provides a unique opportunity to examine the interaction. However, the underlying neural mechanism remains unclear. The current fMRI study addressed this issue by manipulating the phonetic consistency (high vs. low consistency of the character's pronunciation to those of members in the same phonetic family) and the semantic transparency (transparent vs. opaque meaning of the semantic radical to the character's meaning). Participant performed a naming task in the scanner. The fMRI result replicated previous consistency effect that the low consistent characters activated left frontal regions at IFG, MFG, and insula than high consistent characters. The result also showed a semantic effect that the transparent characters activated bilateral AG and left ATL than opaque characters. The most interesting finding was the neural signature of the interaction between the phonological and semantic processing. For low consistent characters with weak phonological cues, the semantic effect was observed that the transparent characters increased activation at AG and ATL for semantic processing, whereas the opaque characters relied on the phonological neural circuit

showing more activation at FG and IFG for phonological processing. On the contrast, for high consistent characters with strong phonological cues, no semantic effect was observed in the reading network. The current findings offer the first clear evidence of the neural correlates of the interaction between semantic and phonological processing in reading Chinese characters.

A36 Pictures produce orthographic neighborhood effects, but only following familiarization

Gabriela Meade[1,2], Phillip J. Holcomb[1]; [1]San Diego State University, [2]University of California, San Diego

Words with many orthographic neighbors (e.g., cake) resemble many other words in the language (e.g., rake, lake, care). Previous studies have shown that words with many neighbors elicit larger amplitude N400s (i.e., more lexicosemantic processing) than words with fewer neighbors, indicating that neighbors are co-activated during word processing. Here, we asked whether the same effect holds with picture stimuli that have labels with many or few orthographic neighbors. In Experiment 1, participants were familiarized with the pictures and their names two days before the ERP session. During the ERP session, they saw the pictures and engaged in a go/no-go semantic categorization task. Experiment 2 was identical except that there was no familiarization before the ERP session. In Experiment 1, we found an effect of orthographic neighborhood, such that pictures with more orthographic neighbors elicited larger amplitude negativities within the N400 window than those with fewer orthographic neighbors. However, we did not observe this effect in Experiment 2. These results suggest that the orthographic neighbors of picture names can be co-activated, but only under certain circumstances. More specifically, we propose that participants in Experiment 1 were covertly naming the pictures and that this gave rise to activation of the lexical representation of the picture name and its neighbors. Finally, the finding that neighborhood effects change with familiarization, a common practice in word production studies, has important methodological implications.

A37 Lexical access and integration in context: a fixation-related fMRI study of the word predictability and word frequency interaction during sentence comprehension

Jie-Li Tsai[1], Guan-Huei Lee[1], Chia-Ying Lee[2], Chung-I Erica Su[1], Tzu-Hsuan Lin[1]; [1]National Chengchi University, Taiwan, [2]Academia Sinica, Taipei, Taiwan

The present study aims to examine the neural correlates of the contextual predictability and frequency effects in the natural reading of Chinese sentences. Processing a word in sentence involves lexical access of word representation and semantic integration with the prior context. Lau, Phillips, and Poeppel (2008) proposed an cortical network of semantic processing in sentence comprehension, including the left posterior and anterior temporal cortex, and the left inferior frontal cortex. With simultaneous eye movement recording, a fixation-related fMRI experiment was conducted to investigate the brain responses contingent to the fixation events on reading words in sentences. Forty participants read one hundred sentences, in which a target word was embedded in the middle to the third-quarter location of each sentence. Half of the targets were low frequency (LF) words and the second half were high frequency (HF) words. The targets were either with low predictability (LP) or high predictability (HP) according to the prior context of the leading sentence fragment. The functional T2-weighted images were acquired (TR = 2s) and the fixation onset of the first-pass gaze on the target was used as the fixation-related event for modeling the hemodynamic brain response. For word frequency, the results showed that low frequency words involved more activations in the left IFG and left insula than high frequency words did. For word predictability, low predictable target words demanded higher activation in the left inferior frontal gyrus (IFG) and left middle temporal gyrus (MTG) than the predictable target words did. These findings suggest that these regions are responsible for the semantic integration of the lexical representation of a word and its prior context. Critically, high and low frequency words revealed different patterns of the predictability effect in the brain. For low frequency words, the left IFG had higher activation for low predictable targets than that of high predictable targets. In contrast, the predictability effect of high frequency words was mainly showed in the anterior and posterior MTG. The findings are consistent with the previous fMRI studies of semantic processing, and further imply the role of the left IFG for controlled retrieval of word semantic and the MTG for automatic access of word representation.

A38 The dynamics of lexico-semantic access in the aging brain

Rocío López Zunini[1], Martijn Baart[1,2], Arthur Samuel[1,3,4], Blair Armstrong[1,5]; [1]BCBL, Basque Center on Cognition, Brain and Language, [2]Tilburg University, [3]IKERBASQUE, Basque Foundation for Science, [4]Stony Brook University, [5]University of Toronto, Scarborough

We investigated how aging modulates lexico-semantic processing in the visual (written), auditory (spoken), and audiovisual (written+spoken) modalities. Participants were 20 young and 21 older adults who performed a delayed lexical decision task (LDT), in which word and pseudoword responses were made 1750 ms after stimulus onset. An electroencephalogram was recorded as participants completed blocks of visual, auditory, and audiovisual stimuli. Neural correlates of lexico-semantic access were investigated with Event-Related Potentials (ERPs) at the single trial level. Our results revealed that young and older adults identified words and pseudowords with similar accuracy. However, there were substantial differences in brain dynamics across the groups that included: 1) a right-lateralized distribution of lexico-semantic access as indexed by the N400 effect (i.e., larger negativities for pseudowords than words) in older adults,

whereas young adults exhibited a widespread effect in the left, middle and right electrodes, 2) longer lasting N400 effects in the visual and audiovisual modalities in older adults relative to young adults, and 3) a larger effect in the audiovisual modality in older adults than in young adults. These results suggest that the evidence used as a basis for making lexical decisions changes with age, potentially reflecting increased reliance on semantic fields of broader breadths in the right hemisphere in older adults.

A39 Learning scientific concepts with metaphor: An ERP study *Vicky Tzuyin Lai[1], Nyssa Bulkes[1]; [1]Department of Psychology, University of Arizona*

According to the conceptual metaphor theory, abstract concepts can be represented by experience-based concepts (e.g. mitochondria is the power company). Scientific concepts are abstract. Can metaphors help students learn scientific concepts? Many education studies exploited the idea, and employed qualitative measures, e.g., analyzing metaphors in student essays. Although the general finding is that metaphors are useful, a gap in knowledge is whether learning induces changes in the targeted scientific concepts. The present study uses EEG to explore the cognitive-neural representations of scientific concepts before and after metaphoric training. [Participants] Eighteen native English speakers participated. Their verbal and non-verbal analogical reasoning abilities were measured with WASI-II. [Materials] The stimuli for pre- and post- training were 80 words depicting scientific concepts and pseudowords that resembled the target words with respect to English phonotactics and length. The stimuli for training were metaphoric and literal examples of each of the scientific concepts. A metaphoric example was "A leukocyte is a colorless cell that eliminates foreign substances from the body. A leukocyte is the body's warrior that fights germs". The literal match started the same first sentence, followed by "Leukocytes help rid the body of illness or diseases". To ensure that these explanations were apt (good), a norming study was conducted (N=23). To assess learning outcome, a science knowledge assessment test with multiple-choice and short-answer questions was constructed. [Procedure] Participants came in for two sessions within a week. In session 1, participants did the assessment test first, and then a word reading task while their EEG was recorded. In each trial, a word/pseudoword was presented for 2 seconds. Participants were instructed to read and think about the word during those 2 seconds, after which they were to type what they were thinking. When a pseudoword trial appeared, they were to type a real word that came to mind. During training, an experimenter played the tutor role, discussing half of the concepts metaphorically and the other half, literally. In session 2, the participants did the word reading task with EEG recorded first, and then the assessment test again. [Results/Discussion]. Pseudowords elicited larger and widespread N400s than words in both sessions, serving as verification. Science words taught metaphorically elicited larger frontal N400s than the very same words untaught. This suggests that metaphoric reasoning enriches the science words with multiple senses, consistent with past findings where words with many senses elicited larger N400s than words with few senses (Berretta et al., 2005). The frontal N400 effect was positively correlated with the assessment test score difference, albeit weak (r=0.26). The test score was positively correlated with the verbal analogical ability (also weak, r=0.33). Lastly, science words taught metaphorically and literally both elicited a long negativity (500-1000 ms) more negative than the same words untaught, likely related to working memory. [Conclusion]. Metaphoric and literal reasoning led to differential changes in the neural representations of scientific concepts. We suggest that metaphors make students think harder about the scientific concepts and come up with more word senses, which aids learning.

A40 The neural network of action language: a comparative meta-analysis *Melody Courson[1,2], Pascale Tremblay[1,2]; [1]Université Laval, Faculty of Medicine, Department of Rehabilitation, Québec, Canada, [2]CERVO research center, Québec, Canada*

Accumulating empirical evidence shows a response of the cerebral motor system during the processing of action language (AL) [1] [2]. It has been suggested that this motor activation could represent motor imagery [3] or motor planning/execution processes, such as motor program selection [4], but the underlying processes remain unknown. Knowing whether activation patterns of AL resemble those of other motor-related processes could help clarify the role of the motor system in AL. The objective of this systematic review and meta-analysis was thus to determine whether the AL network is comparable to that of action observation, motor imagery or motor execution. To this aim, a set of activation likelihood estimation (ALE) meta-analyses was conducted to provide comparative maps of the brain structures involved in AL. A literature search on Pubmed was conducted for each process. Studies published in peer-reviewed journals in English were included if they used fMRI, included at least one group of healthy right-handed participants aged up to 60 years and reported Talairach or MNI coordinates. A total of 91 studies, including 1628 participants (range: 18-56 years), were selected: 16 in AL, 25 in action observation, 20 in motor imagery and 30 in motor execution. Coordinates for all the contrasts of interest were entered in Ginger Ale (Version 2.3.6) which computed activation maps for each motor-related process individually. A conjunction analysis was then conducted between the activation map of AL and the activation map of each of the other motor-related processes. Significant clusters were identified at an uncorrected p-value threshold of .001 and with a minimum volume of 120 mm3 [5]. Results showed that the AL network includes the pre-supplementary motor area (pre-SMA), inferior frontal gyrus (IFG), ventral premotor cortex (PMv), post-central gyrus, posterior middle temporal gyrus

(MTGp), anterior superior temporal gyrus and superior frontal gyrus. The conjunction analyses showed that the AL network shares the IFG, PMv, postcentral gyrus and MTGp with the action observation network and the MTGp and pre-SMA with the motor imagery network. No significant cluster emerged from the conjunction of AL and motor execution. To further understand the mechanisms underlying AL, an additional set of ALE analyses was conducted. Observation and imagery studies were separated into those using action-related tasks (e.g. object grasping) and those using movement (e.g. finger tapping). Conjunction analyses were then conducted between AL and each of these categories. Results showed that the common activation sites between AL and action observation were mostly linked to action. This meta-analysis is the first to provide quantitative comparative motor-related activation maps of AL. The AL network partially overlaps that of action observation and motor imagery, with a larger overlap with observation. These shared activation clusters may result from a complex interaction between motor task (observation vs. imagery) and motor content (action vs. movement). [1] Tremblay & Small (2010) Cerebral Cortex. [2] Hauk et al. (2004) Neuron. [3] Yang & Shu (2014) Experimental Brain Research. [4] Courson et al. (2017) Cortex. [5] Hétu et al. (2013) Neuroscience and Biobehavioral Reviews

A41 Effects of stimulus modality on semantic processing

Joshua Troche[1], Jamie Reilly[2]; [1]University of Central Florida, [2]Temple University

Semantic categorization demands efficient coordination between verbal and nonverbal domains. We hypothesize that access to these feature attributes is to some extent moderated by stimulus modality. We specifically predict that objects presented in pictorial form will bias the engagement of qualitatively different semantic features than the same items presented as words. Thus, orthographic presentation will likely access lexical/encyclopedic knowledge, whereas picture presentation will first engage perceptual similarity. Hence, a stimulus-driven property has the potential to drive differences in semantic categorization. Participants (N=14) were native English speakers (9f; 5m) with an average age of 21.3 years. Tetrads were presented on a screen while gaze was measured by a RED SMI eyetracker. Tetrads came in two versions, a picture and equivalent word version. Each of the tetrads had a theme amongst three of the items based on encyclopedic knowledge of a high school level. Participants had to intuit a theme and determine which item did not belong. After each trial, participants explained why they chose that item. Tetrad order was randomized as well as order of presentation (word-picture or picture-word) Participants would return a week later to complete the version they had yet to complete. Responses for why the item did not belong were classified one of four ways: encyclopedic, perceptual, affective, I don't know. Workers completed the classification of the response on Mechanical Turk. Each response was classified ten times. The Mode classification was considered the consensus and workers had an excellent level of reliability (ICC=.86). A chi-square test was run to determine if differences existed in the response type based on the presentation type (i.e., picture vs word). The chi-square test was significant overall ($X2(2)=76.002;p<.001$) with encyclopedic facts being the most common response in both word (382) and picture (292). The proportion of responses, however, was different across the word (encyclopedic:71.3%, perceptual:18.5%, and affective:10.3%) and picture task (encyclopedic:49.4%, perceptual:42.5%, and affective:8.1%) with perceptual responses being almost equal to encyclopedic responses in the picture task. A linear mixed effects model was performed to determine if any differences existed in gaze measures. The three gaze outcome measures were fixation duration of the target, fixations of the target, and revisits to target. For each of the outcome measures, the best fit model included fixed effects of presentation and response type and random effects of participant and item. The picture version had significantly longer fixation durations ($t(6)=8.06;p<.001$) and significantly more fixations ($t(6)=7.095;p<.001$) and revisits ($t(6)=6.31;p<.001$). There were significant main effects for fixation duration ($t(6)=2.102;p<.05$), fixations ($t(6)=4.856;p<.001$) and revisits ($t(6)=8.362;p<.001$). Pairwise comparisons revealed that perceptual processing led to more fixations and revisits when compared to encyclopedic (fixations: $t=6.833;p<.001$ revisits: $t=15.35;p<.001$) and affective processing (fixations: $t=2.783;p<.001$ revisits: $t=8.06;p<.001$). No significant pairwise comparisons existed for fixation duration. These findings suggest that stimulus presentation does bias the manner in which items are processed. It also indicates that when processed perceptually, more information is extracted from the task than when items are processed lexically. Overall, the findings suggest a semantic system that is flexible to task change.

Meaning: Discourse and Pragmatics

A42 The exceptional role of the first person: Evidence from natural story processing

Matthias Schlesewsky[1], Ingmar Brilmayer[2], Alexandra Werner[3], Beatrice Primus[2], Ina Bornkessel-Schlesewsky[1]; [1]Centre for Cognitive and Systems Neuroscience, School of Psychology, Social Work and Social Policy, University of South Australia, Adelaide, Australia, [2]Department of German Language and Literature I, University of Cologne, Cologne, Germany, [3]Department of English and Linguistics, Johannes Gutenberg-University, Mainz, Germany

The use of natural stories (e.g. narratives) provides us with a new way of studying linguistic information processing in the human brain. It allows us to replicate results from previous, controlled studies, but also opens up possibilities for investigating dependencies that span larger time units. This is, for example, relevant for research about the maximal size of temporal receptive windows. It can also increase our understanding about the role of predictions

in language processing. In narratives, there are "global" predictions in the sense that protagonists will recur several times throughout the story, while temporal ("local") predictions about this recurrence are relatively imprecise (i.e. it is difficult to predict precisely when a protagonist will be rementioned). Here, we present initial EEG observations on the processing of narrative dependencies. Participants listened to a German audio book version of The Little Prince by Antoine de Saint-Exupery (recording by Will Quadflieg, chapters 1–17, excluding chapters 5,6 and 14). The narrative includes passages written from the perspective of the Little Prince, but also dialogical passages from the perspective of the Little Prince's interlocutors, as well as a third person narrator. Twenty-five, monolingual native speakers of German (14 female; mean age 24.4, range 20–29) with normal hearing participated in this experiment. For the current analysis we focused on two main aspects: a. Given the exceptional role of the first person ("I") in comparison to second and third person, we investigated differences in the processing of first, second and third person pronouns. The exceptionality of the first person is motivated from a typological as well as processing perspective and may reflect a more general distinction between self vs other; b. We calculated the so called referential distance (RD) for every pronoun under examination. RD is calculated by counting the number of sentences that lie between the current mention of a discourse referent and its last mention in prior discourse. RD ranges from 0 to 20, while 20 is also assigned to referents without prior mention. Only referentially unambiguous pronouns encoded as grammatical subject were evaluated. In total, the recording contained 79 first person, 35 second person and 95 third person singular pronouns. Results indeed revealed a difference between pronouns: between 150 and 250 milliseconds, first person pronouns showed a strong positivity as opposed to third person pronouns (P300), which in turn elicited more positive-going ERPs than second person pronouns (1 > 3 > 2). In addition, ERPs following first-person pronouns were nearly unaffected by referential distance. For second- and third-person pronouns, by contrast, P3 amplitude decreased with increasing referential distance. Given the previously demonstrated sensitivity of the P300 for self-relevant behaviour, our results provide the first evidence that, even in narratives, the first person serve as an attentional cue for self relevance. In addition, the independence from RD for the first, but not the second and third person, could indicate that this type of attentional cue is prediction independent and constitutes a default in information processing in general.

A43 Gray and white matter correlates of indirect speech act comprehension in behavioral variant frontotemporal degeneration

Meghan Healey[1], Murray Grossman[1]; [1]University of Pennsylvania

Introduction: Language comprehension in a real-world context extends beyond decoding the phonetic, semantic, and syntactic components of speech. In addition, a listener must integrate these linguistic elements with non-linguistic, social elements in order to fully appreciate speaker meaning. A quintessential example of this is indirect speech acts, which are speech acts in which the intended speaker meaning is not directly encoded in the semantic content of the utterance itself. While little research has examined indirect speech acts, they are ubiquitous in daily life: consider, for example, the exchange: "Do you want some cake for dessert? / I'm on a very strict diet right now." In contrast to this indirect reply, consider the direct reply "I do not want any cake for dessert." Behavioral variant frontotemporal degeneration (bvFTD) is a young-onset neurodegenerative disease characterized by executive and social impairment due to progressive gray matter atrophy in frontal and anterior temporal regions. These patients do not have aphasia or a segmental language disorder. Here, we test the ability of these non-aphasic bvFTD patients with focal dementia to comprehend indirect speech acts such as the one above. Methods: Patients with bvFTD and a group of matched control subjects completed a novel indirect speech task. Participants read a short dialogue between two interlocutors (see example above) and performed a simple judgment task (i.e. "Does the reply mean yes or no?"). Dialogues consisted of a polar question and reply, and conditions varied according to inferential demand (direct, indirect). Patients also underwent high-resolution structural T1 imaging and diffusion tensor imaging. To explore the mechanism underlying patient impairment, a targeted neuropsychological battery was collected, probing language, executive, and social measures. Results: Results indicate that control subjects perform at ceiling in both direct and indirect conditions, with no significant difference observed between the two conditions ($Z=-0.577$, $p=0.564$). Patients are significantly impaired relative to controls in the indirect condition ($U=24.50$, $p=0.047$) and perform significantly worse in the indirect condition than their own performance in the direct condition ($Z=2.810$, $p=0.005$). Importantly, patients are not impaired relative to controls in the direct condition ($U=34.00$, $p=0.210$), suggesting that segmental language ability is not responsible for the decrement in indirect performance. Furthermore, correlation analyses indicated that patient performance in the indirect condition was significantly associated with both executive (e.g. Backward Digit Span, Trailmaking Test B), and social measures (e.g. Social Norms Questionnaire), but not language measures (e.g. Multi-Lingual Naming Test, Semantic Word-Picture Test). Imaging results showed impaired indirect speech comprehension in bvFTD is related to atrophy in a fronto-parietal network including orbitofrontal cortex, medial prefrontal cortex, insula, and precuneus (all $p<0.005$, uncorrected). DTI results related indirect speech performance to reduced fractional anisotropy specifically in the corpus callosum, uncinate

fasciculus, superior longitudinal fasciculus, and inferior fronto-occipital fasciculus (all p<0.005, uncorrected). Conclusion: Patients with bvFTD have deficits in indirect speech act comprehension. Neuroimaging data support the hypothesis that indirect speech act comprehension encompasses extralinguistic regions beyond traditional peri-Sylvian language regions. Importantly, these extralinguistic regions related to indirect speech are traditionally associated with social cognition.

A44 Individual Differences in Text Comprehension: A Resting-State Functional Connectivity Study

Anya Yu[1], Benjamin Schloss[1], Chun-Ting Hsu[1], Ping Li[1]; [1]Department of Psychology, The Pennsylvania State University

Reading is one of the fundamental methods through which we acquire new knowledge and skills, and is especially important in the absence of an immersed environment or an instructor (Hanh et al., 2007; Macabasco-O'Connell et al., 2011). Reading comprehension has been shown to be a strong predictor of individual's quality of life as well as future success (Baker, Parker, Williams, Clark & Nurss, 1997), and individual characteristics such as executive function (EF) skills have been reported to be a significant factor that influences reading comprehension success in both children and adults (Cartwright, 2015). Text reading comprehension is a complex cognitive process relative to other processes, and relies on a distributed network of brain regions (Li & Clariana, 2018). It is therefore very likely that text reading comprehension is better captured by an interconnected and interactive neural network. Most neurocognitive investigations of language comprehension are limited to word-level rather than text-level reading (see reviews by Ferstl, 2010 and Mason & Just, 2013). Furthermore, most neuroimaging studies of text comprehension have been focused on investigating reading-related patterns via functional magnetic resonance imaging (fMRI), and evidence showing that resting-state functional connectivity (RSFC) can capture text reading comprehension is lacking. Our study aims to clarify the relationship between RSFC in the language network and reading comprehension performance (measured by Gray's Silent Reading Task) as well as EF skills (measured by the Attention Network Test and Letter-Number Sequencing). Forty-six native English adults were recruited to read five expository scientific texts in the scanner. ROI peak selection was informed by literature on regions correlated with text-reading (see Koyama et al., 2010; Li & Clariana, 2018), which includes the left IFG, SMG, DLPFC, AG, and VWFA. A step-wise algorithm employing an OLS regression model was used to explore whether one or more two-way interactions could better explain variation in the GSRT scores. To address concerns about not adequately controlling for multiple comparisons and overfitting the data, we also used a model based on the decision regression tree algorithm (Breiman, 2001) that has been applied in functional connectivity studies (Richiardi, Eryilmaz, Schwartz, Vuilleumier & Van De Ville, 2010; Venkataraman, Whitford, Westin, Golland & Kubicki, 2012). All of the interactions that explained a significant amount of variance in the data are entered in a leave-one-subject-out cross-validation analysis. The behavioral results confirmed a significant positive correlation between executive function task performances and our reading task performance. While no single predictor had significant main effects with reading and EF indices, the decision tree model revealed significant effect in the VWFA-SMG and SMG-AG interaction that had above chance predicting power on GSRT performance (Spearman's =.37, p=.01). These patterns suggest that the temporoparietal connectivity can act as a reliable classifier distinguishing relatively bad (mean standardized z-score <-5) and good (mean standardized z-score>1) readers. This is convergent with DTI finding correlating temporoparietal white-matter tract integrity with reading performance (Kingberg et al., 2000), suggesting this connectivity is particularly engaged in text comprehension.

A45 Brain-behaviour correlations of angry, dancing, thoughtful triangles: Heider & Simmel in the scanner

Brea Chouinard[1], Tamara Vanderwal[2], Louise Gallagher[1], Clare Kelly[1]; [1]Trinity College Dublin, [2]Yale Child Study Centre

Introduction: There is a robust and reliable response to videos of geometric shapes enacting a social plot, where viewers attribute intentional movement and goal-directed interactions to the shapes (Heider & Simmel, 1944). This paradigm has also proven useful for investigating interpretation of intentionality and determining the goals of others in individuals with autism spectrum disorder (ASD), for whom these difficulties are paramount (American Psychiatric Association, 2013). Previous research has indicated that when describing these Heider & Simmel (HS) type animations, individuals with ASD identify fewer social elements, have a larger proportion of attributions that are irrelevant to the social plot, and use fewer mental state terms than controls (Castelli, 2002; Klin, 2000). Further, neuroimaging investigations have revealed differences between individuals with and without ASD in specifically selected regions of interest during viewing of these HS-type animations (Castelli, 2002). However, the degree to which there is shared activation amongst all brain regions in individuals with ASD, that is inter-subject correlation (ISC), has not yet been studied using HS-type animations. Hence, the current study investigated ISC in individuals with ASD during viewing of a novel HS-type animation. The current project aimed to determine the extent to which information processing was synchronized across individuals with ASD as they watched an HS-type animation using inter-subject correlations (ISC). Methods: Sixteen, intellectually able, language-competent teens with ASD passively viewed an eight-minute HS-type animation in a 3T MRI scanner. Following Hasson et al. (2004) we used inter-subject correlation to detect synchronous network activation across participants during

HS viewing. Outside the scanner a semi-structured social attribution task (Nippold, Mansfield, & Billow, 2007) has been used to elicit narratives, which were transcribed and will be evaluated for complexity and use of mental state language. Following establishment of ISC in ASD, relationships between use of mental state language and ISC can be evaluated to characterize associated brain-behavior relationships. Results: There was a robust pattern of inter-subject correlation, that is, areas in which brain activation was synchronized across participants with ASD as they viewed the HS-type animation. In addition to extensive ISC in visual cortices, there was synchronized activation in left frontal and parietal cortices, as well as bilateral lateral temporal cortex. In several regions within this network, including left inferior frontal and premotor cortex, individual differences in the degree of synchronization were correlated with individual differences in the complexity of language production. Conclusion: We found that passive viewing of a HS-type animation could be used to evaluate ISC in individuals with ASD. There were large amounts of brain activation shared by all individuals with ASD who watched the animation, in areas involved in attention to key object identification and social cognition in addition to visual processing. The current study validates the use of this novel, passive-viewing condition, and this will be further validated using brain-behaviour correlations in the full sample.

A46 The modulation of the N400 effect: reference and dispositional affect

Veena D. Dwivedi[1], Janahan Selvanayagam; [1]Brock University

This 2x2 ERP study had two goals: first, to investigate how sentences exhibiting lexical-pragmatic anomaly are processed with either definite or demonstrative determiners, and second, to investigate how this difference is modulated by affective state. To this end, 22 participants read sentences containing objects that were either congruent or incongruent with context. Sentences such as The connoisseur tasted the wine/#the roof on the tour, were tested, where the latter object type is known to elicit N400 effects vs. its control. In addition, we varied determiner type to include demonstrative that, as in, The connoisseur tasted that wine/#that roof on the tour. In the absence of previous context, using demonstrative that is pragmatically incongruent. We expected this additional violation to amplify the N400 effect (Hagoort, 2003). Next, affective state is known to influence cognitive processing (Loftus et al., 1987). Here we investigate whether this relation extended to linguistic processing. Regarding affect, we hypothesized that individuals with more positive traits would display a more global processing style (Chwilla et al., 2011). These individuals would therefore be more sensitive to violations in meaning that were derived from pragmatic context and/or experience in the world (also called 'heuristics'). Results revealed a significant N400 effect at The connoisseur tasted #the roof on the tour vs. its control The connoisseur tasted the wine; where, amplitude differences did correlate with individuals displaying more positive traits. Meanwhile, N400 effects were attenuated for that wine/#that roof. Instead, this condition revealed a significant P200 effect, where amplitude differences were greater for less positive individuals. We discuss the correlation in terms of morphosyntactic features of that, which serve to direct readers' attention.

Language Therapy

A47 Augmented reading outcomes for people with alexia following treatment paired with transcranial direct current stimulation.

Grace S. Lee[1], Esther S. Kim[1]; [1]University of Alberta

BACKGROUND: Damage to language areas of the brain often leads to a language disorder called aphasia, which impairs speech, writing, and understanding. 68% of people with aphasia (PWA) also present with alexia, a reading impairment. Many existing reading treatments target single word reading and demonstrate little generalization to larger bodies of text. In contrast, multimodal reading therapies target both the sublexical and lexical-semantic routes and have resulted in functional treatment gains. Recently, Transcranial Direct Current Stimulation (tDCS) has been explored as a potential adjunct to augment outcomes of traditional language treatment. tDCS modulates ongoing neural activity to prime the brain for long-term consolidation. Extensive research demonstrates the positive effects of tDCS on the spoken language treatments. However, there remains insufficient investigation on tDCS with reading treatments. This study explored the effects of tDCS paired with a multimodal intensive reading treatment with an individual with alexia. Eye-tracking was also used as a real-time measure of cognitive processing during reading, to provide further insight into treatment induced changes. There is an urgent need for efficacious therapies to remediate reading disorders as the ability to read independently is essential for participation in life. METHODS: P1 was a 63 year old male, with non-fluent aphasia and apraxia of speech, 5 years post-onset of stroke. In a double-blinded, crossover design, P1 received 40 hours of reading treatment (2 hrs/day x 5 days/week x 2 weeks = 20 hours for each phase with 4 week washout between phases = 40 hrs total), in conjunction with anodal-tDCS and sham-tDCS. Reading treatment involved training grapheme-phoneme conversion abilities to target the sublexical reading route, combined with Oral Reading for Language in Aphasia, which is a text-based reading approach to target the lexical-semantic reading route. In addition to behavioural outcomes, eye-movement measures were taken during silent reading. Passages had congruent or incongruent antecedents and anaphors. Measures on the whole passage and individual words were used to compare reading abilities before and after therapy and 1 month after discharge. RESULTS: There were greater improvements in behavioural outcomes measuring lexical-semantic skills

after treatment with anodal-tDCS relative to treatment alone. More substantial gains were observed in reading speed, accuracy, overall reading comprehension and context comprehension. Interestingly, treatment with tDCS did not result in augmented gains in sublexical measures. Both conditions of treatment resulted in similar sublexical improvements. A one-way repeated measures ANOVA on eye-movement measures revealed significant differences in overall fixation duration, number of fixations and gaze duration between pre-treatment, post-treatment and one month follow-up assessments. CONCLUSION: The improvements in both lexical and sublexical domains show that a multimodal reading approach is effective, and that integrating tDCS can lead to augmented treatment results in lexical reading. The significant differences in eye-movements reveals a change to mechanism of reading following treatment. Eye-movement analyses are preliminary, and further analyses are being conducted to better elucidate the nature of changes to the reading process after treatment. This study corroborates growing evidence for the use of tDCS in conjunction with reading therapy.

A48 Left-lateralizing tDCS for aphasia: a randomized, double-blind, placebo-controlled clinical trial

Elizabeth H Lacey[1,2], Fama Mackenzie E[1], Anbari Zainab[1], Turkeltaub Peter E[1,2]; [1]Department of Neurology, Georgetown University, [2]MedStar National Rehabilitation Hospital

Introduction: Roughly 20% of stroke survivors are left with chronic aphasia after the period of spontaneous recovery has stopped or slowed. Although speech-language therapy is effective and can continue to improve recovery in the chronic phase (Brady et al., 2012), the last ten years have seen increasing interest in the use of non-invasive brain stimulation techniques such as transcranial direct current stimulation (tDCS) to enhance the effect of behavioral treatment (Fama & Turkeltaub, 2014). The current study, a randomized, placebo-controlled, double-blind clinical trial, was designed to determine whether a brief course of tDCS intended to enhance left frontal lateralization can improve naming when added to speech therapy in people with chronic aphasia due to left hemisphere stroke. Methods: Participants with left hemisphere strokes and no other neurological issues completed an evaluation of language and cognition tests before treatment. They were randomized 1:2 to a sham condition or 1.5 mA HD-tDCS with anodes over electrode sites F5 and F7 and cathodes over F6 and F8. Stimulation was administered 20 minutes a day for 5 days at the beginning of a one-hour multi-modal speech therapy session. The primary outcome measure was the Western Aphasia Battery Naming and Word-finding score. Secondary outcome measures included oral and written naming of pictures on the Philadelphia Naming Test. The primary and secondary outcome measures were assessed 24 hours after the last day of treatment, and again 3 weeks and 12 weeks later. Effects of tDCS were tested using a repeated-measures ANOVA for effects of arm (tDCS, sham) vs. time (pre, post, 2-week, 3-month). Results: Thirty-nine participants were randomized, 38 were treated, and 37 completed all follow-ups. HD-tDCS was well tolerated; there were no adverse events reported, or attrition due to discomfort from the treatment. The effect of tDCS was not significant for the primary outcome measure, but people in the active condition tended to show greater improvement ($F(3,105) = 1.78$, $P = .16$, partial-eta-squared=.048, small-medium effect-size). Among the secondary outcome measures, a significant effect of tDCS was observed only for written naming ($F(3,96) = 4.68$, $P = .004$, partial eta-squared = .128). Conclusion: We report a negative trial for five consecutive sessions of 1.5 mA HD-tDCS to the bilateral inferior frontal gyri, aimed at increasing left lateralization. Although the trial was negative, the data indicated a weak positive effect of tDCS on the primary outcome measure, and a larger effect on written naming (exploratory). The positive effect sizes observed after a short course of stimulation suggest that further research is needed to optimize tDCS treatment for chronic aphasia. Optimization may require addressing individual differences in responsiveness to stimulation, the choice of electrode locations, the dose in intensity, duration, and number of stimulation sessions, timing of stimulation relative to behavioral treatment, and the behavioral target of treatment. References: Brady MC, Kelly H, Godwin J, Enderby P. Speech and language therapy for aphasia following stroke. Cochrane Database Syst Rev. 2012;5:CD000425. Fama ME, Turkeltaub PE. Treatment of Poststroke Aphasia: Current Practice and New Directions. Semin Neurol. 2014;34:504-513

Language Disorders

A49 Automatic speech analysis technology yields reproducible dysprosodic markers in Primary progressive aphasia

Naomi Nevler[1], Sharon Ash[1], David J Irwin[1], Molly Ungrady[1], Mark Liberman[1], Murray Grossman[1]; [1]University of Pennsylvania

Objective To identify and quantify specific disease biomarkers of prosody from the acoustic properties of speech in patients with primary progressive aphasia, utilizing automatic speech analysis techniques. Methods 59 digitized speech samples were collected from patients with primary progressive aphasia (PPA, non-fluent/agrammatic=15, semantic=21, logopenic=23; ages 50-85 years, 39% males) and 31 matched healthy controls (ages 54-89 years, 36% males). These audio samples were analyzed with a novel, automated speech analysis protocol that relies on automatic speech activity detection. Acoustic measurements of prosody were extracted and calculated, including fundamental frequency (f0) and speech and silent pause durations. We compared these acoustic features between groups and then examined their relationships with clinical tests, gray matter atrophy, and cerebrospinal fluid analytes. Results We found a narrowed f0 range in patients with non-fluent/agrammatic

variant aphasia (mean 3.86±1.15 semitones) compared with healthy controls (6.06±1.95 semitones; p<0.001) and patients with semantic variant aphasia (6.12±1.77 semitones; p=0.001). Mean pause rate was significantly increased in the non-fluent/agrammatic group (mean 61.4±20.8 pauses per minute) and the logopenic group (58.7±16.4 pauses per minute) compared to controls (mean 32.24±9.75 ppm; p≤0.002 per contrast). Narrowed f0 range was associated with atrophy in the left inferior frontal cortex. Cerebrospinal level of phosphorylated-tau (p-Tau) was associated with an acoustic classifier combining f0 range and pause rate (r=0.58, p=0.007). Receiver Operating Characteristic analysis with this combined classifier distinguished non-fluent/agrammatic speakers from healthy controls (AUC=0.94) and from semantic variant patients (AUC=0.86). Conclusions Restricted f0 range and increased pause rate are characteristic dysprosodic markers of speech patterns in non-fluent/agrammatic PPA. These acoustic markers can be extracted automatically from the audio signal and are associated with left inferior frontal atrophy and cerebrospinal p-tau level.

A50 Neuroanatomical substrates of lexical retrieval *Janina Wilmskoetter[1,2], Julius Fridriksson[3], Ezequiel Gleichgerrcht[2], Brielle Stark[3], John Delgazio[2], Gregory Hickok[4], Kenneth Vaden[5], Argye Hillis[6], Chris Rorden[7], Leonardo Bonilha[2]; [1]Department of Health Sciences and Research, College of Health Professions, Medical University of South Carolina, Charleston, [2]Department of Neurology, College of Medicine, Medical University of South Carolina, Charleston, [3]Department of Communication Sciences and Disorders, University of South Carolina, Columbia, [4]Department of Cognitive Sciences, University of California, Irvine, [5]Department of Otolaryngology–Head and Neck Surgery, College of Medicine, Medical University of South Carolina, Charleston, [6]Department of Neurology, Johns Hopkins University, [7]Department of Psychology, University of South Carolina, Columbia*

Background: Deficits in word production are commonly observed in individuals with language processing impairments due to neurological diseases, particularly post-stroke aphasia. Lexical retrieval is related to several word features such as lexical diversity, lexical sophistication, and phonological word properties, whose deficits may significantly impair communication, particularly during discourse. The neuroanatomical bases of different aspects of word production in discourse are not fully understood. This study aimed to assess the gray and white matter underpinnings related to different features of lexical retrieval during connected speech. Methods: We performed voxel-, region-of-interest-, and connectome-based lesion symptom mapping on lexical features of the words produced during discourse from 58 individuals with chronic left hemisphere stroke. In addition, we performed partial correlation on selected region-of-interests and lexical features by controlling for variance from lesion volume. Word features were obtained from picture description tasks, including measures of lexical diversity, lexical sophistication, word length / number of phonemes, phonological neighborhood density, and biphoneme probability. For transcription, we used the Computerized Language Analysis (CLAN) program, and for discourse analysis, we used open source tools (Stanford Core Natural Language Processing, Irvine Phonotactic Online Dictionary, Lexical Complexity Analyzer, Gramulator). Results: After controlling for variance from lesion volume in partial correlations, we observed that measures of lexical diversity were associated with lesions to the left inferior frontal gyrus, supramarginal gyrus, and superior temporal gyrus. Lexical sophistication was associated with lesions to the left superior and middle temporal gyrus. Lexical-phonological measures (number of phonemes, phonological neighborhood density, biphoneme probability) were associated with lesions to the left precentral and supramarginal gyri. Conclusions: Our findings indicate that lexical sophistication and phonological features of lexical retrieval during discourse dissociate to distinct lesion locations associated with the ventral and dorsal language processing stream, respectively. Measures of lexical diversity were associated with areas belonging to both the ventral and dorsal stream. Our findings contribute novel information on the neural substrates of language processing that could be used to predict lexical retrieval in discourse of individuals with chronic post-stroke aphasia and, thus, guide treatment.

A51 Testing embodied cognition with a large premotor cortex lesion - a single case study *Hanna Gauvin[1,2], Kori Ramajoo[1,2], Sonia Brownsett[1,2], Katie McMahon[3,4], Greig de Zubicaray[1]; [1]Faculty of Health and Institute of Health and Biomedical Innovation, Queensland University of Technology, Brisbane, QLD, Australia, [2]School of Psychology and Counselling, Queensland University of Technology, Brisbane, QLD, Australia hanna.gauvin@qut.edu.au, [3]. School of Clinical Sciences, Queensland University of Technology, Brisbane, QLD, Australia, [4]Herston Imaging Research Facility, Royal Brisbane & Womens Hospital, Brisbane, QLD, Australia*

Over the last decade, multiple "embodied cognition" theories have proposed conceptual representations are grounded in the perceptual and motor systems involved in the execution of those actions (e.g., Barsalou, 2008; Gallese & Lakoff, 2005; Pulvermüller, 2005; Glenberg & Kaschak, 2002). Support for these accounts is assumed by fMRI studies demonstrating involvement of premotor and motor cortex in the processing of action words, although it is debatable whether this activity represents evidence for embodiment, spreading activation mechanisms or whether they are merely epiphenomenal. Recently, single case studies of focal brain lesion patients have been used to support a causal role for these regions in category specific action and emotion word recognition problems (e.g., Dreyer et al. 2015) We present data from a patient who underwent gross total resection of a grade II astrocytoma in the premotor cortex. The discrete lesion following the surgical resection extended from the left

frontal gyrus anteriorly to the superior frontal sulcus and posteriorly encompassed the left precentral gyrus, but did not involve the post-central gyrus. The patient received no adjuvant therapy. Given the importance of the premotor area for theories of embodied word meaning representation, the patient was invited to perform a series of tasks previously employed to investigate theories of embodied action and emotion word processing. [Methods] The patient was tested on multiple aphasia batteries to investigate the impact of the tumour resection on language processing at 8 months post-surgery. Furthermore, she performed a battery of lexical decision tasks aimed to test theories of embodied cognition at 10 months post-surgery. Performance was measured on the following lexical decision tasks: (I) Effector specific verbs (arm, face or leg related) and non-words, presented aurally. (II) Disyllabic verbs of manual actions, nouns of non-manipulable entities and non-words with verb-like ending and noun-like ending (de Zubicaray, Arciuli & McMahon, 2013) (III) Trisyllabic nouns and verbs with orthographic cues that are consistent or inconsistent with the spelling patterns of words from that grammatical category (Arciuli, McMahon & de Zubicaray, 2012). (IV) Words with positive, neutral or negative emotional valence and non-words. [Results] Aphasia batteries indicated near ceiling language performance. The performance of the patient on all lexical decision tasks was very accurate and highly comparable to that of healthy participants. [Conclusion] The lesion location presents a near perfect case to test the proposed function of premotor cortex according to theories of embodied cognition. No evidence was found for category specific language impairments or deficits in processing specific effector verbs, or on any other categories across any of the lexical decision tasks. It is worth noting here that the premotor cortex lesion of this patient is much larger than that of patient HS (Dreyer et al.) The current study does not support an indispensable role for the premotor cortex in processing the meanings of action or emotion words.

A52 Bringing Resting-state connectivity into the Operating Room: Comparing task and resting-state functional connectivity in presurgical language mapping

Daniel A. Di Giovanni[1], D. Louis Collins[1], Denise Klein[1]; [1]McGill University

Introduction: Task-based functional magnetic resonance imaging (fMRI) is typically used preoperatively to delineate eloquent cortex. Although non-invasive, this has several shortcomings as it is both labour and time intensive to find and use appropriate tasks. Resting-state fMRI (rs-fMRI) has been proposed to overcome these limitations. Previous work has shown that there is a strong relationship between the underlying network architecture of the brain during tasks and during rest. This project examines the persistence of this relationship in the language network despite the presence of brain tumors, to reinforce the notion that a fundamental intrinsic architecture of the language network drives the task-evoked activity, and hence justifies the use of rs-fMRI techniques to map the same network. This gives further credence to the potential of using rs-fMRI as an effective and efficient tool for presurgical mapping of functional cortex. Methods: Five-minute rs-fMRI scans were collected along with language task fMRI data. The language task consisted of participants naming objects and actions based on visual depictions. The data was examined in two parts: first as a group level analysis between patients and controls, and second on a subject level for 3 randomly selected patients and controls. For the group level analysis, task and resting-state data from tumour patients were compared to healthy controls. To do this, functional connectivity (FC) matrices were extracted using regions of interest (ROI) based on known areas essential for language function. A standard fMRI preprocessing pipeline was applied using the CONN toolbox, except during the denoising of the task scans, the effect of task activation was regressed out of the whole brain signal. This was done so that the resulting task-related functional connectivity matrices would be representative of the underlying functional connectivity. A weighted general linear model was used to determine significant brain activity during the task scans at the first-level of analysis. Pearson correlations with Fisher's Z-transformed values, of each ROI to each other ROI, were used to determine functional connectivity between ROIs and create connectivity matrices for both conditions (Task and Rest) and groups (Patients and Controls). The second-level analysis correlated the rs-FC matrices to the task-FC matrices, first at a group level, and then at the individual subject level. Results: We found a high correlation between the functional connectivity matrices of the language task conditions and the resting-state in both controls and patients. Furthermore, when examined on a subject-level, the functional connectivity matrices of tumor patients correlated at similar level to that of controls. Discussion: The similarity in correlation values in controls and patients suggests that the intrinsic network architecture of the brain and its relationship to the task-evoked activity of the brain is preserved in tumor patients. This is a step forward in demonstrating the usefulness of rs-fMRI for presurgical planning even for such high-level processing such as language, as we can use this data to inform novel ways of mapping functional cortex using only rs-fMRI.

A53 Impaired Phoneme Discrimination and Word Comprehension Due to Acute Left Superior Temporal Gyrus Dysfunction

Luke Adams[1], Kevin Kim[1], Lynsey Keator[1], Amy Wright[1], Sadhvi Saxena[1], Corianne Rogalsky[2], Greg Hickok[3], Argye Hillis[1]; [1]Johns Hopkins University School of Medicine, [2]Arizona State University, [3]University of California Irvine

Few studies have identified significant impairments in phoneme discrimination after unilateral stroke. One study found that deficits in phoneme discrimination were seen in 14 percent of left hemisphere stroke patients acutely, and were associated with word comprehension

deficits. Lesion sites responsible for these deficits were not identified. We tested the hypotheses that acute deficits in phoneme discrimination are associated with infarct and/or hypoperfusion of left superior temporal gyrus (STG), and that deficits recover quickly due to reperfusion of STG or because right STG alone can become sufficient for phoneme discrimination. We evaluated patients with first-ever, unilateral left hemisphere stroke on a phoneme discrimination test within 48 hours of onset, and again 3, 6, and/or 12 months later. We tested phoneme discrimination by verbally presenting pairs of consonant-vowel syllables (real and non-words), to which the patient responded "same" or "different" (n=64). Word comprehension was tested with word-picture matching tests with mixed semantically and phonologically similar foils (n=20) or only phonologically similar foils (n=24). Participants were asked to indicate the picture matching auditory presented stimuli. Associations between phoneme discrimination deficits and tissue dysfunction (hypoperfusion and/or infarct) in 5 language network regions of interest (ROI: left STG; supramarginal gyrus, angular gyrus, arcuate fasciculus, and inferior frontal gyrus) were tested with Fisher's exact tests. Results: Twelve patients with completed testing had both diffusion weighted imaging (DWI) and perfusion weighted imaging (PWI) available at onset, to identify areas of acute tissue dysfunction on MRI. Of these, 4 (33%) had significant impairment in phoneme discrimination at Day 1, in each case associated with both spoken word comprehension impairment and dysfunction of left STG. Two of four with initial phoneme discrimination deficits showed hypoperfusion (but no infarct) in left STG, and recovered to normal phoneme discrimination by 6-12 months. Two patients had infarct, but more extensive hypoperfusion in left STG, and showed improvement, but not recovery, of both phoneme discrimination and word comprehension by 6 months post-stroke. Seven patients had normal phoneme discrimination at all time points tested, and only one of these had hypoperfusion (but no infarct) in left STG. Impaired phoneme discrimination was significantly associated with dysfunction of left STG (p=0.010), but no other ROI. Conclusion: Results show that left STG dysfunction is associated with phoneme discrimination deficits and auditory word comprehension deficits acutely, often due to hypoperfusion; and these deficits recover by 6 months if there is no infarct in left STG. Results also confirm that impaired phoneme discrimination may underlie at least some cases of word comprehension deficits.

A55 Beyond left hemisphere versus right hemisphere in aphasic language recovery: Evidence from effective connectivity during lexical-semantic processing

Erin Meier[1], Jeffrey Johnson[1], Yue Pan[1], Swathi Kiran[1]; [1]Boston University

Traditional models of neural reorganization in persons with chronic aphasia (PWA) propose that optimal, satisfactory, and poor language recovery are characterized, respectively, by reinstatement of premorbid left hemisphere (LH) language activation patterns; recruitment of perilesional LH issue outside canonical language cortex; and reliance on right hemisphere (RH) homologues of damaged LH regions (Heiss & Thiel, 2006; Anglade, Theil, & Ansaldo, 2014). While some support for this hierarchy exists, a great deal of debate revolves around the compensatory capacity of the RH and perilesional LH regions for language recovery. Activation studies that pit LH activation again RH recruitment have not resolved this debate. Therefore, we used fMRI and dynamic causal modeling (DCM; Friston, Harrison, & Penny, 2003) to interrogate bilateral effective connectivity in 30 PWA and 18 age-matched controls during a semantic feature decision task. During the task, participants decided via button press whether written semantic features applied to pictured items. The DCM model space included seven ROIs (i.e., bilateral inferior frontal gyrus, pars triangularis [IFGtri], bilateral posterior temporoparietal cortex [TPC], posterior inferior temporal gyrus [pITG] and left middle frontal gyrus [LMFG]) selected a priori from the activation literature that were activated at a 2nd-level in PWA and/or controls. DCM models were constructed to test whether task-based connectivity patterns in chronic patients aligned with Heiss and Theil's (2006) hierarchy. Various combinations of task-modulated intra-LH, intra-RH and interhemispheric connections were modeled, resulting in 14 models split into four families (i.e., Family #1: LH-lateralized connectivity ["normal" processing]; Family #2: bilateral anterior connectivity [posterior damage]; Family #3: bilateral posterior connectivity [anterior damage]; and Family #4: RH-lateralized connectivity [extensive LH damage]). Family-wise Bayesian model selection (Penny et al., 2010) revealed "normal" LH-lateralized models (i.e., family #1) best fit control data (exceedance probability [xp]=0.949). In PWA, model fit was split between family #1 (xp=0.568) and family #3: bilateral posterior connectivity (xp= 0.424). One-sample t-tests on parameters weighted by model evidence across all families revealed significant task-modulated connections in controls included LITG-LTPC, LITG-LIFGtri, LITG-LMFG and LITG-RITG. For PWA, the aforementioned connections were also significant (although weaker than controls) as were LIFGtri-LMFG, LIFGtri-RIFGtri, RIFGtri-RITG and RITG-RTPC. Critically, connection strength was not related to the amount of spared tissue in LH ROIs (p>0.05 across connections). Connections that significantly predicted patients' fMRI task accuracy were identified via backward stepwise regression and re-entered into a multivariate regression model. This model was significant F(10,18)=2.575, p=0.039, adjusted R-squared=0.360) and included positive predictors, where greater strength of certain connections (i.e., LIFGtri-LMTG, LITG-LMFG, LMFG-LIFGtri, RIFGtri-LIFGtri, RTPC-RIFGtri) was indicative of better task accuracy, as well as negative predictors, where greater strength of other connections (i.e., LMFG-LMTG, LMTG-LMFG, RITG-RIFGtri) was related to poorer task accuracy. In all, task-

modulated connections that related to better task accuracy were not confined to interactions between canonical language regions (LIFGtri, LITG, LTPC) nor were all intra-RH and interhemispheric connections maladaptive for task performance. As such, traditional structure-function-behavior recovery models of chronic aphasia must be re-evaluated in light of recent connectivity studies that highlight more nuanced recovery patterns in PWA.

A56 Individual Pseudo-Lesioning to Assess Secondary White Matter Connectivity Changes in Post-Stroke Aphasia

Natalie Busby[1], Ajay D. Halai[1], Geoffrey J.M. Parker[1,2], Matthew A. Lambon Ralph[1]; [1]University of Manchester, [2]Bioxydyn Ltd.

Post-stroke aphasia patients are traditionally grouped based on aphasia classification, however these sub-categories are often fluid and arbitrary, and therefore other data-driven methods of classifying patients may be more clinically relevant. Groups of patients may recover behaviourally in different ways, however often subtle widespread white matter connectivity changes away from the lesion itself may be difficult to assess in comparisons with controls. If more sensitive measures of connectivity were possible, associations with behavioural improvement may be found. Sixty-six chronic post-stroke aphasia patients and twenty-two aged matched controls were recruited. Using hierarchical clustering patients were grouped into four clusters based on lesion size and location. Whole-brain connectivity maps were acquired for each patient using FSL's probtrackx function to initiate streamlines from every voxel within the brain. Connectivity scores were calculated by summing the number of streamlines passing through each voxel. In this way, every voxel has a connectivity score which represents how well connected it is to the rest of the brain. These maps were termed Anatomical Connectivity Maps (ACMs) and reflected whole-brain connectivity. Initially, patient's average connectivity scores in white matter tracts were compared to controls to determine tracts with significantly reduced connectivity. As a secondary analysis, each patient's own binary lesion was used as an exclusion mask in the set of controls meaning no streamlines were initiated in or could enter this 'lesion'. This resulted in each patient having a set of controls with their own 'lesion' (termed pseudo-patients). In this way we could emulate each individual's lesion and therefore could compare the instantaneous effect of the lesion back to the patient's actual connectivity. This sensitive measure allowed us to identify subtle long-range secondary connectivity changes which may be associated with behavioural improvements in language ability. Four clinically-relevant clusters of patients emerged and were termed insula, fronto-parietal, temporo-parietal and whole middle cerebral artery (MCA). Compared to controls, the largest lesion group (whole MCA) had the lowest connectivity scores in all white matter tracts tested. The insula cluster had significantly reduced connectivity the uncinate fasciculus and frontal portions of the superior longitudinal fasciculus (SLF) and inferior fronto-occipital fasciculus (IFOF). Conversely, the temporo-parietal lesion group had lower connectivity scores in posterior portions of the IFOF, SLF and inferior longitudinal fasciculus (ILF). In the fronto-parital group, connectivity was conserved in the majority of tracts except the SLF. Across all patients, increased connectivity scores within the left SLF and ILF positively correlated with phonology scores. Compared to their own set of pseudo-patients, a subset of patients showed widespread upregulation and/or Wallerian degeneration. Across patients, increases in chronic connectivity vs instantaneous connectivity was positively correlated with the left IFOF and uncinate, whilst connectivity in the left SLF negatively correlated with speech quanta. Therefore, grouping patients based on their lesion may be useful clinically as it reveals group-level connectivity changes associated with the lesion. However it does not capture the variability seen between patients. Individual 'pseudo-lesioning' may offer a sensitive measure to assess secondary whole brain connectivity associated with behavioural recovery post-stroke.

Language Development

A57 Brain activation for spoken and sign language in infancy: Impact of experience in unimodal and bimodal bilinguals

Evelyne Mercure[1], Samuel Evans[2], Laura Pirazzoli[3], Laura Goldberg[1], Harriet Bowden-Howl[1,4], Kimberley Coulson[1,5], Sarah Lloyd-Fox[3], Indie Beedie[1], Mark H. Johnson[3,6], Mairead MacSweeney[1]; [1]University College London, [2]University of Westminster, [3]Birkbeck - University of London, [4]University of Plymouth, [5]University of Hertfordshire, [6]University of Cambridge

Adult neuroimaging studies robustly demonstrate that sign language is processed in a similar brain network as spoken language in adulthood (Capek et al., 2008; Emmorey, 2001; Hickok et al., 1996; MacSweeney et al., 2004; MacSweeney et al., 2008; Petitto et al., 2000). This is a strong argument for the idea that classical language areas of the left hemisphere are specialized for the processing of natural languages independent of their modality. In infancy, spoken language activates a similar network to the adult language network and activation of perisylvian areas are often observed to be larger in the left than right hemisphere (Dehaene-Lambertz et al., 2002; Minagawa-Kawai et al., 2010; Pena et al., 2003). The neural representation for sign language has never been studied in infancy and it is unclear how experience of different language modalities influence the neural substrate of language in infancy. The present study used functional Near Infrared Spectroscopy (fNIRS) to compare and contrast the neural representation of spoken and sign language in three groups of infants with different language experience. Data is presented from 60 infants between 4 and 8 months: 19 monolingual infants exposed to English exclusively, 20 unimodal bilingual infants who were frequently and regularly exposed to

English and one or more additional spoken language(s), and 21 bimodal bilingual infants with a Deaf mother exposed to English and British Sign Language (BSL). FNIRS with 46 channels was used to measure brain activation while infants were presented with audiovisual videos of short stories in spoken or sign languages. Univariate analyses and multivariate pattern analyses (MVPA) were used to study the neural substrate of spoken and sign language in the three groups of infants. A support vector machine using a leave-one-participant-out cross validation and permutation testing was used to decode patterns of activation for each modality. In monolinguals, patterns of activation for spoken and sign language could be classified at a level greater than chance using left hemisphere channels (proportion correct = 0.68; p = 0.04), but not right hemisphere channels (proportion correct = 0.50; p = 0.71). In unimodal bilinguals, decoding revealed that spoken and sign language could be classified with an accuracy close to significance level based on all channels (proportion correct = 0.62; p = 0.09), but not based on either hemisphere alone (Left: proportion correct = 0.55; p = 0.40; Right: proportion correct = 0.57; p = 0.18). In bimodal bilinguals, MVPA could not classify spoken and sign language (All channels: proportion correct = 0.50; p = 0.54; Left: proportion correct = 0.57; p = 0.57; Right: proportion correct = 0.52; p = 0.45). Univariate analyses revealed group differences in the amplitude and lateralisation of brain activation to language. Bimodal bilinguals demonstrated reduced amplitude of their language activation, while unimodal bilinguals showed increased right lateralisation for language compared to monolinguals. These results suggest that early language experience influences the neural substrate of language. Language modalities were better distinguishable in groups of infants for whom one modality (sign language) was unfamiliar.

A58 Pinpointing the neuroanatomical correlates of foreign language learning ability and musical aptitude

Sabrina Turker[1,2], Annemarie Seither-Preisler[1,3], Susanne M. Reiterer[5], Annemarie Peltzer-Karpf[2], Peter Schneider[5]; [1]Centre for Systematic Musicology, University of Graz, [2]Department of English and American Studies, University of Graz, [3]BioTechMed Graz, Austria, [4]Department of Linguistics, University of Vienna, [5]University Hospital Heidelberg, Department for Neuroradiology, Heidelberg, Germany

Various studies have shown that (1) musical ability and foreign language acquisition are positively correlated (Christiner & Reiterer, 2013; Dogil & Reiterer, 2009) and (2) working memory is an excellent predictor for foreign language aptitude (Wen, 2016). However, very few studies so far have investigated the relationship between these abilities considering variation in the neuroanatomy of specific brain regions (Golestani et al., 2006, 2011; Wong et al., 2007), such as auditory cortex. Interestingly, high musical ability could recently be linked to the morphology of Heschl's gyrus (HG), a region essential for basic auditory processing (Seither-Preisler et al., 2014; Benner et al., 2017). Its importance for other abilities such as foreign language aptitude remains yet to be uncovered. The main aim of our research lies in further exploring the intricate interdependence between musicality, language aptitude and working memory in different age groups. Although numerous studies have highlighted positive correlations between them, hardly any studies have looked at the basis and nature of these relationships. Moreover, we are using innovative brain segmentation procedures for relating the aforementioned abilities to structural variation in human auditory cortex, more specifically HG, using BrainVoyager QX software. Our projects involve healthy, German-speaking adults (N=30, aged 20-40 years) and children/teenagers (N=55, aged 10-17 years). All subjects underwent extensive behavioral testing, including language aptitude tests [Hindi speech imitation test (Reiterer, 2009), LLAMA (Meara, 2005) and MLAT (Carroll & Sapon, 1959)], working memory skills (digit span backward and forward, non-word span) and musicality (AMMA; Gordon, 1986). Additionally, the young subjects' performance in an arithmetic fluency test (Vogel et al., in press) and the MULTAP (Christiner & Reiterer, 2017) was included. All subjects took part in MRI sessions (T1 Scans) and we analyzed the number of HG in the auditory cortices of these individuals and calculated possible interdependencies between these characteristics. On the behavioral level, we were able to find striking correlations between all investigated measures, namely working memory and speech imitation skills, as well as musicality and language aptitude in both age groups. Additionally, the gross morphology of auditory cortex of adults could be successfully linked to high language learning ability and musicality. Gifted adults had significantly more HG duplications, but only in the right hemisphere. Preliminary findings of a subgroup of the children and teenagers reveal no brain-morphological differences in auditory cortex according to aptitude so far. In the children/teenager sample, we were further able to highlight various behavioral relationships between self-rated aptitude, parents' rating and with school grades, as well as with musical ability, singing skills and higher scores in a variety of cognitive measures (e.g., working memory). In summary, we were able to identify specific neuroanatomical markers for language und musical aptitude in right auditory cortex. These markers, which are highly stable over time, are likely to be under pre-natal and/or genetic influence and may thus represent a neural basis for an individual's intrinsic motivation to learn new languages and to play musical instruments.

A59 Socioeconomic Status (SES) differences in children's N400 responses when learning new words from linguistic context.

Yvonne Ralph[1], Julie M. Schneider[1], Mandy J. Maguire[1]; [1]University of Texas at Dallas

Introduction: Coming from a low-income home has negative impacts on language and brain development, vocabulary being particularly vulnerable (Hoff, 2013;

Nobel et al. 2012). As children enter school this vocabulary disparity is exacerbated (Bradley & Corwyn, 2002). To better understand how word learning skills and the neural underpinnings of word learning may differ related to SES, we recorded the EEG of children from low SES (LSES) and higher SES (HSES) homes as they performed a word learning from context task. Our primary goal is to identify if the groups display differences in word learning abilities or neural markers of word learning based on the N400 which, in previous studies with both children (Abel et al, 2017) and adults (Mestres-Misse, et al 2007), has been shown to reliably index word learning across presentations. Methods: Sixty-four (30 low SES) right-handed, 8 to 10-year-old (M=8.97; SD =.78) children had their behavioral and EEG responses recorded while engaged in a word learning task. SES was based on government standards for free or reduced lunch. Stimuli were 50 sentence triplets, presented one at a time, on a computer monitor. Each sentence in the triplet ended in the same made up word. After the presentation of each triplet, participants indicated whether the made-up word represented a real word and, if so, what it was. Responses were correct if the participant identified the intended target word or if their response created three semantically plausible sentences. All of the words in the sentence, other than the target word, were in children's productive vocabularies by about 30 months of age (Fenson, et al 1994). Analysis Only correct trials were included in the analysis. ERPs were time-locked to the final target word in each sentence and the corresponding EEG was epoched from -100 msec to1500 msec. Data were averaged across trials and subjects and baseline corrected. The average amplitude across frontal electrodes between 300-500 msec post stimulus was computed for each presentation and these averages were statistically compared using a 2(SES) x 3(Presentation) RMANOVA. Results Children from low SES homes learned fewer words (M=44%; SD =.23) than their higher SES peers (M=57%; SD=.19; t(59)=2.41, p<.02). The N400 analysis revealed a main effect of presentation (F(2,124)=4.83, p=.01), but no interaction. Due to substantial variability in the LSES group (SD=2.5, high SES group SD=1.6) we analyzed each group independently. The N400 attenuated across presentations for the HSES group (F(2,131)=2.86, p=.03, one tailed), but not the LSES group. Conclusion Children from LSES homes learned fewer words than their higher SES peers and failed to exhibit an N400 attenuation across presentations. We hypothesize that the lack of N400 attenuation is due to greater variability in neural engagement within and between participants in the LSES group. This high level of variability in the N400 provides evidence that children from LSES homes may engage different compensatory strategies for word learning (Maguire et al., 2018) as well as evidence of differences in neural structures underlying language processing (Nobel et al., 2012).

A60 What can neuroscience teach us about the origin of language?

Oren Poliva[1]; [1]Bangor University

In the brain of primates, the auditory cortex connects with the frontal lobe via the temporal pole (auditory ventral stream; AVS) and via the inferior parietal lobe (auditory dorsal stream; ADS). The AVS is responsible for sound recognition, and the ADS for sound-localization, voice detection and integration of calls with faces. I propose that the primary role of the ADS in non-human primates is the detection and response to contact calls. These calls are exchanged between tribe members (e.g., mother-offspring) and are used for monitoring location. Detection of contact calls occurs by the ADS identifying a voice, localizing it, and verifying that the corresponding face is out of sight. Once a contact call is detected, the primate produces a contact call in return via descending connections from the frontal lobe to a network of limbic and brainstem regions. Because the ADS of present day humans also performs speech production, I further propose an evolutionary course for the transition from contact call exchange to an early form of speech. In accordance with this model, structural changes to the ADS endowed early members of the genus Homo with partial vocal control. This development was beneficial as it enabled offspring to modify their contact calls with intonations for signaling high or low levels of distress to their mother. Eventually, individuals were capable of participating in yes-no question-answer conversations. In these conversations the offspring emitted a low-level distress call for inquiring about the safety of objects (e.g., food), and his/her mother responded with a high- or low-level distress call to signal approval or disapproval of the interaction. Gradually, the ADS and its connections with brainstem motor regions became more robust and vocal control became more volitional. Speech emerged once vocal control was sufficient for inventing novel calls.

A61 An Investigation of the Relationship between Reading and Speech Production in Children and Adolescents

Cassidy Fleming[1], Angela Cullum[1], Jacqueline Cummine[1,2]; [1]Faculty of Rehabilitation Medicine, University of Alberta, [2]Neuroscience and Mental Health Institute, University of Alberta

Purpose. Approximately 10-15% of children have reading difficulties, including developmental dyslexia and specific comprehension deficit. Relationships between basic reading processes and brain structures in adults have been widely reported in neuroimaging literature. However, few studies have examined these relationships in children, and many face limitations of small sample size. The primary objective of this study is to examine the relationship between structural characteristics of the brain and reading performance across the developmental trajectory by using a combination of diffusion tensor imaging (DTI; i.e., fractional anisotropy), and volumetric magnetic resonance imaging (MRI; i.e., volume and thickness) measures. Method. Child and adolescent participants aged 3 to 17 (n=444) were obtained from the Pediatric Imaging, Neurocognition and Genetics (PING) Study database.

Participants were included if they were 6 to 17 years of age, right handed, native English speakers, had completed the NIH Toolbox Oral Reading Recognition Test (TORRT), did not have vision or hearing problems and did not have a diagnosis of attention-deficit hyperactivity disorder. Volume, thickness and fractional anisotropy of brain regions and white matter tracts implicated in reading and speech production were extracted from the PING Study database, along with TORRT reading scores. Participants were divided into four age groups (years;months): 3;0 to 6;11, 7;0 to 11;5, 11;5 to 13;11 and 14;0 to 17;11. Blockwise multiple linear regression analysis was used to examine the relationship between age-corrected TORRT reading scores and DTI and MRI measures by age group, while controlling for potential confounds including prenatal alcohol exposure, parental education and occupation, household income, and racial minority status. Results. The neural correlates of reading performance vary significantly across development and reflect the demands of reading across the developmental trajectory. The regression model for each age group accounts for between 9.9% and 33.9% of the variance in reading scores. Regions of the brain associated with articulatory representations have a significant influence on reading at every stage of development, including the pars triangularis, cerebellum and putamen. Significant changes continue to occur throughout late childhood and adolescence. Significance. The PING study database provided a unique opportunity to examine neural correlates of reading performance in a large cohort of children and adolescents. The findings of this study expand our understanding of brain-behavior relationships in reading, and the influence of articulation on reading, providing evidence to support the print-to-speech model. Finally, these findings have the potential to inform optimal treatment of individuals with reading disabilities.

Multilingualism

A63 The impoverished comprehension of non-native speech in noise

Esti Blanco-Elorrieta[1], Nai Ding[2], Liina Pylkkänen[1,3], David Poeppel[1,4]; [1]New York University, [2]Zhejiang University, [3]NYUAD Institute, [4]Max Planck Institute

INTRODUCTION. There is strong evidence that under unfavorable listening conditions (e.g. noise) bilinguals have a deficit in the comprehension of their second language (L2) compared to their first language, despite performing similarly in quiet listening conditions. For example, if bilingual speakers enter a noisy party, they will be able to follow the conversation if their interlocutor is speaking in their native language. However, they will have trouble understanding what is being said if their interlocutor speaks in their second language. Although the prevalence of this phenomenon has been previously established (Florentine et al., 1984; Bradlow & Bent, 2002; Garcia-Lecumberri & Cooke, 2006; Rogers et al., 2006), the causes and neurobiological bases of this dissociation have not been elucidated. In this study we used neural entrainment to different linguistic levels of representation to investigate the bases of the impoverished comprehension of L2 speech in noise. METHODS. We collected MEG data from 40 Chinese-English bilinguals. Participants listened to four-syllable isochronous sentences in English and in Chinese (cf. Ding, Melloni, Zhang, Tian & Poeppel 2016) at 4 different levels of noise, ranging from completely clear speech (15 dB) to unintelligible speech in a noisy background (-15 dB), in 7.5 dB intervals. The sentences consisted of 4 monosyllabic words that were combined to form a two-word noun phrase (adjective + noun) and a two-word verb phrase (verb + noun). The combination of these two phrases resulted in a four-word sentence (e.g., "big rocks block roads"). In order to meaningfully characterize the effect of noise across varied L2 proficiency levels, we tested bilinguals who were native speakers of Chinese with low level of English (16), with high level of English (12), and native speakers of Chinese who were currently English dominant (born to Chinese parents in the US; 12). RESULTS. Behavioral results show distinct psychometric curves for the comprehension of L1 and L2 speech, which vary by the language profile of the tested group. MEG results reveal two distinct phenomena: i) the tracking of syllabic rhythm decreases linearly as noise increases; and ii) the tracking of higher level phrasal structure is non-linearly disrupted by noise, as shown by a) the complete lack of entrainment to phrases at the highest level of noise (-15 dB) regardless of language profile and b) only native speakers (but not L2 speakers) tracking phrasal structures at -7.5 dB. CONCLUSION. This study quantifies the influence of noise in the cortical tracking of linguistic structures in connected speech, and provides evidence to suggest that -7.5 dB may be the threshold level of noise at which L2 comprehension is disrupted. Previous research has posited that greater availability of higher-level top-down linguistic information may account for this difference in L1 vs. L2 comprehension. The present study shows that a more automatic lower-level phenomenon, oscillatory tracking of speech, may also underlie the prevalent effect of impoverished comprehension of L2 speech in noise.

A64 Neurodevelopmental impact of early bilingual acquisition on children's syntactic processing

Neelima Wagley[1], Frank Hu[1], Alisa Baron[2], James Booth[3], Teresa Satterfield[1], Lisa M. Bedore[2], Ioulia Kovelman[1]; [1]University of Michigan, [2]University of Texas - Austin, [3]Vanderbilt University

How does bilingual acquisition influence children's neural architecture for sentence processing? Language acquisition is characterized by progressive use of inflectional morphology marking verb tense and agreement ("Today he is baking a cake" or "Every day he bakes a cake"). Children's acquisition of linguistic milestones is also linked to increased neural specialization of the left inferior frontal (IFG) and posterior temporal (pSTG) regions associated with language processing. We used functional Near-Infrared Spectroscopy (fNIRS) to investigate how bilingual exposure influences children's cortical organization for

processing morphosyntax. 65 Spanish-English bilingual children growing up in the U.S. (7-9 yo) judged English sentences with grammaticality violations in earlier- (verb agreement, -ing) and later-acquired (verb tense/agreement, -ed/s) omissions, or correct structures. Children had high dual-language proficiencies and were faster and more accurate when processing violations of the earlier- than the later-acquired structures. Task accuracy was related to greater English exposure. Neuroimaging analyses revealed robust activations along the dorsal route involved in syntactic processing: left IFG (BA 44) to the left pSTG and STS. Overall task accuracy and performance on a behavioral Spanish morphosyntax assessment significantly predicted brain activity during the grammaticality task in key frontal, temporal, and temporoparietal regions. The findings parallel those previously found for young monolingual children with earlier neural specialization of the left temporal regions, followed by increased specificity of the frontal regions (dorsal IFG regions) considered critical for syntactic processing. The findings suggest that early-exposed and highly proficient bilinguals may show a cumulative impact of dual-language exposure and use on the neural architecture for language processing.

A65 How spatial-temporal metaphors shape time conceptualisation in bilinguals

Yang LI[1], Guillaume Thierry[1]; [1]School of Psychology, Bangor University

Chinese, similarly to English, places the future in the front space and the past behind the speaker. However, some expressions in Chinese involve counter-intuitive spatial-temporal metaphors referring to the opposite direction of the common future-in-front orientation. For example, the year before last (□□, qian-nian) and the day before yesterday (□□, qian-tian) in Chinese both contain the character □(qian) which literally means 'front'. Conversely, words referring to the year after next and the day after tomorrow in Chinese both contain the character □ (hou), which literally means 'back'. Here, we investigated how such spatiotemporal metaphors unconsciously affect time conceptualization in Chinese-English bilinguals. English controls and Chinese-English bilingual participants sat in the centre of a sound-attenuated room and heard stimuli played through loudspeakers located in front of them and in their back. Stimuli consisted of audio recordings of days of the week (e.g., "Thursday") or years (e.g., "2017"). On each trial, participants indicated whether the stimulus heard was either one day / year away from the present time in the past or future or two days / years away from the present time in the past or future by pressing designated buttons. English native speakers were only tested in English while Chinese-English bilingual participants were tested once in Chinese Mandarin and once in English. When dealing with Chinese stimuli, Chinese-English bilinguals displayed no congruency effect of time reference in relation to loudspeaker location. However, when the spatial-temporal metaphor in Chinese conflicted with the combination of English stimulus and loudspeaker location, we recorded increased N400 amplitudes as compared to compatible combinations. For instance, the stimulus "2019" presented through the front loudspeakers elicited a greater N400 than the same stimulus presented in the back of the participant, and, reciprocally, the stimulus "2015" presented through the back loudspeakers elicited a greater N400 than the same stimulus presented in the front of the participant. This effect was found for both years and days of the week and applied when the gap in time between present day/year and stimulus was two rather than one. Furthermore, Bayes factor analysis of the N400 modulations elicited by the conflict between Chinese spatial-temporal metaphors and spatial location of the loudspeakers delivering the stimuli showed the effects were of the same magnitude in either direction. Finally, we found no such conflict effect in English participants performing the task in English. We conclude that spatial-temporal metaphors implicitly modulate conceptualization of time in bilinguals, not when they operate in the language that feature these metaphors, but when they operate in their second language. Implications for language non-selective access in bilinguals and linguistic relativity are discussed.

A66 The impact of successive bi-/multilingualism on the cognitive abilities of healthy older speakers: Evidence from Norwegian academics.

Valantis Fyndanis[1], Sarah Cameron[1], David Caplan[2], Christina Davril[3], Nina Hagen Kaldhol[1], Monica Knoph[1], Hanne Gram Simonsen[1], Ane Theimann[1], Charalambos Themistocleous[4,5], Thomas Bak[6]; [1]University of Oslo, Oslo, Norway, [2]Massachusetts General Hospital, Boston, USA, [3]University of Freiburg, Freiburg, Germany, [4]Johns Hopkins University, Baltimore, USA, [5]University of Gothenburg, Gothenburg, Sweden, [6]University of Edinburgh, Edinburgh, UK

While it is well established that healthy older speakers exhibit age-related cognitive decline, a growing body of research suggests that both simultaneous and successive bilingualism are associated with cognitive benefits, enhancing aspects of executive functioning in healthy older speakers and even delaying the onset of dementia. It has recently been argued (e.g., Bialystok et al., 2014) that a bilingualism-driven cognitive benefit is more likely to be detected in nonverbal cognitive tasks than in verbal tasks. Interestingly, a bilingual advantage has been found not only in people who speak two or more languages, but also in infants who are only exposed to two languages. This suggests that not only speaking, but also listening to two or more languages may confer a cognitive advantage. However, the bilingual advantage has been called in question because of potential confounding factors involved in several studies, such as immigration status, socioeconomic status, and educational level. Moreover, it has been suggested that bi-/multilingualism should be treated as a continuous and not as a categorical variable, as is usually the case. The goal of this study is to investigate whether different degrees of bilingualism in different

modalities (speaking, writing, listening, reading) have a differential effect on the cognitive abilities of healthy older individuals who are of the same immigration status and of similar socioeconomic status and educational level. The study also explores if a bilingual advantage only emerges in nonverbal cognitive tasks. Eighty-three healthy older (aged 55-70) native speakers of Norwegian differing in the degree of bi-/multilingualism were tested with tasks tapping verbal and nonverbal inhibition and switching, as well as nonverbal fluid intelligence. The degree of bi-/multilingualism was determined by the amount of use of one or more languages other than Norwegian established through a comprehensive questionnaire. Separate scores were computed for speaking, writing, listening, and reading. All participants were university professors living and working in the metropolitan area of Oslo. All had learned their first foreign language after the age of 5, and none of them were immigrants. Correlation analyses were performed between the different measures of bi-/multilingualism and the cognitive effects computed for each task. Results show that the higher the degree of bi-/multilingualism in the reading modality, the more enhanced the nonverbal inhibition ability; and the higher the degree of bi-/multilingualism in the writing modality, the more enhanced the nonverbal shifting ability. The correlations are small but significant. The results are not confounded by nonverbal fluid intelligence. No effect of bi-/multilingualism on verbal cognitive tasks was found. Results are consistent with the literature arguing that successive bilingualism confers a cognitive advantage, which usually emerges in nonverbal tasks. Results suggest that not only speaking but also writing or reading two or more languages can confer a cognitive advantage. It appears that "modality of bi-/multilingualism" interacts with inhibition and shifting. References Bialystok, E., Poarch, G., Luo, L., & Craik, F. I. (2014). Effects of bilingualism and aging on executive function and working memory. Psychology and Aging, 29, 696–705.

A67 Neural Correlates of Spoken Word Processing in Korean-Chinese-English Trilinguals: An fMRI Study

Say Young Kim[1], Fan Cao[2]; [1]Hanyang University, Seoul, Korea, [2]Michigan State University, MI, USA

INTRODUCTION: Previous neuroimaging studies provided inconsistent evidence as for whether brain network of L2 is similar to or different from that of L1(e.g., Marian et al., 2007; Zhao et al., 2012). A recent study with Korean-Chinese-English trilinguals (Kim et al., 2016) suggests that the assimilation and accommodation pattern in bilingual reading network is influenced by language distance between L1 and L2. Using a visual rhyming judgment task, the results showed that the brain network involved in L2 reading is similar to the L1 network (assimilation) when the distance in orthographic transparency between L1 and L2 is small (Korean L1 and English L2), while the L2 network is significantly different from the L1 network (accommodation) when L2 is more opaque than L1 (Korean L1 and Chinese L2). However, in comparison to reading, there has been not many studies that focused on the similarity and differences between L1 and L2 during spoken word processing. The current study using Korean-Chinese-English trilinguals examined whether and how brain network involved in spoken word processing, in comparison to written word processing, is affected by language distance between L1 and L2 using an auditory rhyming task. METHOD: During functional magnetic resonance imaging (fMRI) scanning, Korean trilingual participants were asked to make an auditory rhyming judgment, where they had to indicate whether subsequently presented auditory word pairs rhyme (e.g., late-hate) or not (e.g., pint-mint). All the participants performed Korean rhyming (KK), English rhyming (KE), and Chinese rhyming (KC) tasks. The proficiency on English and Chinese in the Korean trilingual participants were matched. RESULTS & CONCLUSION: The results of the whole brain activation provided evidence of strong assimilation patterns regardless of two typologically different L2s (Chinese and English). KK showed greater activation in the bilateral STG than KC, and no region was greater for KC than KK. In addition, KK showed greater activation in the left STG and IFG than KE, and no region was greater for KE than KK. However, the subsequent ROI (at STG: -50, -28, 6) analyses revealed an L2 specific accommodation pattern in Chinese L2 auditory processing, but not in English L2 auditory processing. We also found a significant negative correlation between brain activation in this region and the rhyming decision latency for KK and KE, but not for KC. The results of the current study suggest that, for phonological processing of spoken words, L1 and L2 recruited largely shared brain regions and relative involvement of language specific regions is also expected.

A68 Bilingual Recruitment of Inhibitory Control While Translating

Jamie Renna[1], Yazmin Medina[1], Ksenija Marinkovic[1,2], Katherine J. Midgley[1], Phillip J. Holcomb[1]; [1]San Diego State University, [2]University of California, San Diego

Bilingualism requires the management of two languages within one linguistic system. Cognates, or words with similar orthography and semantic representation across two or more languages, are valuable for studying how bilinguals navigate communication while controlling multiple languages. For instance, Christoffels et al. (2007) observed a cognate facilitation effect during a picture-naming task, indicating a non-target language was activated and facilitated processing during production of words in the target language. The present study further explored the question of non-target language activation by utilizing false cognates, which are words similar in form across languages but different in meaning. If both languages are activated at the presentation of a word, perhaps the different semantic representations of false cognates are also concurrently activated and rather than facilitation the processing of false cognates would instead result in competition. We hypothesized that evidence for

competition would come in the form of an interference effect whereby false cognates would be more difficult to produce than non-cognates and real cognates. To test this, we collected electroencephalography (EEG) data while English/Spanish bilinguals completed a translation-production task. From this EEG data, we extracted event-related potentials (ERPs). Participants were instructed to verbally translate words presented visually on a computer monitor and ERPs were time-locked to the presentation of each word. English and Spanish words were randomly intermixed and included 100 non-cognates (e.g., English "dog" and Spanish "pero"), 100 false cognates (e.g., English "sunrise", which translates to "amancer" in Spanish, and Spanish "sonrisa" which translates to "smile" in English), and 100 cognates (e.g., English "list" and Spanish "lista") with 50 of each type in each language. We predicted that translating false cognates would result in increased effort due to the need to inhibit the alternative meaning of the word in the target language. We expect this would result in a larger ERP negativity for false cognates compared to non-cognates and real cognates. Consistent with this prediction, in frontal electrode sites there was a small increase in an N400-like negativity for false cognates compared to cognates in the 400–600 ms time window. While this pattern is consistent with the results of Christoffels et al.'s (2007) cognate facilitation findings, we found an even larger divergence among the word types between 600 and 800 ms, with false cognates showing greater negativity than both non-cognates and cognates. Together these results are consistent with our hypothesis that when multiple meanings are activated, increased cognitive demand is required by speakers to suppress the unwanted meaning in the target language.

A69 Neural processing of sound in bilinguals: The influence of early-life dual language exposure on auditory processing in adults

Erika Skoe[1]; [1]University of Connecticut

The literature on the neurobiological correlates of bilingualism is vast. Yet, despite this wealth of knowledge, comparatively little is known about how being exposed to multiple spoken languages influences sound processing in the brain. Over the past decade, the frequency-following response (FFR) has emerged as an important electrophysiological tool for studying individual variability in the neural processing of sound associated with language. The FFR, a neuro-electric potential recorded at the scalp, is a phase-locked response to periodic aspects of sound (e.g. vowels, vocal pitch contours) that reflects a composite of multiple generators within the auditory neuroaxis. Recent reports indicate that bilingual children, adolescents, and adults, who learned both languages simultaneously, have more robust neural responses to the fundamental frequency (F0) of vowels, as measured by the FFR. Comparisons of simultaneous vs. sequential bilingual children have further suggested that these neural enhancements track with the total years of bilingual experience. However, an alternative interpretation is that these group differences are reflective of differential patterns of auditory exposure during sensitive periods in the development of the auditory neuroaxis. The FFR undergoes considerable developmental changes: the amplitude of the FFR to the F0 increases sharply in early childhood, reaching its maximum between ages 5-8, after which the amplitude declines progressively. Studies of FFRs from musicians have suggested that experience-dependent plasticity is amplified and longer lasting when it coincides with periods of significant developmental change. If early-life auditory experiences are indeed critical for shaping later-life auditory function, this leads to the prediction that the magnitude of the FFR enhancement should relate to individual differences in language exposure early in life, with current language exposure making less of a contribution. To test this possibility, FFRs to synthesized speech sounds were recorded in young adults (n=23, 18-24 years), who learned English in conjunction with another language before the age of 4 years. At the time of testing, all participants self-rated their English proficiency at the native-level. Participants ranged in terms of their current proficiency in the non-English language (NEL), with ratings spanning from 4-10 (10 = native level of fluency). They also ranged in terms of their current daily exposure to NEL (0-50%), and their early life (0-3 years of age) NEL exposure (5-100%). In this data sample, there was also a strong association between the amount of NEL exposure during the 0-3 age window and the amount of decay in NEL exposure from infancy to current age. Consistent with predictions, the magnitude of the neural response to F0 correlated with participants' earliest language exposure to NEL but not their current language exposure. Specifically, participants with greater exposure to NEL during the first three years of their life had stronger neural responses to sound than those reporting less early life exposure to NEL. These findings add to the evidence that dual-language experience influences the neural processing of sound, and they provide new insight into the underlying mechanisms, and experiential factors, that contribute to auditory plasticity associated with bilingualism.

A70 Age of acquisition of L2 affects alpha power during bilingual speech in noise processing

Angela Grant[1,2], Kristina Coulter[1,2], Shanna Kousaie[2,3], Annie C. Gilbert[2,3], Shari Baum[2,3], Vincent Gracco[2,3,4], Denise Klein[2,3], Debra Titone[2,3], Natalie Phillips[1,2]; [1]Concordia University, [2]Centre for Research on Brain, Language, and Music, [3]McGill University, [4]Yale University

Research on bilingualism has grown exponentially in recent years. Yet, little of that research has investigated a common aspect of language comprehension: understanding speech in noise. Electroencephalography (EEG) studies conducted in monolingual participants have revealed that listening to speech in noise results in increased alpha power, which is thought to be due to increased attentional demands (e.g., Obleser et al., 2012). It remains unclear whether these results would extend to processing in bilinguals. In the

current study, we tested English/French bilinguals who did not significantly differ in L2 proficiency as measured by letter and category fluency. These bilinguals were split into groups of 17 early (L2 acquired by age five) and 18 late (L2 acquired after age 5) sequential bilinguals, as well as 15 simultaneous bilinguals. Participants were presented with highly semantically constrained auditory sentences such as "We saw a flock of wild geese" in both languages and in both noise (16-talker babble) and in quiet. EEG was recorded while participants listened to the sentences and repeated the final word. Only sentences where the final word was produced correctly were analyzed. The data was segmented for time-frequency analyses from 0-1000ms after the terminal word, with a 500ms pre-stimulus baseline. We conducted a 2 (Language) x 3 (Age of Acquisition) x 2 (Listening Condition) x 3 (Electrode) x 6 (Time quantified in 100ms intervals from 100ms to 700ms) mixed ANOVA of power in the alpha band. We found a significant main effect of Language, such that alpha power was higher in the L2. That main effect was qualified by a trending interaction with Time, such that the effect of Language was driven by differences in an early (100-200ms) window. We also observed an interaction of Listening Condition by Age of Acquisition (AoA), such that processing speech in noise elicited more alpha power in late bilinguals compared to simultaneous bilinguals. Early bilinguals did not differ from either group, in quiet or noise. Our results, when interpreted in the theoretical context where alpha power indexes attentional control (e.g. Wostmann et al., 2017), suggest that listening in the second language requires additional attentional control compared to the first language, particularly early in processing during word identification. Additionally, although our participants did not differ in their L2 proficiency, our results suggest that under difficult processing demands, AoA modulates the amount of attention required to process the L2.

Poster Session B

Thursday, August 16, 3:05 – 4:50 pm, Room 2000AB

Control, Selection, and Executive Processes

B1 The interplay between interference control and L2 proficiency in L2 auditory sentence comprehension in the presence of verbal and non-verbal masking

Jungna Kim[1], Klara Marton[1], Brett A. Martin[1], Loraine K. Obler[1]; [1]The CUNY Graduate Center

Listening to speech in the presence of interfering auditory stimuli is a well-studied challenge for second language listeners (Krizman, et al., 2017). It is reasonable to assume that the ability to manage auditory interference can be related to the ability to pay attention to the target message and suppress the irrelevant information. The goal of the proposed study is to examine the differential effects of first language (L1) and second language (L2) interference, as compared to non-verbal noise on L2 auditory sentence comprehension, and the role of L2 proficiency in this interference control process. Forty Korean-English bilinguals aged 18-40, who were born in Korea, were recruited from New York City. They had no history of neurological disease or hearing loss. They were divided into two proficiency groups: high vs. low-intermediate. In order to test the effect of different types of auditory interference during L2 auditory sentence comprehension, an auditory sentence comprehension test with the following experimental conditions was created: 1) L2 target sentences with non-verbal interference (i.e., speech-modulated noise), 2) L2 target sentences with L2 interference, and 3) L2 target sentences with L1 interference (-3 dB signal-to-noise ratio). Participants listened to 40 target sentences in each condition and were asked to make a judgment for each sentence whether it was semantically plausible or implausible. The target and interference sentences were presented by a female or male voice; participants were cued by a picture to which voice they should pay attention to in the verbal interference conditions. Accuracy was analyzed using mixed-effects analyses of variance. The experimental conditions and the groups were fixed factors, and the subject was a random effect. Additionally, the interaction between proficiency group and condition was included in the analysis. There was a main effect of both condition ($F(1,4) = 3.953$, $p < 0.01$) and proficiency group ($F(1,1) = 35.402$, $p < 0.001$). Both groups performed near ceiling on the baseline measures (Conditions 1 and 2), and not significantly worse on L2 targets in the non-verbal noise condition than in English baseline. The high proficiency listeners showed significantly higher accuracy for L2 targets in the L1 interference condition than the L2 interference condition whereas the low-intermediate L2 listeners showed the opposite pattern. The interaction between condition and group was significant in the L1 interference condition only ($F(1,4) = 11.511$, $p < 0.001$). These findings indicated that bilingual listeners with high and low-mid levels of L2 proficiency were differentially affected by the L1 and L2 interference. The effect of L1 interference was stronger for the lower proficiency L2 listeners than for the high-proficiency L2 group. A possible explanation is that, due to their incomplete linguistic knowledge of L2, they did not have enough cognitive resources to process the information in the L2 distractors when they focused on the target L2 sentences whereas L1 interference may have strongly derailed their attention from the target (Filippi et al., 2012). Our data are consistent with the possibility that achieving higher proficiency in an L2 includes achieving the ability to resist distractor interference.

B2 Lexical selection and the elusive role of the left IFG: an fMRI study

Hanna Gauvin[1,2], Katie McMahon[3,4], Greig de Zubicaray[1]; [1]Faculty of Health and Institute of Health and Biomedical Innovation, Queensland University of Technology, Brisbane, QLD, Australia, [2]School of Psychology and Counselling, Queensland University of Technology, Brisbane,

QLD, Australia, [3]School of Clinical Sciences, Queensland University of Technology, Brisbane, QLD, Australia, [4]Herston Imaging Research Facility, Royal Brisbane & Womens Hospital, Brisbane, QLD, Australia

According to prominent neurobiological models of lexical selection, the left inferior frontal gyrus (LIFG) plays an important role in resolving semantic interference in speech production, performing domain-general, top-down control processes (e.g., Belke & Stielow, 2013; Oppenheim et al., 2010; Schnur et al., 2009). However, a role for the LIFG is not consistently reported across studies using various semantic interference paradigms. Continuous naming studies (patient studies and neuroimaging) have consistently failed to observe significant LIFG involvement. Blocked cyclic naming paradigm studies (neuroimaging, neurostimulation and lesion patients) show equivocal results, with as many studies demonstrating LIFG involvement as ones that don't. Results from the Picture-Word Interference (PWI) paradigm are likewise inconsistent. In this study, we investigated the role of the LIFG in semantic interference in PWI. In particular, we investigated whether response set membership (in which distractor words are also target picture names) influences LIFG involvement. It has been proposed that distractors that are also eligible responses are allocated greater attention, or that non-response set distractors require greater inhibition (e.g. Roelofs, 1992, 2003; Lamers et al., 2010). We therefore hypothesised that LIFG involvement would vary according to response set membership. [Methods] Twenty healthy participants named 40 target pictures while ignoring a superimposed distractor word during fMRI. Each target picture was presented with 4 distractor words that varied according to response set membership (2) x semantic relatedness (2). fMRI data were acquired with a sparse sampling design using a 3T Siemens Magnetom Prisma using a 64-channel head coil. Data were analysed using SPM 12. The following ROI's were selected a priori from the Hammers et al (2003) probabilistic atlas: left pSTG, left MTG, left + right ACC, left PTL and left IFG. [Results] LME analysis of the behavioral data (random: Participants + Items, fixed: Distractor Condition + Response Set Membership) show no significant effect of response set membership. There was a main effect of distractor condition, with the typical semantic interference effect (RTs semantically related distractors > unrelated). No significant interaction was observed. The fMRI data largely replicated the behavioural data: There was no significant main effect of response set membership or interaction with semantic context in the LIFG or other ROIs. In the typical Response Set member condition, significant activation was observed for the Related>Unrelated contrast in the left pSTG and MTG, replicating previous studies. We next combined the data from the two response set conditions to contrast Related> Unrelated conditions, this time revealing significant activation in the LIFG. [Conclusion] Our findings suggest that LIFG involvement does not differ markedly between response set and non-response set distractor manipulations. That significant LIFG activation was observed only when data from response-set membership conditions was combined suggests the inconsistent results reported in the literature might reflect signal-to-noise or statistical power issues. The findings partly support models of speech production that assume strengthening of conceptual-lexical connections and interference effects when distractors are response set members compared to non-response set members.

B3 Interference interacts with prediction during language comprehension: Implications for predictive coding

Pia Schoknecht[1], Dietmar Roehm[1], Ina Bornkessel-Schlesewsky[2]; [1]University of Salzburg, [2]University of South Australia

Effects of similarity-based interference from cue overlap during sentence comprehension have been found in numerous behavioral studies (Jäger et al. 2017, for a review), but the underlying neurobiology is less well understood (but see Martin et al. 2012; Lee and Garnsey 2015). We present an ERP study on memory retrieval, interference and prediction during language processing. Thirty-two young, healthy, right-handed, native speakers of German read sentence pairs word-by-word. A context sentence introduced two noun phrases (NPs). A target sentence referred back to one of the NPs; the article was our critical word. Interference was manipulated via a gender match/mismatch between the NPs in the context. In the high interference condition (1), the article is ambiguous; in the low interference conditions (2, 3), there is only one compatible NP in the context. Recency was manipulated via the distance of the distractor NP to the retrieval site (article). Note that recency was manipulated for high and low interference conditions, but is only presented for low interference conditions here, as it does not become relevant until the noun position in the high interference case. Prediction was measured via offline cloze probability (CP) of the critical article (range: 0 – 1) and following noun (range: 0 – 1). Examples (German originals, literal English translations, critical word in asterisks): (1) High interference context: Im Schuppen steht ein Grill und im Garten ein Rasenmäher. In.the shed stands a grill-MASC and in.the garden a lawnmower-MASC. (2) Low interference / short distractor distance context: Im Schuppen steht ein Grill und im Garten ein Motorrad. In.the shed stands a grill-MASC and in.the garden a motorbike-NEUTR. (3) Low interference / long distractor distance context: Im Garten steht ein Motorrad und im Schuppen ein Grill. In.the garden stands a motorbike-NEUTR and in.the shed stands a grill-MASC. (4) Target: Peter putzt *den* Grill jeden zweiten Sonntag. Peter cleans the-MASC grill each second sunday. Single trial brain responses were analyzed in a standard N400 time window at the article using linear mixed models with sagittality, laterality, interference (high, low/short distance, low/long distance) and CPs of the article and following noun as predictors. Random intercepts by

subjects and items were included. Results showed an interaction of interference, article CP and noun CP. Effects of interference only emerged when both article CP and noun CP were low and manifested themselves as increased N400 effects for the high interference and low interference / short distance conditions in comparison to the low interference / long distance condition. This suggests that prediction outweighs the effects of interference. It also indicates that low interference – i.e. absence of feature overlap and of a recent distractor – reduces uncertainty in the reactivation of potential candidates for the upcoming noun. Neurophysiologically, this resembles a silencing of prediction errors (i.e. a reduced N400). We conclude that interference may play a crucial role in a hierachically organised, cortical predictive coding architecture for language in that it drives inferences drawn about the input when predictability is low.

Speech Motor Control and Sensorimotor Integration

B4 Syllable sequencing into words: A computational model of speech production

Meropi Topalidou[1], Emre Neftci[1], Gregory Hickok[1]; [1]Department of Cognitive Sciences, University of California Irvine

Speech production is a complicated task that is based on the ability to sequence at the phoneme, syllable, and word levels. In 1951, Karl Lashley outlined the problem of serial order in behavior, where he proposed the existence of an underlying parallel representation for the performance of serial behavior. The serial order of the sequence according to him is encoded into the activity level of each unit associated with it. An extension of this idea is the competitive queuing (CQ) model by Grossberg (1978a, 1978b). The CQ model contains two layers comprising parallel representations of the phonemes. The plan layer is considered as the working memory of the word, activating all the nodes of the sequence with activity amplitudes equivalent to their positions. The nodes of the choice layer receive input from the plan layer. Expression of the sequence is achieved through the interaction of graded activation from the plan layer and inhibitory connections within the choice layer. Based on this idea, Bohland et al. (2010) introduced Gradient Order DIVA (GODIVA) model, which consists of a plan and a motor loop. The plan loop comprises a sequential structure and phonological content buffers which interact through a cortico-basal loop. Then both buffers send input to the initiation and speech maps, respectively. These maps are another cortico-basal loop called the motor loop. Recently, it has been argued that speech planning at the phonological level involves an internal feedback control mechanism that can detect and correct phonological selection errors prior to overt speech output (Hickok, 2012). While GODIVA is successfully implements syllable sequence production, it lacks internal feedback control. Our goal was to implement a mechanism that can achieve internal speech error detection and correction during multi-syllables production. We used the architecture proposed as one level in the Hierarchical State Feedback Control (HSFC) model as described in Hickok, et al. (2011). The network comprises four structures corresponding to functional-anatomic regions: lexical (pMTG), auditory-phonological (pSTS), motor-phonological (pIFG), and auditory-motor intermediary (Spt) levels. The lexical level is bidirectionally connected to both the auditory and motor levels, which themselves are connected to each other via the Spt auditory-motor interface level. Internal error correction is hypothesized to occur via auditory-motor interaction in cases where the motor plan does not match the lexical and auditory targets (Hickok, 2012). Analysis of network behavior showed that motor errors can be corrected by Spt driving the correction. Another outcome of the analysis was that the bidirectionality of the model was responsible for making predictions for the upcoming word or phonemes during perception. As a result, not fully audible or understandable words can be inferred from this prediction mechanism. Our model does not contain any buffer or working-memory to retain the sequence or multi-representation of phonemes in different layers, as most models of sequencing. The needed information of the sequence is provided by the connections weights between the word (in lexical level) and the phonemes (in auditory and motor level).

B5 Changes in sensorimotor control of speech observed in oscillations of the EEG mu rhythm

Tim Saltuklaroglu[1], Ashley Harkrider[1], Tiffani Kittilstved[1], David Thornton[1], David Jenson[1]; [1]University of Tennessee Health Sciences Center

Background: The EEG mu rhythm is a sensorimotor rhythm characterized by peaks in alpha (8-13 Hz) and beta (15-25 Hz) that are sensitive to aspects of internal modeling. During movement, alpha activity may reflect sensory to motor feedback, while beta activity captures motor to sensory projections (i.e., forward models). As such, mu rhythms represent changes in sensorimotor control imparted by exogenous and endogenous speech manipulations. Stuttering is characterized by sensorimotor dysfunction related to internal modeling deficits. These deficits can be overcome temporarily by exogenous and endogenous manipulations that alter sensorimotor control to improve fluency. Such manipulations clearly alter sensorimotor control. However, it is not clear how they impact neurotypical speakers with respect to internal modeling mechanisms and changes to feedforward/ feedback motor control contributions over the time course of utterances. Thus, the purpose of this study was to determine whether changes in sensorimotor control resulting from speaking conditions that induce fluency in people who stutter (PWS) can be measured using electroencephalographic (EEG) mu rhythms in neurotypical (non-stuttering) speakers. Methods: Neurotypical adults spoke in one control condition (solo speaking) and four experimental conditions that exogenously or endogenously manipulated sensorimotor control [choral speech,

delayed auditory feedback (DAF), prolonged speech and pseudostuttering]. Independent component analysis (ICA) was used to identify sensorimotor mu and perilabial EMG components from EEG recordings. Time-frequency analyses measured μ-alpha and mu-beta event-related synchronization (ERS) and desynchronization (ERD), alongside EMG activity, during each speech condition. Results: 19/24 participants contributed mu components. Relative to the control condition, the choral and DAF (exogenous) conditions elicited increases in μ-alpha ERD in the right hemisphere. In the pseudostuttering (endogenous) condition, increases in μ-beta ERD were observed in the left hemisphere. No differences were present between the prolonged (endogenous) speech and control conditions. Strongest mu activity coincided with EMG activity (i.e.., during speech production), beginning about 300 ms following the cue to speak. Conclusions: Differences observed in the experimental conditions are thought to reflect sensorimotor control changes. Increases in right hemisphere μ-alpha ERD likely reflect increased reliance on auditory feedback during the choral and DAF conditions. This finding provides further evidence that mu-alpha activity captures sensory-to-motor feedback during movement tasks and exogenous speech manipulations induce stronger feedback control. In the left hemisphere, increases in μ-beta ERD during pseudostuttering suggest stronger activation of forward models, possibly due to syllable repetitions that strengthen sensory predictions and the novelty of the task. Significance: Changes in sensorimotor control related to feedforward and feedback control in fluency-enhancing speech manipulations can be measured using time-frequency decompositions of EEG μ rhythms in neurotypical speakers. This quiet, non-invasive, and temporally sensitive technique may be applied to learn more about normal sensorimotor control and fluency enhancement in persons who stutter.

B6 Planning to manipulate virtual objects elicits activation of motor-related brain activity: evidence from ERPs in a CAVE automatic virtual environment

Cheryl Frenck-Mestre[1,2], Ana Zappa[1], Dierdre Bolger[1], Jean Marie Pergandi[1], Pierre Mallet[1,2], Anne-Sophie Dubarry[1,2], Daniel Mestre[1,2]; [1]Aix-Marseille Univ, [2]Centre National de Recherche Scientifique

Numerous studies have shown that processing auditory or written verbs that denote an action elicit activation in the motor cortices responsible for the planning and execution of said movement. The question remains as to the timing of activation, however; does motor activation occur in parallel with lexical access or only as a subsequent by-product? To investigate this question, we recorded EEG from 20 participants in a GO/NOGO paradigm in a CAVE automatic virtual environment (CAVE). Participants listened to auditory verbs and either performed the action on subsequently presented virtual objects or not. We measured motor-related cortical activity, as reflected by desynchronization in the μ frequency bands (8-12 Hz), and ERP language related components during the auditory processing of the verb at frontal, central and centro-parietal electrodes. We compared activity elicited during GO trials (prior to actual movement) to that elicited by NOGO trials. For all trials, a clear pattern of language related ERPs was obtained (an N1/P2 complex followed by an N400). This first result provides proof of concept that recording EEG in a CAVE, under well controlled conditions, is feasible and can produce clear linguistic processing components. We are currently investigating whether our results also provide evidence of action-related μ suppression at centro-parietal sites during the processing of the linguistic stimuli, and whether it varied as a function of trial type (GO/NOGO). Greater action-related μ suppression during verb processing for GO trials, but prior to movement proper, would bolster the claim that sensory-motor processing is part and parcel of the conceptual representation of linguistic information.

Perception: Speech Perception and Audiovisual Integration

B7 Neural representation of phonemic categories in tonotopic auditory cortex

Deborah F. Levy[1], Stephen M. Wilson[1]; [1]Vanderbilt University Medical Center

How do our brains transform continuously varying acoustic signals into categorical phonemes? Categorical perception is one of the most fundamental processes in speech perception, but it is not yet known where in the auditory processing stream representations of speech sounds cease to be veridical (faithfully representing the exact acoustic properties of the stimulus) and become categorical (representing sounds as linguistic categories). In this study, we used functional MRI and multivariate pattern analysis to investigate the representation of vowels in tonotopic primary auditory cortex (PAC). We addressed two questions: (1) Can phonologically contrastive but acoustically similar vowel phonemes be distinguished from one another based on neural activity in PAC? (2) Is there any evidence that differential sensitivity to phonological boundaries may begin to emerge at the level of PAC? We scanned fifteen participants with 7 Tesla fMRI. First, participants' individual categorical boundaries for synthetic vowels on a spectrum from [i] to [□] were determined behaviorally using identification and discrimination tasks. Then, for each participant, four vowels that were equidistant in acoustic space but perceptually grouped into two phonemic categories were generated. Next, tonotopic maps were created for each participant based on phase-encoded analysis of passive listening to non-linguistic frequency sweeps. The bounds of PAC were defined both functionally and anatomically as tonotopic voxels falling within Heschl's gyrus. Each participant's four vowels were then presented in a block design with an irrelevant but attention-demanding level change detection task. Finally, we used multivariate pattern analysis to determine (1) whether the endpoint,

prototypical vowels could be distinguished from each other using information contained in PAC; and (2) whether the vowel pair that crossed the categorical boundary would be more neurally discriminable than the equally spaced vowel pairs that did not cross the boundary and so fell within the same perceptual category. We found that participants' endpoint [i] and [□] tokens could be robustly distinguished from each other using neural data contained in PAC (mean classifier accuracy=64.6%, t(14)=5.54, p<0.001, one-tailed) and that discrimination was better between pairs of vowels that crossed the categorical boundary than those that did not (mean difference in classifier accuracy=4.8%, t(14)=2.15, p=0.025, one-tailed). These findings demonstrate that even acoustically similar phonemes can be discriminated based on information contained within PAC. Previous research using intracranial electrocorticography has provided some evidence that speech sounds may be represented categorically in the lateral superior temporal gyrus. Our findings suggest that PAC, an upstream region often thought to purely represent the acoustic properties of a stimulus, may already be warping acoustic representations towards phonemic, linguistically relevant categories.

B8 Neural coding schemes for lexically-driven prediction in superior temporal cortex

Ediz Sohoglu[1], Matthew Davis[1]; [1]University of Cambridge

We use fMRI and representational similarity analysis to determine how lexical predictions are combined with speech input in superior temporal cortex. Is expected speech content enhanced to leave a 'sharpened' version of the sensory input (McClelland and Elman, 1986)? Or is expected content subtracted away to leave only those parts that are unexpected i.e. 'prediction error' (Rao and Ballard, 1999)? Recent work suggests that for degraded speech, multivoxel patterns in posterior superior temporal cortex are best explained by prediction error representations (Blank and Davis, 2016). However, that study used an artificial listening situation in which speech was highly distorted and strong predictions obtained from prior written text. In the current work we apply similar multivoxel pattern analysis methods to a more naturalistic listening situation in which speech is clearly presented and predictions obtained directly from the speech signal itself (i.e. from lexical content). Listeners (N=21) heard 64 bisyllabic words in which the second (offset) syllable was strongly or weakly predicted by the first syllable based on long-term lexical knowledge e.g. items like "Cac-tus" where "tus" is the only syllable that follows "Cac" (Strong prediction) and items like "Be-ta" where "ta" is amongst many syllables that follow "Be" in English (Weak prediction). By cross-splicing between items, we also created 64 non-words in which the second syllable mismatched with listeners' predictions (e.g. "Cac-ta"). To maintain attention, listeners performed an incidental task and pressed a button every time a brief pause was heard during the spoken word. We used a sparse event-related fMRI sequence and the cross-validated Mahalanobis distance (Walther et al., 2016) to test how the representational fidelity of offset-syllables differed as a function of prior strength (Strong/Weak) and congruency (Matching/Mismatching). If multivoxel patterns in superior temporal cortex represent a sharpened version of the sensory input, prior strength and congruency should have additive effects on representational fidelity whereas if multivoxel patterns represent prediction error, these two manipulations should result in interactive influences (Blank and Davis, 2016). In a searchlight analysis, offset-syllables could be reliably distinguished in Heschl's Gyrus bilaterally (HG; $p < .05$ FWE corrected within a bilateral temporal lobe search volume). Using the resulting left and right HG clusters as functional regions-of-interest, we observed a significant interaction between prior strength and congruency in the right HG ROI such that the representational fidelity of offset-syllables decreased with increasing prior strength when predictions were matching but increased when mismatching ($p < .05$ FWE small volume corrected). However, no significant interaction, nor any main effects, were observed in left HG. These preliminary findings suggest that prediction strength and congruency have interactive effects on multivoxel response patterns, consistent with auditory prediction error representations of speech in superior temporal cortex.

B9 Language-driven anticipatory eye-movements in naturalistic environments

Evelien Heyselaar[1], David Peeters[1,2], Peter Hagoort[1,2]; [1]Max Planck Institute for Psycholinguistics, The Netherlands, [2]Radboud University, Donders Institute for Brain, Cognition, and Behaviour, The Netherlands

Recently, there has been an increased interest in linguistic prediction, the idea that we anticipate upcoming linguistic input. One principle question that has received very little attention, however, is when, i.e. in which everyday contexts, we predict. Although ample evidence indicates that we are able to predict, whether we do so outside the laboratory, and whether we do it all the time, are open questions that have been difficult to answer. In the current three-part study, we use an updated version of the visual world paradigm (VWP) to answer the when question, and, while doing so, we also provide empirical evidence for characteristics of prediction that have, as of yet, received little to no empirical support. Although the traditional VWP has been applauded for a more naturalistic way to measure the interaction between language and the visual world, it is not without its limitations (2D line images, source-less spoken sentences, etc.). In Experiment 1 we therefore immersed participants in rich, everyday 3D environments in Virtual Reality, with a virtual agent directly delivering the critical sentences in a monologue to the participant. Experiment 1 tested whether this increased richness still induced anticipatory eye-movements. As we are rarely in an environment with a low number of objects, in Experiment 2 we increased the number of objects present to determine whether participants are still able to anticipate

the referent object given the critical verb. Thereby we were also able to test whether working memory plays a role in anticipatory behaviour, as is proposed in current theories of linguistic prediction. In Experiment 3 we manipulated the probability of hearing a predictable sentence, thereby testing for the role of error-based learning on anticipatory behaviour. Participants showed the traditional anticipatory saccadic behaviour: they fixated the referent object before it is named when the object was predictable given the verb, but no early fixations where observed when the object was not predictable. We observed this behaviour for all three of our experiments, although significantly less when there were more objects (Experiment 2) or less predictable sentences (Experiment 3) compared to Experiment 1. Thus, when manipulating the probability of hearing a predictable sentence, we still found robust anticipatory eye-looks to objects, even when only 25% of the sentences predicted said object. Additionally, we show a significant difference in anticipatory behaviour as a function of working memory capacity such that participants with a lower capacity showed less robust anticipatory behaviour. Overall, our study suggests that participants do constantly and consistently predict, even when it seems inefficient to do so. Our study is one of the first to attempt to measure linguistic anticipation in naturalistic environments, and although some of our results support the proposed mechanisms underlying linguistic prediction (i.e. the role of working memory), some of our results were unexpected (i.e. no statistical learning effect). Therefore, our study highlights the need to focus on what participants actually do in naturalistic environments, not what they can do in controlled laboratory settings.

B10 Early neural reconfiguration predicts future sound-to-word learning success

Gangyi Feng[1], Bharath Chandrasekaran[2], Patrick C.M. Wong[1]; [1]The Chinese University of Hong Kong, [2]The University of Texas at Austin

Learning a foreign language in adulthood is challenging, especially when it comes to mapping novel, non-native sound categories onto meanings. The present study examined the neural dynamics underlying novel sound-to-meaning mapping acquisition across different learning stages in the adult brain and make an attempt to uncover the neural reconfiguration that is tightly related to the word learning success. Previous studies have examined either the neural end-stage of learning (e.g., pre- vs. post-neural differences) or have examined pre-training neural predictors of learning. Less is known about how neural reconfigurations at different stages of learning contribute to the individual learning success. Here, we trained 19 native English speakers (mean age = 25.9 y, SD = 4.6 y; no tonal language experience) to learn pseudo-words that entailed learning lexically meaningful pitch patterns (i.e., four Mandarin tones). Participants underwent nine behavioral training sessions, in which they were required to associate 24 pseudo-words with common object meanings, and three functional Magnetic Resonance Imaging (fMRI) scan sessions (i.e., Pre-, Mid, and Post-training sessions), during which they performed a loudness judgment task with a repetition priming paradigm (two repetition effects: tone repetition [tone change vs. no change] and talker repetition [talker change vs. no change] effects) to assess brain representation of sound. We calculated the univariate brain activations (BA) that related to tone/talker repetition effect and the interregional functional connectivity (FC). We further measured the neural pattern reconfiguration (pattern similarity) of these two metrics between scan sessions (e.g., Pre-vs-Mid reconfiguration). Machine-learning approach (i.e., support vector regression with leave-one-out cross-validation) was employed to build and validate prediction models with those reconfiguration metrics as predictors to predict individual learning outcomes. We found that both BA and FC patterns reconfigurations at the early stage of training (i.e., Pre-vs.-Mid) significantly predicted individual learning outcomes ($Ps < 0.001$). In contrast, we did not find significant outcome prediction at the later stage of training (i.e., Mid-vs.-Post). This finding was confirmed by using different FC network-construction and a permutation test with 10,000-iteration. Direct comparison between early and late models in predictive power revealed significant differences for both BA and FC reconfiguration ($Ps < 0.01$). Further prediction analysis on individual connections or voxels revealed that the early stage of neural reconfiguration showed different learning-related reconfiguration patterns compared to that at the later stage of training. Our findings represent a rare example of the neural dynamics of language learning across multi-day training and imaging sessions. Sound-to-meaning mapping at the early stage is critical for learners' brain connectivity and local activation pattern to adapt and reconfigure according to the content of learning. The pattern of functional neural reconfiguration at the early stage of learning could be a powerful neural marker of individual learning success. Our study provides an avenue for understanding the neural mechanism of learning more generally, which may aid in designing personalized training protocols to optimize learning outcomes for all learners.

B11 Neural processing of hyperarticulated speech in second language learners

Yang Zhang[1], Keita Tanaka[2], Yue Wang[3], Dawn Behne[4]; [1]University of Minnesota, [2]Tokyo Denki University, [3]Simon Fraser University, [4]Norwegian University of Science and Technology

It is a well-known fact that people adjust speaking style to accommodate the communicative needs of their listeners. For instance, the infant-directed speech is associated with higher pitch, expanded pitch contour and range, longer syllables, and hyperarticulation of vowels. While pitch exaggeration gets reduced in foreigner-directed speech, phonetic exaggeration in the formant patterns remains a dominant feature. Researchers argue that pitch exaggeration may serve to attract and maintain attention as well as convey and elicit positive affect whereas

hyperarticulation directly facilitates phonetic and word learning by providing wider separation of phonetic categories and larger within-category variability. But the underlying brain mechanisms for these effects remain unclear. This magnetoencephalography (MEG) study investigated how formant exaggeration in hyperarticulated speech affects brain processing of speech in second language (L2) learners. The MEG data were collected from ten healthy adult listeners (ages 20-24) who studied English as a second language for at least eight years in school. The experiment was conducted with a 122-channel whole-head MEG system (Elekta-Neuromag) in a magnetically shielded room. The subjects were instructed to watch a DVD video and ignore the stimuli during MEG recording. The stimuli were randomly presented in blocks, including three computer-synthesized vowels, [i], [a], [u], in both exaggerated and non-exaggerated forms. The speech sounds were normalized in sound intensity and duration with identical pitch contours. The stimuli were delivered binaurally at a sensation level of 50 dB via a plastic ear insert with interstimulus interval randomized in the range of 900~1100 ms. Eye activities were monitored via two pairs of bipolar electrodes. Trials contaminated by EOG activities and other disturbances with MEG peak amplitudes larger than 3000 fT/cm were removed. The preprocessed MEG data were further analyzed using source estimation and time-frequency methods. Consistent with a previous ERP study on native speakers of English, the MEG data from second language learners showed stronger N1m responses for all the three formant-exaggerated vowels. Time-frequency analysis further indicated the importance of neural oscillatory activities including the beta band for coding the hyperarticulated speech. The MEG results provide strong evidence for an early effect of automatic processing of formant exaggeration in the auditory cortex independent of effortful listening, which may facilitate L2 speech perception and acquisition.

B12 Cortical Tracking of Predictive Coding Features in Continuous Speech

Hugo Weissbart[1], Katerina Kandylaki[2], Tobias Reichenbach[1]; [1]Imperial College London, [2]University of Maastricht

To understand spoken language, the brain must process, as well as predict. acoustic and linguistic features at different levels of abstraction. However, the neural encoding of these features in continuous naturalistic speech remains poorly understood due to the complexity of natural speech that impedes averaging of neural responses, for instance. Moreover, neural responses to acoustic and linguistic features are difficult to disentangle since both occur simultaneously. Here we measured cortical signals in response to continuous naturalistic speech in both a comprehended and an uncomprehended language through electroencephalography (EEG). We then modeled the obtained responses through acoustic and linguistic features, including a feature that emerges only from sequences of words and that relates to prediction errors, a key quantity in predictive coding theory. Methods: We measured the cortical activity of healthy volunteers listening to audio books from EEG. We then described the acoustic and linguistic information in the acoustic stimuli through different acoustic and linguistic features on the word level. Acoustic information was described through the word onset, and this was obtained by aligning the text with the audio signal. Prior knowledge on predictability of a word was included as word frequency. We then added the surprise of a word; this feature was obtained as the negative logarithm of the probability of each word in its particular sequence. In particular, the probability of each word in its sequence was computed through a recurrent neural network modeling prediction of words in the language. The surprise served a proxy for prediction error and also encodes the amount of information gain received when a new word arrives in a sequence. This gain is measured relatively to the entropy of the model, evaluated on the entire probability distribution of prediction at each word, that we used as another linguistic predictor. We then employed linear regression to predict the EEG responses from the linguistic and acoustic features. We considered shuffled features, where the word onsets were left unchanged but the values of the linguistic features were taken from an unrelated text, as well as EEG responses to a foreign language as a control. Results and Conclusion: We obtained a specific EEG correlate of the surprisal and entropy of a word in its sequence as computed from a deep neural network. This neural response was found in the delta and beta frequency bands and could not be explained by the acoustic properties or by word frequency alone. Moreover, the response to surprisal was modulated by the amount of certainty, measured by entropy. Latencies and topographies of response to surprise was different whether the word could be predicted with high or low entropy as defined by the previous context. Latencies found for the response to entropy indicates that the brain precisely predict the timing of upcoming word. The results support the predictive coding hypothesis where a sequence of words leads to the active prediction of the next word.

B13 Testing the engagement of dorsal stream motor areas during the perception of phonemes, words, and environmental sounds

Kelly Michaelis[1], Andrei Medvedev[1,2], Peter Turkeltaub[1,2,3]; [1]Georgetown University Interdisciplinary Program in Neuroscience, [2]Georgetown University Medical Center, Department of Neurology, [3]Medstar National Rehabilitation Hospital

Recent research has shown that frontal lobe motor areas typically responsible for speech production are also active during speech perception, especially when speech is noisy or ambiguous. However, the broader literature on speech perception clearly implicates temporal lobe pathways, not motor systems, as the major structures underlying speech perception. While the evidence for motor involvement in perception continues to increase,

it has not been fully incorporated into a neurobiological model of speech processing and several critical questions remain unanswered. In the context of the dual stream model (Rauschecker & Scott, 2009), we hypothesize that unambiguous words are processed solely in the ventral stream within the temporal lobe, and speech production pathways in the dorsal stream are flexibly engaged when this ventral stream processing is insufficient to identify a word (i.e. during sublexical perception or high noise conditions) or when additional information, such as seeing the speaker, obligatorily engages motor speech systems. This study provides one of the first tests of motor involvement in word perception, and tests whether motor engagement is specific to perception of pronounceable auditory signals, as theories of motor involvement predict. We tested these hypothesis by examining EEG signatures of motor activity during the perception of auditory phonemes, auditory single words, and audiovisual single words in an adaptive four alternative forced choice task that manipulated signal-to-noise ratios (SNRs) to achieve two levels of difficulty for each stimulus type (80% accuracy and 50% accuracy). To confirm that motor activity is speech-specific, we also examined perception of meaningful auditory environmental sounds in the same task context. Word stimuli consisted of matched lists of unique English words, with near phonological neighbors as foils. Phoneme stimuli were CVC tokens. EEG was recorded using a 128-channel Geodesic sensor net. Data from seven electrodes corresponding to left premotor and motor cortex was preprocessed in EEGLAB and subjected to time-frequency analyses. We tested for differences in sensorimotor-linked μ (8-12Hz) and low beta (13-20Hz) power between stimulus conditions using nonparametric permutation-based paired t-tests. Participants were 10 healthy adults (mean age 24.6, 5 female). Each condition showed a pattern of μ/beta power suppression (indicating greater motor activity) in the pre- and post-stimulus periods, with greater μ/beta suppression in the three speech conditions (auditory words/phonemes, audiovisual words) than for the environmental sounds ($p<.01$). In line with our hypotheses, the audiovisual and phoneme conditions showed marginally greater pre- and post-stimulus μ/beta suppression than the auditory word condition ($p<.05$). Our results suggest that motor involvement in perception is specific to speech, and that sublexical processing and visual input preferentially engage dorsal stream motor areas, even when task difficulty is held constant. These findings suggest a role for the motor system in the perception of sublexical speech and in audiovisual contexts, and support a model in which the dorsal stream is flexibly engaged for perception depending on the nature of the speech stimuli. Future analyses will evaluate dorsal stream connectivity by testing for differences in beta band coherence between motor and posterior temporal speech regions.

Perception: Auditory

B14 Neural oscillations track changes in speech rate shown by MEG adaptation and perceptual after-effects

Matthew H Davis[1], Lucy J. MacGregor[1], Helen Blank[1,2], Stephen A. Engel[3], Saskia Helbling[1,4], Ediz Sohoglu[1], Leonhard Waschke[5]; [1]University of Cambridge, UK, [2]University Medical Center Hamburg-Eppendorf, Hamburg, Germany, [3]University of Minnesota, Minneapolis, [4]Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany, [5]University of Lübeck, Germany

Typical speech rates in conversation or broadcast media are around 150 to 200 words per minute. Yet, human listeners show an impressive degree of perceptual flexibility such that, with practice, they can understand speech presented at up to three times that rate (Dupoux & Green, 1997, JEP:HPP). However, exposure to time-compressed speech also leads to a perceptual after-effect: normal speech sounds unnaturally slow immediately after listening to time-compressed speech. Both these effects can be readily experienced using software built into most podcast players. However, the underlying functional and neural mechanisms that are responsible remain unspecified. In this work, we use behavioural and MEG experiments to explore the perceptual and neural processes that support speech rate adaptation and after-effects. We test whether and how these effects might arise from changes in delta and theta oscillations in the Superior Temporal Gyrus which track connected speech. In two behavioural studies, we first quantify the magnitude of the perceptual after-effect observed for 14 native English speakers listening to feature podcasts from The Guardian (@guardianaudio). In two experiments, we confirmed that: (1) participants report that speech at a natural speech rate sounds slower than normal after exposure to fast speech (50% time compression) and conversely that exposure to slowed speech (150% time expansion) leads listeners to report that natural speech sounds faster than normal. (2) Both these after-effects depend on the duration of the adaptation period; larger and long-lasting perceptual after-effects are observed after exposure to 60-seconds of time-compressed or expanded speech than after 20-seconds exposure.
We also explored neural correlates of these perceptual adaptation and after-effects using MEG recordings from 16 native-English listeners. During an initial, 60-second period of natural speech we observed cluster-corrected significant cerebro-acoustic coherence (cf. Peelle, Gross & Davis, 2013, Cerebral Cortex) between auditory MEG responses and the amplitude envelope of speech in delta (0.1-3.2Hz) and theta (4.7-8.2Hz) ranges. During 40-second periods of adaptation to 60% time-compressed and 167% time-expanded speech we see significant increases (for 60% speech) and decreases (167% speech) in the peak frequency of delta but not theta entrainment. These effects build-up over time shown by a significant time (0-20sec, vs 20-40sec windows) by time-compression/expansion (60% vs 167%) interaction on the magnitude ($F(2,30) = 45.81$, $p<.001$) and peak frequency

(F(2,30)=6.96, p<.01) of delta coherence. However, changes in the peak frequency of cerebro-acoustic coherence are smaller than the degree of compression/expansion applied to speech. This suggests a limit on the flexibility with which neural oscillations can entrain to speech at different rates despite speech remaining fully intelligible throughout. Although perceptual after-effects were pronounced in this group of listeners (confirmed by post-MEG behavioural data), these after-effects were not associated with any reliable change in the magnitude or frequency of cerebro-acoustic coherence. We are currently analysing multivariate temporal receptive fields (cf. Crosse et al, 2016, Frontiers Hum Neurosci) to determine whether differences in the timing of oscillatory entrainment are linked to perceptual adaptation or after-effects. These findings have implications for oscillatory accounts of speech perception and comprehension which will be discussed.

B15 Transcutaneous vagus nerve stimulation enhances non-native speech categorization *Fernando Llanos[1], Jacie R. McHaney[1], Matthew K. Leonard[2,3], William L. Schuerman[2], Han G. Yi[2], Bharath Chandrasekaran[1,4,5,6,7]; [1]Department of Communication Sciences and Disorders, The University of Texas at Austin, [2]Neurological Surgery, University of California, San Francisco, [3]Weill Institute for Neurosciences, University of California, San Francisco, [4]Institute for Mental Health Research, The University of Texas at Austin, [5]Department of Psychology, The University of Texas at Austin, [6]Department of Linguistics, The University of Texas at Austin, [7]Institute for Neuroscience, The University of Texas at Austin*

Learning to categorize non-native speech is extremely challenging for adults. This challenge is due to a loss of sensitivity to acoustic features that are not linguistically relevant in the native context. In rodent models, pairing vagal nerve stimulation (VNS) with sounds enhances cortical auditory plasticity that is specific to stimulus spectrotemporal properties (Engineer et al., 2011, 2015). VNS-induced cortical plasticity is similar to cortical plasticity induced by nucleus basalis stimulation (Engineer et al., 2011), suggesting that effects arise from upregulation of the cholinergic system. Based on these findings, it may be possible to use VNS to facilitate non-native speech category learning in humans. Here, we examine the extent to which pairing auricular transcutaneous vagus nerve stimulation (tVNS) with auditory training stimuli facilitates learning of Mandarin Chinese tones. Mandarin Chinese has four phonologically distinctive tone contours: high-level (T1), low-rising (T2), low-dipping (T3), and high-falling (T4). These linguistically relevant tones are perceptually cued by at least two dimensions: pitch height and pitch direction. English learners of Mandarin tones are perceptually more sensitive to pitch height cues than to pitch directional cues (Gandour, 1981). Native English speakers naïve to tonal languages were trained with feedback (correct/incorrect) to categorize Mandarin tones across six training blocks of 40 speech stimuli with high phonetic variability (four tones, five syllables, four talkers). Training was followed by one generalization block of 40 novel stimuli with no feedback A 500-ms train of 15 biphasic electric pulses (pulse width = 100 μs) was transcutaneously delivered at 25 Hz through the ear concha, targeting the auricular branch of the vagus nerve (Frangos et al, 2015). Pulses started 300 ms before the target stimulus onset. Pulse amplitude was set to 0.2 mA below the sensory threshold using a two-step staircase procedure. To examine the specificity of tVNS in tone learning, we paired VNS with different tone sets. In a pitch direction condition (N=10), tVNS was paired with tones from the two tone categories contrasting in pitch direction (T2, T4). In the pitch height condition, tVNS was paired with tones from the categories contrasting in pitch height (T1, T3). We compared the proportion of correct responses across blocks between the two tVNS conditions and a control condition of twenty native English speakers receiving Mandarin tone training with no tVNS (Reetzke et al., 2018). Linear mixed-effects analyses with block, control, and tVNS conditions as fixed effects, and subject as random effects, revealed an enhancement of accuracy-by-block under tVNS, relative to the control database (b=2, SE=0.73, t=2.72, p=0.01). This result provides evidence for tVNS-induced enhancement in Mandarin tone learning. Linear-mixed effect analyses also revealed an enhancement of accuracy-by-block in the pitch-height condition, relative to the pitch-direction condition (b=2.45, SE=1.08, t=2.26, p=0.02), and the control group (b=5.85, SE=1.75, t=3.33, p<0.001) suggesting that VNS-induced plasticity can be modulated by stimulus parameters. These results indicate that tVNS can enhance sensitivity to linguistically-relevant acoustic dimensions, thus setting a preliminary basis for potential translational applications in individuals with speech perception deficits.

B16 The relation between speech-in-noise and vocal pitch recognition abilities in high-functioning autism spectrum disorder *Stefanie Schelinski[1,2], Katharina von Kriegstein[1,2]; [1]Max Planck Institute for Human Cognitive and Brain Sciences, [2]Technical University of Dresden*

The ability to recognise auditory speech in a noisy environment is critical for successful communication in everyday situations. There is evidence that in autism spectrum disorder (ASD), speech perception is reduced under noisy conditions [1,2]. Currently it is unclear, whether difficulties in speech-in-noise perception are associated with difficulties in perceiving basic acoustic features of voices that are relevant for speech-in-noise perception. A key acoustic feature for speech-in-noise perception is the fundamental frequency which is perceived as vocal pitch [3]. Here, we investigated speech-in-noise recognition abilities and its relation to vocal pitch perception abilities in a group of adults with high-functioning ASD (n = 16) and typically developing individuals (n = 16; matched pairwise on age, gender, and intelligence quotient). The ASD group has been previously shown to have difficulties in vocal pitch perception but intact non-vocal pitch perception abilities [4]. In the speech-

in-noise recognition test, we investigated the individual thresholds for speech recognition when speech was presented with different levels of speech-shaped noise. The ASD group showed significantly higher thresholds as compared to the control group, i.e. typically developing individuals understood speech in higher noise levels. Within the control group, performance in the speech-in-noise recognition test correlated with performance in vocal pitch, but not non-vocal pitch perception. Within the ASD group, there were no correlations between speech-in-noise recognition and vocal or non-vocal pitch perception abilities. This indicated that in controls better speech-in-noise recognition abilities were associated with better vocal pitch perception, but not in the ASD group. Our results suggest that perceptual impairments, i.e. difficulties in vocal pitch perception might contribute to speech-in-noise recognition difficulties in ASD. In line with our previous results on vocal emotion recognition this implies that communication difficulties in ASD might not only be based on higher-level cognitive difficulties, but also on impaired basic perceptual processing. References [1] Alcantara, Weisblatt, Moore, & Bolton (2004). Speech-in-noise perception in high-functioning individuals with autism or Asperger's syndrome. Journal of Child Psychology and Psychiatry, 45(6), 1107-1114. [2] Groen, van Orsouw, Zwiers, Swinkels, van der Gaag, & Buitelaar (2008). Gender in voice perception in autism. Journal of Autism and Developmental Disorders, 38(10), 1819-1826. [3] Anderson, & Kraus (2010). Sensory-cognitive interaction in the neural encoding of speech in noise: a review. Journal of the American Academy of Audiology, 21(9), 575-585. [4] Schelinski, Roswandowitz, & von Kriegstein (2017). Voice identity processing in autism spectrum disorder. Autism Research, 10(1), 155-168.

B17 Bilinguals and monolinguals hear the world differently

Jennifer Krizman[1], Adam Tierney[1,2], Trent Nicol[1], Nina Kraus[1]; [1]Northwestern University, [2]Now at Birkbeck, University of London

There is evidence of bilingual advantages for inhibitory control and auditory encoding, two processes that are fundamental to daily communication. Yet, it is not known if bilinguals utilize these cognitive and sensory advantages during real-world listening. To test our hypothesis that bilinguals engage these processes during real-world listening, bilinguals and monolinguals performed a selective attention task, a necessary skill for listening in complex environments. During the selective attention task, cortical and subcortical auditory evoked responses were collected to determine if auditory encoding during active listening differs between bilinguals and monolinguals. Participants additionally were tested on a measure of inhibitory control. We found that although monolinguals and bilinguals performed similarly on the selective attention task, the groups differed in the neural and cognitive processes that contributed to their performance on this task. Specifically, bilinguals demonstrated enhanced cortical and subcortical auditory encoding relative to monolinguals, and their performance on the inhibitory control test related with performance on the selective attention test, a relationship that was not seen for monolinguals. These results are consistent with the hypothesis that bilinguals utilize inhibitory control and enhanced auditory processing in real-world listening situations.

Perception: Orthographic and Other Visual Processes

B18 How the brain learns to read in environments with high-risk of illiteracy: an fNIRS study of reading development in rural Côte d'Ivoire

Kaja Jasinska[1,2], Axel Blahoua[3], Fabrice Tanoh[4]; [1]University of Delaware, USA, [2]Haskins Laboratories, USA, [3]Centre d'Action et de Recherche pour la Paix, Abidjan, Côte d'Ivoire, [4]Université Félix Houphouët-Boigny, Abidjan, Côte d'Ivoire

Introduction. Learning to read is complex process dependent on multiple linguistic and cognitive systems, and crucially requires quality education to achieve mastery. Millions of children in sub-Saharan Africa fail to achieve target literacy outcomes. The failure to provide quality primary education to all children has profound consequences: 39% of youth aged 15-24 and 41% of adults aged 15+ are illiterate (World Bank, 2012), creating severe economic and social disadvantage within the local community and globally. In Côte d'Ivoire, youth (16-24 years) literacy rates are 53% (UNESCO, 2017). Child labor in cocoa agriculture is a significant problem in rural Côte d'Ivoire, associated with poverty and adversity (e.g. children engaged in hazardous work). These agricultural activities also limit school attendance. Our specific aim is to understand how the brain learns to read when faced with the challenges of inconsistent access to education and low educational quality. We examine language, cognitive, and reading development and measure how the brain's reading circuit develops in children at high-risk for illiteracy. Methods. 650 primary-school children ages 6-14 (Grade 1, 3, 5) completed language (French, local language) and literacy assessments and were interviewed about cocoa labor. 67 children completed a functional near infrared spectroscopy (fNIRS) neuroimaging study that examined neural activation for reading. fNIRS is highly portable and ideally-suited for studying brain development using field neuroimaging protocols developed for low-resource contexts (Jasinska and Guei, 2018). fNIRS task used a 2 x 3 design: modality (speech, print) by lexicality (word, pseudoword, false-font/vocoded speech). Neuroimaging data were analyzed using a general linear model (NIRS-SPM). Results. Many of the basic components of literacy are not evident even among 5th graders. On average, a 5th grader could correctly read only 27/100 letters and 2-letter combination. Phonological awareness in both French (std. beta = 0.33, $p < .01$) and a local language (std. beta = 0.34, $p < .01$) positively and significantly predict

reading outcomes. However, cocoa labor has a negative impact on children's reading scores (std. beta = -0.37, p < .05). A child's environment (i.e., socioeconomic status, cocoa labor) influenced neural activation while reading: decreased neural activation in the left IFG was observed with increased familial household resources. Among children with minimal reading ability, greater activation for false-fonts was observed in the left IFG, suggesting the reading circuit is not yet fully sensitive to orthography and lexical information, even by 5th grade. Crucially, this pattern of brain activation is different from younger children at comparable reading levels reported elsewhere in the literature (e.g. Turkeltaub et al., 2003; Jasinska and Petitto, 2014). Discussion. Poverty and adversity impact the neural systems for reading in a sample of highly vulnerable children. Understanding the complex relationships between impoverished environment, delayed and/or inconsistent access to education, children's linguistics and cognitive development, and reading outcomes yields new information about reading development in environments with a high risk of illiteracy. Portable fNIRS informs how the developing brain responds to high-risk environments and can identify neurodevelopmental periods when targeted educational programs can have maximal impacts on learning outcomes.

B19 Decoding of word frequency from pre-stimulus MEG activation in a repetition priming paradigm *Susanne Eisenhauer[1], Benjamin Gagl[1,2], Christian J. Fiebach[1,2]; [1]Goethe University Frankfurt, Germany, [2]Center for Individual Development and Adaptive Education of Children at Risk (IDeA), Frankfurt, Germany*

Visual word recognition is facilitated through predictive context, e.g., in sentences or texts, resulting in fast reading times and reduced neuronal activation. Conceptually, this facilitation can be reconciled with predictive coding models, which attribute neuronal processing efficiency and facilitated behaviour to the proactive use of prior information to predict upcoming sensory inputs. As a consequence, predictable stimulus characteristics should be encoded in neuronal activation patterns prior to stimulus presentation, which was found previously for low-level visual percepts. We hypothesized that such predictive coding mechanisms should also be active during visual word recognition. Thus, we assumed that for predictable words, pre-stimulus neuronal activation patterns should encode important information about the expected stimulus, i.e., word frequency and orthographic properties quantified by the orthographic Levenshtein distance 20. We tested this hypothesis using a repetition priming task and simultaneous MEG recording (N=39). High predictability of letter string characteristics was realized by a high probability of identical prime-target pairings (75%). We expected that the information provided by the prime is encoded in the neuronal signal prior to target presentation. Time-resolved multivariate pattern classification analyses (MVPA) supported this hypothesis, by revealing that word frequency, but not orthographic familiarity, can be significantly decoded ($p < 0.05$) from the pre-target MEG activation. Interestingly, these pre-target neuronal codes seem to differ from representations activated during prime presentation, as there was only generalization within the pre-target delay interval but no temporal generalization from prime presentation to delay. These results indicate lexical-level word characteristics are pre-activated to facilitate word recognition in predictive contexts. Our findings support the hypothesized role of expectation-based predictive mechanisms during visual word recognition.

B20 Encoding of abstract letter identity in deaf readers: the role of lexical feedback *Eva Gutierrez-Sigut[1,2], Marta Vergara-Martínez[1], Manuel Perea[1,3]; [1]University of Valencia, [2]University College London, [3]Basque Center on Cognition, Brain, and Language*

Most deaf people find reading very difficult. Here we analyzed whether this was partly due to weaker lexical feedback during orthographic encoding. In an ERP masked identity priming experiment with hearing readers, Vergara-Martínez et al.'s (2015) behavioral data showed no advantage for matched-case over the mismatched-case (RTs: HOUSE-HOUSE = house-HOUSE) for words, whereas there was an advantage for nonwords (RTs: SOUTA-SOUTA < souta-SOUTA). Furthermore, the ERPs showed a matched-case effect in the N/P150 component that dissipated for words (but not for nonwords) in the N250 and N400 components. Vergara et al. (2015) argued that the absence of case effects in words (but not in nonwords) was due to top-down lexical modulation. Critically, in a behavioral masked priming experiment with deaf readers, Perea et al. (2016) found an advantage of the matched-case over the mismatched-case condition for both words and nonwords, and argued that this was due to a weaker lexical feedback in deaf than in hearing readers. In the present experiment, we use a more sensitive measure, ERPs, to investigate the time course of abstract letter identity encoding with the matching-case priming manipulation in a group of 20 congenitally deaf readers. Participants made lexical decisions to five-letter Spanish word and nonword targets. The target stimuli were presented in uppercase and preceded by: a) a matched-case identity prime (ALTAR-ALTAR); b) a mismatched-case identity prime (altar-ALTAR); or c) an unrelated prime. Behavioral results replicated the pattern reported by Perea et al. (2016) with deaf readers: we found an advantage for matched-case over the mismatched-case condition for both word and nonword targets. Interestingly, the ERP results showed a similar pattern to that of Vergara-Martínez et al. (2015) with hearing individuals. Specifically, we found a main effect of case N/P150, which dissipated for words (but not for nonwords) in later time windows (N250 and N400). In addition, the analysis of the relationship between this effect and several reading comprehension and phonological processing measures showed that: i) there

were no significant correlations between the size of the ERP effects of case and reading/phonological processing measures; ii) the effect of case in response times for words (but not for nonwords) was positively correlated with reading ability and phonological skills, as well as with word knowledge. Taken together, these findings favor the view that processing of orthographic features during word processing may follow a different pattern in deaf readers than in hearing readers.

B21 Localization of dual stream contributions to sublexical and lexical-semantic reading: a multivariate lesion-symptom mapping study of left hemisphere stroke survivors

J. Vivian Dickens[1], Mackenzie E. Fama[1], Andrew T. DeMarco[1], Elizabeth H. Lacey[1,2], Rhonda B. Friedman[1], Peter E. Turkeltaub[1,2]; [1]Georgetown University Medical Center, Washington, DC, USA, [2]MedStar National Rehabilitation Hospital, Washington, DC, USA

Introduction: Over the past half century, studies of alexia, an acquired disorder of reading, have enriched our understanding of the neurocognitive architecture subserving reading and language. The reading deficits observed in alexia reflect impaired sublexical and lexical-semantic processing and are frequently characterized along the dimensions of lexicality (word versus nonword), orthographic regularity (regular versus irregular spelling-sound correspondences), and concreteness (abstract versus concrete meaning). Localization of dorsal and ventral stream areas essential to reading aloud words that vary along these dimensions remains a matter of investigation. Here, we apply multivariate lesion-symptom mapping (LSM) in left hemisphere stroke survivors to identify brain areas critical for effects of lexicality, orthographic regularity, and concreteness in reading aloud. Methods: Participants were 73 native English speakers at least 6 months post unilateral left hemisphere stroke with no other significant neurological or psychiatric disorders. The reading battery consisted of three pairs of matched lists targeting effects of lexicality, orthographic regularity, and concreteness, respectively: words/pseudowords, regular/irregular, and concrete/abstract. The latter two tasks were completed by a subset of participants (N = 48). Accuracies in reading aloud items in the six categories served as the behavioral outcomes, with accuracy on the corresponding matched items being covaried in each analysis (e.g., for concrete word reading, abstract word reading was included as a covariate). To account for voxelwise lesion covariance, we applied support vector regression lesion-symptom mapping (SVR-LSM), a multivariate LSM method that considers all voxels in one regression, using a MATLAB toolbox developed in our lab (https://github.com/atdemarco/svrlsmgui/). To further minimize lesion autocorrelation effects, lesion size was regressed out of the analyses, and significance was determined through a permutation approach at a voxelwise threshold of $p < .005$, with cluster-level family-wise error controlled at .05. Results: Inaccurate concrete word reading was associated with lesions to pars orbitalis and pars triangularis of left inferior frontal gyrus. Inaccurate regular word reading was associated with lesions spanning left planum temporale, parietal operculum, and ventral precentral gyrus. Inaccurate pseudoword reading was related to lesioned left ventral precentral gyrus, overlapping with the region implicated in reading regular words, although this cluster was just below the cluster-level threshold ($p = .0509$). Conclusions: Our results demonstrate specific cortical regions important for effects of concreteness, regularity, and lexicality in reading aloud. Lesions to left anterior inferior frontal gyrus may diminish the normal concrete word advantage by degrading semantic control and selection. Left planum temporale, parietal operculum, and ventral precentral gyrus underlie auditory, somatosensory, and articulatory representations, respectively. That lesions to these regions resulted in diminished reading of regular words points to a critical role for sound-motor integration in sublexical decoding of print. The association of poorer pseudoword reading with lesioned ventral precentral gyrus further supports the role of articulatory-based representations in phonological decoding. Overall, our application of multivariate LSM provides evidence for a specialized role for dorsal stream areas in accessing articulatory-based representations in sublexical reading and for ventral stream areas, particularly left anterior inferior frontal cortex, in lexical-semantic contributions to reading.

Grammar: Syntax

B22 fMRI evidence for binding theory during anaphora resolution in naturalistic listening

Jixing Li[1], Murielle Fabre[1], Wen-Ming Luh[1], John Hale[1]; [1]Cornell University

INTRODUCTION Within generative grammar, syntactic constraints have been identified that restrict possible pronoun-antecedent relationships. For instance in Chomsky's (1981) Binding Theory, personal pronouns must not be bound by an antecedent within the same clause. However, debates persist over the precise role that binding theory play in the cognitive process of pronoun resolution. The current study compared brain activity associated with a syntax-sensitive computational model and a neural network model for pronoun resolution while participants listened to an audiobook during fMRI recording. The syntax-sensitive Hobbs algorithm (Hobbs, 1977) follows binding theory and implements gender/number matching, whereas the neural network model (Clark & Manning, 2016) encodes a set of semantic and discourse-level features with no explicit use of syntactic structures. The results revealed larger clusters associated with the Hobbs algorithm in the left Broca's area and the bilateral Angular Gyrus--a network that has been reported in the neuroimaging literature for morpho-syntactic processing during anaphora resolution (e.g., Hammer et al., 2007; Matchin et al., 2014; Santi & Grodzinsky, 2012). METHODS 49 English speakers (30 female, mean age=21.3)

listened to an audiobook version of "The Little Prince" for about 100 minutes. BOLD functional scans were acquired using a multi-echo planar imaging (ME-EPI) sequence with online reconstruction (TR=2000 ms; TE's=12.8, 27.5, 43 ms; FA=77; matrix size=72x72; FOV=240.0x240.0 mm; 2 x image acceleration; 33 axial slices, voxel size=3.75x3.75x3.8 mm). Preprocessing was carried out with AFNI and ME-ICA (Kundu et al., 2011). The audiobook contains 277 third person pronouns that are correctly predicted by the Hobbs algorithm. For each of the 277 third person pronouns, we computed the Hobbs distance, namely the number of noun phrases that the algorithm skips while searching for the antecedent. Our hypothesis is that a higher Hobbs distance yields a processing effort due to syntactic and morphological constraints. We also computed the coreference score between the pronoun and its antecedent using the neural network model trained on the CoNLL-2012 Shared Task data (Pradhan et al., 2012). The negative of this score was taken to index processing difficulty due to semantic and discoursal factors. The observed BOLD signal was modeled by the two difficulty measures for pronoun resolution time-locked at the offsets of 277 third person pronouns in the audiobook. We also included a binary regressor which marks the presence of the third person pronouns, and three control regressors: RMS intensity at every 10 ms of the audio; word rate at the offset of each word, and log-frequency of each word in the unigram set from Google ngrams. RESULTS The Hobbs algorithm significantly correlates with activity in the left Precuneus, the bilateral Angular Gyrus, the left Inferior Frontal Gyrus and the left Inferior Temporal Gyrus. The neural network model only shows marginally significant activation in the right Superior Temporal Gyrus ($p<0.05$ FWE, $k>=50$). CONCLUSION Anaphora resolution modeled by the Hobbs algorithm is supported at the brain level in a network including the left Broca's area, thus suggesting that the human parser attributes a central role to syntactic and morphological information during pronoun resolution.

B23 Voice (mis)match in Korean right dislocation constructions: An ERP study

Bum-Sik Park[1], Kiyong Choi[2], Daeho Chung[3], Wonil Chung[1], Say Young Kim[3], Myung-Kwan Park[1]; [1]Dongguk University, [2]Kwangwoon University, [3]Hanyang University

It has been reported that voice mismatch in elliptical contexts leads to degradedness, suggesting that (limited) identical syntactic forms are required for ellipsis licensing (Merchant 2007). The purpose of this study is to investigate the processing effect of voice mismatch in Korean right dislocation (RD) constructions, where the sentence final RDed remnant is assumed to be derived via ellipsis (cf. Park and Kim 2009, Ott & de Vries 2015). We conducted an ERP experiment, employing 240 sets of eight elliptical RD conditions in Korean with 2x2x2 factorial design (voice types of the antecedent clause, explicit/implicit correlate, (mis)match of the remnant). Representative materials are below, where implicit correlates are within parentheses: (1) Active condition (explicit/implicit, voice match/mismatich): (Max-ka) namwu-lul caluasse, Max-ka/*Max-eyuyhay. 'Max cut the tree, Max/*by Max'. (2) Passive condition (explicit/implicit, voice match/mismatch): (Max-eyuyhay) namwu-ka caliuasse, Max-eyuyhay/*Max-ka. 'The tree was cut by Max/*Max'. First of all, we collected the ANOVA results of the offline acceptability task with the materials, and they showed that Korean speakers consistently judged the three mismatch conditions unacceptable except the passive implicit mismatch condition in (2). In particular, the mismatch in the active implicit condition was rated the worst among them in (1). The results were generally consistent with online acceptability task except the explicit and implicit condition In general, these results were also consistent with those from the ERP recordings. Sixteen Korean speakers participated in the experiment, and ERPs were measured at the sentence final RDed remnant (Max-ka 'Max-Nom'/ Max-eyuyhay 'Max-by'), the case/postposition marker of which cues a different voice type of the elliptical clause. At this critical element, similar/different ERP components were obtained among conditions. In pairwise comparison, the explicit/mismatch/passive condition in (2) recorded P200, P400, and a marginal P600/sustained positivity, whereas the implicit/mismatch/passive condition recorded P200 followed by a significant P600. By contrast, the explicit/mismatch/active condition in (1) recorded a significant N400 and N600, whereas the implicit/mismatch/active condition recorded a marginal N400 followed by significant N600. We take these ERP results to point to three things. First, the P200 and the P600 component elicited commonly in the passive/ mismatch condition in (1) can be ascribed to the presence of structural case on the remnant (i.e., Nominative), This amounts to the structural case mismatch on the remnant, and possibly resulted in eliciting the P600(-like) component as an index of structural repair of voice mismatch. Second, by contrast, the components N400 and N600 evoked commonly in the active/mismatch condition is due to the lexical/morphological case/postposition mismatch on the remnant, which ended up yielding the component as an index of semantic integration. Finally, while the explicit conditions involving voice mismatch had ERP effects around 400 ms, the implicit conditions involving voice mismatch had prolonged ERP effects around 600 ms. This suggests that the implicit correlate yielded a intensifying effect of voice mismatch.

B24 From Desynchronization to Synchronization: A Lifespan Shift of Alpha-Band Power During Sentence Comprehension

Caroline Beese[1], Benedict Vassileiou[1], Angela D. Friederici[1], Lars Meyer[1]; [1]Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany

Sentence comprehension remains largely intact across the lifespan, except for when domain-general cognitive resources are taxed. Specifically, as successful sentence

comprehension requires the encoding of rich and detailed verbal information, difficulties may arise from a decline in verbal working memory capacity with age. In the literature outside of sentence comprehension, memory encoding success has been associated with oscillatory power increases within the theta band and decreases within the alpha and beta band in young adults; in older adults, these power changes are attenuated. However, it remains an open question whether age-related oscillatory attenuation associates with difficulties in verbal working memory-intensive sentence comprehension. To address this question, we here assessed sentence-encoding success in 18 younger (mean age: 24 years), 16 middle-aged (mean age: 43 years) and 13 older adults (mean age: 64) via a verbal working memory-intensive comprehension task; in parallel, the electroencephalogram (EEG) was recorded. Comprehension accuracy was quantified as the ratio of later-remembered (LR) and later-not-remembered (LNR) sentences—indirectly indicating encoding success. From the EEG, oscillatory power within the theta, alpha, and beta band was derived, separately for LR and LNR sentences. First, we assessed the subsequent memory effect (SME) by comparing LR and LNR power within each age group and frequency band, using cluster-based permutation t-tests. Then, the band-wise oscillatory power differences (i.e., LR – LNR) were compared between age groups, using cluster-based permutation analyses of variance. As expected, the behavioral results showed better encoding performance for younger than middle-aged than older adults. The EEG results showed lower oscillatory power within alpha band, most pronounced over the fronto-parietal midline, to predict better sentence encoding, in young adults only. This negative SME was less pronounced in middle-aged adults, turning into a positive SME in older adults. Potentially, this neural desynchronization-to-synchronization shift across the lifespan reflects a cognitive shift in encoding strategies: At young age, bottom-up encoding may dominate, achieved through cortical disinhibition—allowing enriched information routing throughout the language network. At old age, resource limitations may necessitate an increased reliance on top-down encoding, mirrored in cortical inhibition to avoid information overload. We suggest that declining language comprehension across the lifespan is characterized by changes to the underlying electrophysiological processing networks that are, in turn, associated with changes in the functional dynamics within these networks during task performance.

B25 Korean Negative Polarity Items: Evidence from ERP responses

Sanghoun Song[1], Wonil Chung[2], Eunjeong Oh[3], Myung-Kwan Park[2], Euhee Kim[4]; [1]Incheon National University, [2]Dongguk University, [3]Sangmyung University, [4]Shinhan University

Previous neuro-imaging studies have examined the neural processes of licensing negative polarity items (NPIs) in English such as ‘any’ and ‘ever’ in the anomalous sentences without NPI-licensing elements like negation, which elicited an N400 followed by a P600 compared to their grammatical counterparts (cf. Drenhaus et al., 2004, 2005, 2006). They suggested that the failure in licensing of NPIs engenders semantic integration costs (N400), but the additional P600 component from unlicensed NPIs reflects different aspects of processing them. Xiang, Grove and Giannakidou (2016) also noted that explicit and implicit negative meanings were integrated into the grammatical representation in distinct ways, leading to a difference in the P600, and calling for a separation of semantic and pragmatic integration during NPI licensing. Turning to Korean, it is controversial whether the two NPIs in Korean such as the nominal ‘amwu N-to’ (any N) and the adverbial ‘te isang’ (any more) are licensed by nonveridical contexts like interrogatives and ‘-ki cen-ey’ (before)-clause in Korean, although it is well established that they are licensed by an overtly negated predicate (Lee, 1999; Hwang, 2013). Thus, in order to examine how Korean NPIs enter into licensing relation during online processing, this study conducted two ERP experiments in addition to offline and online acceptability tasks with ‘amwu-N-to’ (Experiment 1) and with ‘te isang’ (Experiment 2) within four different contexts: (a) negative; (b) positive; (c) interrogative; (d) Korean ‘before’-clauses. Twenty-one right-handed normal functioning Korean native speakers (14 males, mean age 23), participated in the two experiments. In offline acceptability, there was a significant effect of type factor, $F(3,60)=142.75$, $p<0.001$, in EXP 1, and a significant effect of type factor, $F(3,60)=79.36$, $p<0.001$, in EXP 2. In Experiment 1 with the nominal ‘amwu N-to’, the ERP component N400 was elicited in the anomalous conditions such as (b) ($F(1,20)=18.7$, $p<0.001$), (c) ($F(1,20)=9.3$, $p<0.01$), and (d) ($F(1,20)=13.9$, $p<0.001$), compared to their grammatical counterpart (a), but no P600 component was elicited. Furthermore, there was an N600 in condition (b) and (c). However, in Experiment 2 with the adverbial ‘te isang’, N400 followed by marginal ‘anterior’ P600 was elicited in the anomalous condition (b), compared to its grammatical counterpart (a). However, (c) relative to (a) evoked an marginal anterior P600, and (d) relative to (a) elicited a significant anterior P200 and ‘anterior’ P600. The results indicate that, first, N400 was evoked by both NPIs at issue in illegal environments like a positive clause. Since N400 is regarded as a neural index of incomplete semantic integration, it follows that the Korean NPIs’ licensee-licensor relation is resolved via semantic processes. Second, ‘amwu+N+to’–containing non-negative conditions elicited N400, whereas ‘te isang’–containing question and ‘-ki cen-ey’ clauses elicited anterior P600. We take the latter anterior P600 component to reflect not a violation of NPI licensing but a cognitive load of discourse/pragmatic processing due to the lexical meaning of ‘te isang’. Third, directly comparing the two NPIs in terms of neural profiles, we find that during processing ‘amwu+N+to’ is cognitively more demanding than ‘te isang’.

B26 Neural signature of Cross-Linguistic Influence in L2 Learning

Hiroshi Ishinabe[1,2], Hyeonjeong Jeong[3,4], Shigeyuki Ikeda[3], Takayuki Nozawa[5], Kohei Sakaki[1], Motoaki Sugiura[3,6], Ryuta Kawashima[3]; [1]Graduate School of Medicine, Tohoku University, [2]Department of Social Care, Higashiosaka Junior College, [3]Institute of Development, Aging and Cancer, Tohoku University, [4]Graduate School of International Cultural Studies, Tohoku University, [5]Research Center for the Earth Inclusive Sensing Empathizing with Silent Voices, Tokyo Institute of Technology, [6]International Research Institute of Disaster Science, Tohoku University

INTRODUCTION: It has been suggested that the cross-linguistic similarity between mother tongue (L1) and second language (L2) is an important factor in determining brain activation patterns during L2 processing and determining whether learners acquire L2 successfully or not (Jeong et al., 2007, Kotz, 2009). However, it is difficult to control factors such as L2 proficiency or linguistic features (i.e. syntax) when it comes to designing experiments. Furthermore, it is still unclear whether this effect of cross-linguistic factor influences the initial stage of brain mechanism of L2 grammar learning, and if so, how? In this study, we hypothesized that the neural mechanisms during L2 learning are affected by the cross-linguistic similarity as well as during L2 grammar processing. To test the hypotheses, the present fMRI study investigates brain activation during L2 learning using artificial languages. METHODS: Thirty-Seven Japanese native speakers were recruited (Sixteen females and twenty-one males, mean age: 20.4, SD: 1.2). We created two artificial languages which were named DL (Dissimilar Language) and SL (Similar Language). In DL, word order (Verb-Subject-Object) and morphosyntactic system were NOT similar to the participant's L1 (Japanese). In SL, word order (Subject-Object-Verb) and morphosyntactic system were similar to the participant's L1. Both DL and SL were written in Roman letters, and had the same eleven words. The participants were randomly assigned into two groups: the DL learning group and the SL learning group. We controlled individual differences such as IQ, their L2 (i.e. English) proficiency, and foreign language anxiety level. Both groups underwent MRI scans during Grammar-Learning Session (Learning) and Grammar-Test Session (Testing) at three time-points (1st-phase, 2nd-phase, and 3rd-phase) in a day. The fMRI data of Learning and Testing were modeled separately using a General Linear Model. To elucidate the effect of individual learning skill, a correlation analysis was conducted between the gain score of Testing and activation in the observed brain areas. Statistical analyses were performed with SPM12, using a random effects model (corrected to $p<0.05$ by FWE). RESULTS: Comparison between DL and SL groups during Testing revealed that the DL group recruited greater activation in the left inferior frontal gyrus. In contrast, SL group recruited greater activation in the lingual gyrus. Consistent with previous findings (Jeong et al., 2007), the results of Testing demonstrate the cross-linguistic effect due to linguistic similarity. Furthermore, the correlation analysis revealed that activation patterns in the left IFG and lingual gyrus during the 1st and the 3rd Testing phases were significantly correlated with the gain scores of each participant in the DL and SL groups, respectively. Comparison between the DL and SL groups during Learning showed that the DL group recruited greater activation in the left IFG than the SL group did. In contrast, the SL group recruited the left hippocampus and left caudate. Consistent with the results of Testing, the left IFG plays a crucial role in the cross-linguistic effect due to linguistic distance even during grammar learning. CONCLUSION: Cross-linguistic differences are the major determinant of brain mechanism involved in the initial stage of L2 learning.

Meaning: Lexical Semantics

B27 Spatial attention and perceptual-motor representations of demonstratives: a fast fMRI study using naturalistic auditory stimuli

Roberta Rocca[1], Torben E. Lund[2], Marlene Staib[1], Kristian Tylén[1,3], Kenny R. Coventry[4], Mikkel Wallentin[1,2,3]; [1]Department of Linguistics, Cognitive Science and Semiotics, Aarhus University, Denmark, [2]Center of Functionally Integrative Neuroscience (CFIN), Aarhus University, Denmark, [3]The Interacting Minds Centre, Aarhus University, Denmark, [4]School of Psychology, University of East Anglia, United Kingdom

Spatial demonstratives, i.e. words like this and that, are lexical items used to indicate physical or contextual distance. In spite of their minimal semantic specificity, they can trigger attentional shifts and establish a joint focus of attention on referents in the physical environment, thus functioning as interfaces between linguistic representations, attention and perceptual processes. While the behavioral correlates of spatial demonstratives are receiving more and more attention in the experimental literature, no research has been conducted on how this peculiar intertwining between linguistic, attentional and perceptual processes is implemented in the brain. This may be due to the fact that studying demonstratives raises methodological challenges. As their meaning hinges on the context of utterance, attempts at investigating their neural underpinnings call for the need to simulate rich linguistic and physical environment within the constraints intrinsic to neuroimaging. With these challenges in mind, we conducted a naturalistic fMRI experiment (N = 28) where participants listened to specially crafted dialogues with a controlled number of spatial demonstratives (as well as a number of other function words). The dialogue involved two synthesized voices, each recorded onto a separate channel of a stereo track. This allowed to embed the target words in both a rich linguistic context, and a 3D-like spatial setting. A fast acquisition sequence (TR = 388ms, multi-band EPI acquisition) was used to capture signal changes at word-level resolution, relying on evidence for the presence

of high-frequency components in the BOLD signal (Lewis et al., 2016). We isolated regions involved in processing spatial demonstratives via random effects univariate analyses. Given our liberal assumptions on the shape of the hemodynamic response for sustained linguistic stimulation, we modelled neural response using finite impulse response models and used RETROICOR cardiac and respiratory models for denoising. We found bilateral posterior superior parietal activation in response to spatial demonstratives in areas associated to attentional orienting and functional representation of space, with activation being significantly stronger for distal than for proximal demonstratives. These results are compatible with behavioral evidence showing that spatial demonstratives are likely to encode the attentional status of the referent, as well as its functional perceptual-motor features (e.g. graspability). In order to confirm the reliability of these patterns, we computed inter-subject correlations both on the full time series and across time windows. This allowed to explore which events generate peaks in activation within our ROI, so to elucidate the functional profile of these areas in the context of sustained linguistic stimulation. Additionally, we submitted the parameter estimates from the univariate model to multivariate pattern analysis, so to identify patterns specific to the representation of spatial demonstratives compared to other types of referencing expressions. Our results contribute to establishing a grounding of neural representations for spatial demonstratives onto non-linguistic perceptual and attentional resources. They also contribute to validating fast fMRI paradigms using naturalistic auditory stimuli as a reliable experimental procedure to investigate language phenomena at short time scales, within rich contexts and at a computationally sustainable cost.

B29 Dynamic Conceptome: Semantic hubs and spokes form functional modules in the whole-brain graphs with intra-/inter-modular connectivity

Seyedehrezvan Farahibozorg[1,2], Olaf Hauk[1]; [1]MRC Cognition and Brain Sciences Unit, University of Cambridge, [2]Wellcome Centre For Integrative Neuroimaging, Nuffield Department of Clinical Neurosciences, University of Oxford

The fast temporal dynamics of connectivity between nodes of the semantic networks while a concept unfolds in the brain are largely unknown. To tackle this, in this study we proposed an unprecedented translation of the predictions of the hub(s)-and-spokes framework (Lambon-Ralph et al. 2016, Patterson et al. 2007) into quantifiable concepts of network community and modularity from graph theory. Importantly, without imposing any restrictions on the number or locations of the potential hub and spoke modules and connectivity among them, we aimed at identifying these characteristics of the semantic networks using a data-driven approach. For this purpose, we recruited 19 healthy native English speakers (age 18-40) who performed a semantic target detection task in a visual word recognition paradigm while Electro-/Magnetoencephalography (EEG/MEG) data (70/306 channels) were recorded simultaneously (Elekta Neuromag). We compared word categories with strong visual (e.g. sun), auditory (e.g. whistle) and hand-action (e.g. wrench) attributes and hypothesised that while hub modules should be involved in all the three pairwise comparisons, spoke modules for each sensory-motor modality should only be modulated in the two pairwise comparisons that involved their corresponding category. Preprocessing included Maxfilter, band-pass filtering (0.1-45Hz), ICA artefact rejection and epoching. Forward modelling and source estimation were performed on combined EEG/MEG data and based on individual MRIs using boundary element models and L2 minimum norm estimation. Whole-brain networks were reconstructed by parcellating the cortex based on EEG/MEG-adapted Desikan-Killiany Atlas (Farahibozorg et al. 2018) and computing a parcel-parcel (74 x 74) spectral coherence matrix. We reconstructed networks in three time windows (50-250ms, 150-350ms and 250-450ms) and three frequency bands of Alpha (8-12Hz), Beta (13-30Hz) and Gamma (30-45Hz). Thereafter, we identified functional modules for each network using Louvain approach (Blondel et al. 2008) and found consensus modules across subjects, conditions, times and frequencies using a method similar to Lancichinetti & Fortunato (2012). Finally, we conducted statistical comparisons between module-module connectivity matrices of different word categories and applied cluster-based permutations in order to correct for multiple comparisons using a method similar to Zalesky et al. (2010). Key results comprised: (i) Eight consensus modules were identified across time windows, frequencies, conditions and subjects. Interestingly, while the left anterior temporal lobe (ATL), posterior middle temporal (pMTG) and angular gyrus (AG) were clustered together and formed a single temporo-parietal module, the right ATL, pMTG and inferior parietal cortices were identified as stand-alone modules; (ii) Right ATL, right pMTG and right parietal modules were identified as potential semantic hub modules; (iii) Bilateral occipital and left parietal modules were identified as visual spokes, a bilateral central module as a hand spoke and a left temporo-parietal module as well as bilateral frontal cortices as auditory spokes; (iv) We found modulations of three types of intra-/inter-modular connections including hub-hub, spoke-spoke and hub-spoke connectivity. These results provide the first data-driven characterisation of global integrator semantic hubs, spokes and connectivity among them. Additionally, results can further specify the role of the right-hemispheric semantic hubs and unravel temporo-spectral profiles of the involvement of ATL and parietal cortex as integrator semantic hubs.

B30 Neural correlates of selection and inhibition of semantic features: an fMRI study of Chinese classifiers

Chu-Hsuan Kuo[1], Min Liu[1], Hsuan-Chih Chen[2], Tai-Li Chou[1]; [1]National Taiwan University, [2]Chinese University of Hong Kong

In Chinese, classifiers have varying degrees of overlapping semantic features with their corresponding nouns. Count classifiers, which individualize nouns, are semantically distinct from mass classifiers, which are general measurements of nouns. The present functional magnetic resonance imaging study aimed to clarify the neural correlates of processing erroneous count versus mass classifier use during reading comprehension. Twenty-nine native Chinese speakers made semantic congruency judgments on congruent, intra-classifier (IA) violated, and inter-classifier (IE) violated phrases. The IA and IE violations involved changing a correct classifier to an incorrect classifier of the same category (e.g. count-count or mass-mass) and of a different category (e.g. count-mass or mass-count), respectively. Functional connectivity as revealed by psychophysiological interactions analysis revealed whether there would be condition-specific connectivity between brain regions during semantic judgments. The IE violation condition produced more activation in the bilateral inferior frontal gyri (IFG) when contrasted with the IA violation condition, suggesting that searching for overlapping features may result in increased demand on semantic processing when dealing with between-category classifier errors. The bilateral IFG were functionally connected to the medial frontal gyrus, suggesting a certain degree of inhibition and interference resolution of irrelevant semantic features between an incorrect classifier and noun. The right IFG was also functionally connected to the left middle temporal gyrus (MTG), suggesting a need for lexical retrieval and selection of semantic features. Overall, these results suggest that the bilateral IFG functions as part of a larger semantic network involving the medial frontal gyrus and the left MTG during the processing of Chinese classifiers.

B32 Do experiential semantic features predict automatic semantic priming in verbs?

Taylor Kalmus[1], Lisa Conant[2], Colin Humphries[2], Jeffrey Binder[2], Leonardo Fernandino[2]; [1]Carroll University, [2]Medical College of Wisconsin

Prior research established that a model of concept representation based on a set of experiential attributes (CREA) predicts automatic semantic priming effects for nouns (Fernandino et al., 2016). Here, we assessed whether this effect is also present for verbs and whether the magnitude of the effect is similar for the two-word classes. We hypothesized that the magnitude of the semantic priming effect in a lexical decision task would correlate with a measure of semantic similarity between the prime and the target word derived from the CREA model. As a base for comparison, we also evaluated an alternative model of concept representation, Latent Semantic Analysis (LSA, Landauer & Dumais, 1997). In the noun condition, targets consisted of English nouns or matched pseudowords, with nouns used as primes. In the verb condition, targets consisted of English verbs or matched pseudowords, with verbs as primes. Nouns and verbs were presented in separate blocks. All words were previously rated on a set of 65 semantic features through Amazon Mechanical Turk (Binder et al., 2016). Words and pseudowords were matched for letter length, bigram and trigram frequency, and orthographic neighborhood size. Primes and targets were matched for word length. The possibility for forward association priming effects was eliminated by excluding any pairs with nonzero values in the USF Free Association Norms. For each model (CREA and LSA), semantic similarity between prime and target was estimated as the cosine between the vector representations of the two words. Prime-target pairs represented a continuous distribution of word similarity values ranging from 0 to 1. Each target word was presented twice (on separate days), each time preceded by a different prime. The priming effect for a given target word was calculated as the difference in response times between the two presentations. Each trial started with a central fixation cross (duration jittered 1-2 sec), followed by the prime (150 ms), a mask (hash marks, 50 ms), and the target (2 sec). The prime was presented in lowercase and the target in uppercase letters. Participants were instructed to ignore the prime and make a speeded lexical decision on the target. The task was performed in two sessions approximately one week apart. Twenty-six subjects completed the study. Results replicated the findings of Fernandino et al. (2016), showing a highly significant correlation between CREA cosine differences and priming for nouns ($r=.45$, $p<.001$). However, the correlation for verbs was much smaller ($r=.18$), not reaching significance across trials ($p>.1$), although it was marginally significant across participants ($p=.06$). Furthermore, there was a significant Model x Word Category interaction, in which priming for nouns was better predicted by CREA than by LSA while priming for verbs was better predicted by LSA than by CREA ($p=.023$). Correlation between CREA cosine differences and priming was significantly lower for verbs than for nouns ($p= .05$). These results show that, while ratings of experiential features strongly predict automatic semantic priming for nouns, their predictive power is considerably smaller for verbs, possibly due to the higher context-dependency of verb meaning.

B33 The neural basis of concrete noun and verb meanings in congenitally blind individuals: An MVPA fMRI study

Giulia Elli[1], Rashi Pant[1], Rebecca Achtman[2], Marina Bedny[1]; [1]Johns Hopkins University, [2]DePauw University

How is the neural basis of concrete word meanings (e.g. fox, sparkle) influenced by sensory experience? We used univariate and multivoxel pattern analyses (MVPA) to compare noun and verb responsive networks between congenitally blind (N=16) and sighted (N=16, blindfolded) individuals. Participants listened to pairs

of words and judged their semantic similarity during fMRI scans. Words were blocked by semantic category. There were 4 verb categories: sound emission ("to boom"), light emission ("to sparkle"), mouth action ("to bite"), hands action ("to caress"); and 4 noun categories: birds ("the crow"), mammals ("the lion"), natural places ("the marsh"), manmade places ("the shed"). Consistent with previous findings, univariate analysis in sighted participants revealed partially non-overlapping networks active during noun (Inferior Parietal lobule, IP; Precuneus, PC; Inferior Temporal Cortex, IT) and verb processing (Middle Temporal Gyrus, MTG). We find that these networks show similar patterns of selectivity with univariate analysis in blind individuals. Using the univariate results, we defined subject-specific verb- and noun-preferring regions of interest (ROIs). Within each ROI, a linear support vector machine (SVM) classifier was trained to decode among verbs and among nouns. In both groups, we observed a double-dissociation in sensitivity to distinction among verbs and among nouns: classification was significantly more accurate for verbs than nouns in the MTG and for nouns than verbs in IP and PC (2Group x 3ROIs x 2WordType repeated-measures ANOVA: Group $F(1,30)=12.43$, $p=0.001$; ROI $F(2,60)=12.09$, $p<0.000$; WordType $F(1,30)=18.76$, $p<0.000$; Group x ROI $F(2,60)=3.37$, $p=0.04$; ROI x WordType $F(2,60)=22.32$, $p<0.000$; all other effects $Ps>0.05$). Furthermore, in IP and PC, classification among concrete nouns was successful in both groups (Sighted: IP $t(15)=9.02$, PC $t(15)=8.0$; Blind: IP $t(15)=4.76$, PC $t(15)=4.52$; $Ps<0.000$). However, MVPA revealed some between-group differences in neural responses to concrete nouns. First, classification in IT was above chance, and better for nouns than verbs, only in the sighted group (Sighted: verbs $t(15)=4.6$, $p<0.001$; nouns $t(15)=6.63$, $p<0.000$; Blind: verbs $t(15)=0.6$; nouns $t(15)=1.45$; 2Groups x 2WordType repeated-measures ANOVA: Groups $F(1,30)=22.8$, $p<0.000$; WordType $F(1,30)=9.64$, $p=0.004$; Group x WordType $F(1,30)=3.9$, $p=0.06$). Second, within noun-responsive IP and PC, the classifier discriminated between mammals and birds only in the blind group (Blind: IP $A'=0.62$, $t(15)=2.15$; PC: $A'=0.63$, $t(15)=3.93$; $Ps<0.005$; Sighted: IP $A'=0.51$, $t(15)=0.27$; PC: $A'=0.48$, $t(15)=0.34$; $Ps>0.4$; 2Group x 2ROI repeated-measures ANOVA: Group $F(1,30)=10.07$, $p=0.003$; other effects $Ps>0.3$). This was despite the fact that overall classification was better in the sighted group (Group $F(1,30)=12.43$, $p=0.001$). In the behavioral data, blind participants also judged some birds considered highly dissimilar by sighted subjects (e.g. the crow – the parrot) to be more similar ($t(29.75)=2.44$, $p=0.02$). These findings suggest that the neural basis of word meanings is similar among blind and sighted individuals, with the MTG and IP/PC preferentially representing verbs and nouns, respectively. These results are consistent with the hypothesis that these regions encode abstract representations of events/verb-meanings (LMTG) and entity concepts (IP/PC). However, when making semantic similarity judgments about taxonomically similar animals, blind individuals may rely more on the IP/PC "entity concept" network, whereas sighted subjects rely more on IT appearance knowledge.

B34 Not all "visual knowledge" are created equal: Blind individuals' judgments about animal appearance.

Judy Sein Kim[1], Giulia Elli[1], Erin Brush[1], Marina Bedny[1]; [1]Johns Hopkins University

How does the way we acquire information affect what we know and how we represent it? Are learning that tigers have stripes by seeing a picture or by reading about them in a book equivalent? We explore this question by comparing knowledge of animal appearance in individuals who are congenitally blind and those who are sighted. Previous studies show that blind individuals acquire rich information about vision. For example, blind children understand the difference between 'look' and 'see' (Landau & Gleitman, 1985). Blind adults know the relationships among colors (e.g., that red is similar to orange but not blue), as well as the meanings of visual verbs (e.g., glance vs. stare; Shepard & Cooper, 1992; Bedny et al., unpublished data). Are there types of information that are nevertheless uniquely or preferentially acquired through vision? In Experiment 1, 20 congenitally blind and 20 sighted control participants sorted cards with animal names (Braille or print) based on their shape, texture, or color. Blind participants' sorting based on shape and texture were correlated with the sighted (shape: rho=0.83, texture: rho=0.77), although not as correlated as sighted participants were with each other (comparing blind-to-sighted vs. sighted-to-sighted correlations, shape: $t(37)=1.71$, $p=0.09$; texture: $t(36)=4.16$, $p=0.0002$). In contrast, blind participants' sorting based on color was not correlated with that of the sighted (rho=0.34, $p=0.25$), although sighted participants were correlated with each other (B-S vs. S-S: $t(37)=11.66$, $p<0.0001$). For color, only blind participants' sorting was correlated with taxonomic similarity (blind: rho=0.47, sighted: rho=0.08), suggesting that blind participants use knowledge about taxonomy to infer animal colors. One possible explanation for blind individuals' lack of agreement with the sighted on color sorting is that animal colors are difficult to describe using language. To test whether sighted individuals can verbalize distinctions in shape, texture, and color, a second group of sighted participants (Experiment 2, n=14) were asked to provide descriptions of animals for each dimension (e.g., "Describe the shape of the animal so that someone who knows nothing about animals can pick it out from a book of photographs"). Contrary to predictions, sighted subjects were able to describe best the dimension about which blind participants know least: color. Sighted participants' descriptions closely matched the sighted groups' sorting from Experiment 1 for color (rho=0.65) and texture (rho=0.8). By contrast, shape descriptions deviated from sighted participants' shape sorting (rho=0.4). Thus, verbalizability does not fully account for which aspects of

animal appearance blind individuals acquire. Arbitrary object-color mappings may be unlikely to be learned, even though they are linguistically available. These results suggest that not all "visual knowledge" are created equal. Sighted but not blind individuals may learn animal colors because they are behaviorally relevant for referent identification or because they are easier to learn through the visual modality. By contrast, blind individuals may preferentially acquire knowledge about visual appearance that is structured (e.g. into a similarity space or schema), and behaviorally or inferentially relevant (e.g. look vs. see and stare vs. peek).

Language Therapy

B35 Effects of auricular vagus nerve stimulation on novel orthography acquisition: a pilot study

Tracy Centanni[1], Vishal Thakkar[1], Alexis Jefferson[1], Carly Stacey[1], Navid Khodaparast[2]; [1]Texas Christian University, Fort Worth, TX, USA, [2]Nexeon MedSystems Inc., Dallas, TX, USA

For typically developing adults as well as for children with dyslexia, the acquisition of a novel orthography is a difficult task and fluency is often unattainable. While the brain is hardwired for language, the reading network must be allocated and optimized from scratch in every individual brain. In dyslexia, the visual word form area is often hypoactivated and recent studies suggest this lack of involvement may lead to poor fluency. Invasive cervical vagus nerve stimulation (cVNS) can drive plasticity in the adult brain and has shown recent promise in the treatments of tinnitus and post- stroke motor impairment. This invasive approach is not practical for reading-based interventions. However, the auricular nerve, a branch of the cervical vagus nerve, innervates the cymba conchae region of the outer ear and projects to similar brain regions as cVNS. This pilot study evaluated whether or not this non-invasive form of vagus nerve stimulation could be useful in driving plasticity for newly learned letter-to-sound correspondences. Adults between the ages of 18-24 years old were recruited for this study. All participants had no history of reading or language impairment, ADHD, or other neurological diagnoses, scored in the average range on nonverbal IQ and reading measures, and were not taking any medications at the time of the study. Participants completed ten 30-minute training sessions in which they learned letter-to-sound correspondences in Hebrew. Participants were randomly assigned to one of two control conditions (training with an in-person tutor vs. a customized computer program) or the active stimulation group. In the active group, participants completed the computer-based training program while receiving low levels of electrical stimulation to the left cymba conchae. Participants were tested at 3 time points to track progress on letter identification, rapid letter reading, and pseudoword reading: once at the halfway point, (on Day 6) once on the final day of lessons (on Day 10), and once more at least a week following their final lesson (retention). Participants receiving stimulation were monitored daily to ensure no adverse reactions to the intervention and to ensure the level of current was well within tolerable levels. There were no differences in performance between the two control groups, so these groups were combined for comparison with the active stimulation group. The active stimulation group exhibited faster reading times and higher accuracy on pseudoword reading compared to the control group as early as day 6. We present these findings as well as the longer-term performance of the stimulation group and possible behavioral predictors of individual success in the training program. This pilot study demonstrates for the first time that non-invasive auricular vagus nerve stimulation may be a valuable tool in improving reading acquisition and fluency not only in a typically reading adult, but perhaps also in individuals with dyslexia. Additional studies are ongoing in our lab to optimize the parameters of this approach for maximum improvement, evaluate the neural correlates of this training, and to evaluate its efficacy in populations with communication disorders.

B36 French version of the Phonological Component Analysis: Preliminary results with three participants

Michele Masson-Trottier[1,2], Karine Marcotte[1,2], Carol Leonard[3,5,6], Elizabeth Rochon[3,4,5,7], Ana Inés Ansaldo[1,2]; [1]Centre de recherche de l'Institut de gériatrie de Montréal, [2]École d'orthophonie et d'audiologie, Université de Montréal, [3]Department of Speech-Language Pathology, Faculty of Medicine, University of Toronto, [4]Toronto Rehabilitation Institute – University Health Network, [5]Heart and Stroke Foundation, Canadian Partnership for Stroke Recovery, [6]Audiology and Speech-Language Pathology Program, School of Rehabilitation Sciences, University of Ottawa, [7]Rehabilitation Sciences Institute, University of Toronto

Anomia is the main symptom, and most persistent aphasia sign. Among anomia therapy procedures, Phonological Component Analysis (PCA) has been proven effective in improving the naming capacities of some English-speaking persons with chronic aphasia [1]. PCA uses phonological cues associated with the target word to elicit naming. The present study aims to identify the effects of an adapted French Canadian PCA therapy [2] on the accuracy and response time (RT) of native French speakers with aphasia. The present work, part of a larger ongoing study, presents the preliminary results of three chronic aphasia participants. Each participant received 1 hour of PCA therapy, 3 times per week for 5 weeks (total of 15 hours). Considering the variability of responses to individual items on a day-to-day basis [3], the average performance (accuracy and RT) on the first week of therapy was compared to the average performance of the last week using a related sample – Wilcoxon test. The scores on the Test de Dénomination de Québec: TDQ-60 [4] were also compared before and after therapy to measure generalization. At the group level, the therapy was effective at improving accuracy (rate)

(from 0.28±0.45 to 0.59±49, p<0.0001) and RT (in seconds) (from 27.4±31.0 to 17.6±16.1, p=0.012). At the individual level, 2/3 participants showed a significant improvement for accuracy (PA01: from 0.30±0.46 to 0.63±0.48, p=0.002, PA02: from 0.32±0.47 to 0.83±0.38, p<0.0001) and RT (PA01: N.A., PA02: from 26.3±21.7 to 14.0±17.8, p=0.001) on treated items. The third participant did not reach a significant level of improvement at the last week (PA03, accuracy: from 0.22±0.41 to 0.32±0.47, p=0.239, RT: from 31.8±55.4 to 21.6±13.14, p=0.158). On the TDQ-60, PA01 did not improve (from 36 to 33 out of 60), whereas both PA02 and PA03 both improve (respectively, from 24 to 42 and from 15 to 22). The results replicate results obtained in previous work1, PCA leads to improvements in naming for some aphasic participants. It is important to continue this work to find markers predicting the effectiveness of this therapy. In addition, future studies will examine the neurobiological substrates supporting the effectiveness of PCA. [1] Leonard, C., Rochon, E. & Laird, L. Aphasiology 22, 923-947 (2008). [2] Masson-Trottier, M., Marcotte, K., Léonard, C., Rochon, E. & Ansaldo, A. I. in Academy of Aphasia – 55th Annual Meeting (Baltimore, USA, 2017). [3] Stark, J., Renn, F. & Kambitsis, T. Frontiers in Psychology, doi:10.3389/conf.fpsyg.2016.68.00113. [4] Macoir, J., Beaudoin, C., Bluteau, J., Potvin, O. & Wilson, M. A. Aging, Neuropsychology, and Cognition, 1-14 (2017).

Language Disorders

B37 Leukoaraiosis Predicts Naming Outcomes after Treatment in Aphasia

Lisa Johnson[1], Alexandra Basilakos[1], Brielle C. Stark[1], Sigfus Kristinsson[1], Bonilha Leonardo[2], Chris Rorden[3], Julius Fridriksson[1]; [1]University of South Carolina Department of Communication Sciences and Disorders, [2]Medical University of South Carolina, [3]University of South Carolina Department of Psychology

Background Baseline aphasia severity and lesion volume has frequently been found to account for the greatest amount of variance in language recovery. In addition to these factors, it is likely that overall brain health, which is important for neuroplasticity and is characterized by measures of functional and structural integrity, may predict language recovery. In this study, we used contralesional leukoaraiosis (white matter hyperintensities attributed to, for example, artherosclerotic disease) as a surrogate measure of brain health. Based on prior work showing that the presence of leukoaraiosis negatively influences stroke outcomes, we predicted that those individuals with chronic aphasia demonstrating more advanced leukoaraosis in the contralesional hemisphere would make less or no improvement following speech-language treatment. This is the first study, to our knowledge, using leukoaraiosis as a potential predicting factor in aphasia recovery. Aims The purpose of this study was to determine whether leukoaraiosis can predict naming outcomes after treatment in individuals in the chronic stage of aphasia recovery. Methods Behavioral and neuroimaging data from 14 participants (3 F, age, M=63.14±7.9 years) in the chronic phase of stroke (months post-onset, M=73.2±61.2) were included. These data were obtained from a larger database as part of an ongoing study investigating factors that predict chronic aphasia recovery. Mean baseline aphasia quotient (AQ), a measure of aphasia severity obtained from the Western Aphasia Battery (WAB), was 46.2 (SD=14). All participants completed three weeks of daily aphasia therapy. The Philadelphia Naming Test (PNT) was administered at baseline and immediately following treatment. Proportional changes in PNT scores were used as the primary dependent variable. In addition, we obtained high-resolution T2 MRI scans for all participants. Leukoaraiosis severity was scored on T2 MRI scans using the modified Fazekas scale, where periventricular hyperintensities (PVH) and deep white matter hyperintensities (DWMH) are rated on a 4-point scale (0 being absent, 3 being severe). Fazekas scores, lesion volume, and baseline aphasia severity were separately correlated with proportional change in correct naming and subsequently compared using Fisher r-to-z transformation. Results Baseline WAB AQ, lesion volume, and PVH were not correlated with proportional change in correct naming (r=-0.26, p>0.05 for all); however, the correlation between DWMH and proportional change in correct naming resulted in a significant correlation (r=-0.85, p<0.0001). That is, higher DWMH ratings were significantly correlated with worse naming outcomes. Moreover, using Benjamini and Hochberg multiple comparison correction, the strength of the correlation between DWMH and naming outcomes was significantly greater than the relationship between naming outcomes and AQ (z=0.28, p=0.20), lesion volume (z=0.28, p=0.21) and PVH (z=0.37, p=0.37). Summary Given the small sample size, these results are preliminary. However, our results suggest that brain health, as measured by contralesional leukoaraiosis, provide an additional variable to consider for predicting recovery. Results from this study indicate general brain health should be considered when investigating neural correlates of disordered language, rather than lesion and baseline severity factors alone.

B38 Oscillatory dynamics during lexico-semantic retrieval: Evidence for neuroplasticity of language in patients with left-hemisphere temporal tumors

Shuang Geng[1], Lucia Amoruso[1], Polina Timofeeva[1], Santiago Gil Robles[2], Íñigo Pomposo[2], Nicola Molinaro[1,3], Manuel Carreiras[1,3]; [1]BCBL,Basque Center on Cognition, Brain and Language, San Sebastian, Spain, [2]Neurosurgery Cruces University Hospital. BioCruces, Bilbao, Spain, [3]Ikerbasque, Basque Foundation for Science, Bilbao Spain

M/EEG studies investigating the oscillatory dynamics subserving language production suggest that word retrieval might be functionally related to power changes in low-frequency bands (theta and alpha). However, little is known about how oscillatory activity within this frequency range is modulated in patients with tumors in the temporal lobe, a brain region typically associated to semantic

processing. We recorded magnetoencephalographic (MEG) signals from 5 patients with tumors in their left temporal lobe while they performed a picture-naming task before and 3 months after surgery. The basic idea behind this task is that the picture represents the concept to be expressed and thus, naming the picture, requires access to lexical memory. We performed time–frequency analysis to examine how power varied during word retrieval before and after surgery. In line with previous studies, we found modulations in the theta-alpha frequency range during lexico-semantic retrieval. More specifically, we found left-lateralized post vs. pre significant differences in these frequency bands in the time window were previous effects on lexical access have been reported (from ~200ms after picture onset up to ~500ms). Overall, these results suggest that theta-alpha frequencies are involved in lexical-semantic retrieval and that the presence of tumors in temporal areas induce plastic functional changes in the neural oscillatory dynamics associated to word retrieval.

B39 Predictive Neural Correlates of Action Naming and Recovery in Chronic Stroke Patients

Lynsey M Keator[1], Shannon M Sheppard[1], Kevin Kim[1], Sadhvi Saxena[1], Amy Wright[1], Rajani Sebastian[1], Argye E Hillis[1,2,3]; [1]Department of Neurology, Johns Hopkins University School of Medicine, [2]Department of Physical Medicine and Rehabilitation, Johns Hopkins University School of Medicine, [3]Department of Cognitive Science, Krieger School of Arts and Sciences, Johns Hopkins University

Introduction: Anomia is a common consequence following neurological damage and affects both object and verb naming (Hillis & Caramazza, 1995; Hillis et al., 2006; Thompson et al., 2012; Tranel et al., 2001; Zingeser & Berndt, 1990). Previous studies have identified neural correlates critical to action naming; however, few have examined these impairments longitudinally or considered acute lesions for prognosis. Brodmann area 37 (inferior temporal gyrus, fusiform gyrus) (Ardila, Bernal, Rosselli, 2015) is commonly associated with involvement across domains of visual recognition (perception) and semantic language function. We tested the hypothesis that behavioral impairments specific to action naming and semantic processing were associated with left hemisphere lesion volume and location and that these acutely identified areas are predictive of impairments at the chronic stage; greater damage results in compromised action naming and semantic processing. Methods: In this study, we recruited, consented, and assessed participants with unilateral left hemisphere ischemic strokes within 48 hours of stroke and then assessed the same group chronically (6-12 months post stroke). The cohort included 14 participants (6 women) aged 28-87 years (M=55.85; SD= 12.52). The Hopkins Action Naming Assessment, short form (HANA; Breining, et al., 2015a) and Pyramids and Palm Trees Test, short form (PPTT; Breining et al., 2015b) were administered to assess naming abilities specific to verbs and amodal semantic processing, respectively. All participants received an acute MRI scan, including diffusion weighted-imaging (DWI). Areas of acute ischemia were traced on DWI scans. We normalized DWI images and lesion tracings and calculated proportion of damaged tissue in each of the parcels of the Brodmann atlas (82 areas) for each participant. The analysis regressed lesion volume and relied on permutation thresholding (5000 permutations; $p<0.05$). Only regions where at least two participants had damage were included. Scores from the HANA and PPTT at acute and chronic time points were associated with acute lesions to calculate percent of voxels damaged. Results: At the acute time point, participants achieved a mean score of 21 (SD= 9.72) on the HANA and mean score of 13.78 (SD=.42) on the PPTT. Acutely, impaired action naming and semantic processing were associated with Brodmann area 37 (Z= 2.07, Z=1.69). Nine patients showed improvement at the chronic time point in the HANA with a mean score of 24 (SD= 7.72) and all fourteen participants scored 14 (equivalent to 100% accuracy) in the PPTT. Longitudinally, participants' HANA scores were associated with Brodmann areas 30 (Z=2.63) and 37 (Z=3.10). Conclusions/Summary: The results of the lesion mapping analysis indicate the importance of Brodmann area 37 in action naming at the acute stage, and also after cortical reorganization of language functioning preceding the chronic stage of recovery. We found acute lesions are indicative of recovery patterns; those with acute damage to Brodmann area 37 demonstrated poorer outcomes in action naming at the chronic stage, even when there were no chronic semantic processing deficits. Localization of acute lesions and lesion mapping are imperative considerations when considering recovery, therapy outcomes, and prognosis.

B40 Functional modularity supports treatment-induced recovery in chronic aphasia

Yuan Tao[1], Brenda Rapp[1]; [1]Johns Hopkins University

Network analyses of functional connectivity have revealed that the brain is organized in a non-random, modular structure consisting of densely inter-connected clusters (or modules) of brain regions. Critically, modular structure relies on two types of "hubs": "local hubs" that connect regions within one module, and "global hubs" that facilitate communication between modules. Modular structure in functional connectivity has been linked to cognitive performance in healthy populations (e.g. Bassett et al., 2011) and various neurological disorders (e.g. Bucker et al., 2009; Lynall et al., 2010; Duncan & Small, 2016). Understanding how lesions affect modularity structure can provide critical insights into neural plasticity. Computer simulation research predicts that lesions affecting hub areas will have the most widespread effects (Honey & Sporns, 2008). However, the consequences of actual lesions and how they relate to behavior is less clear. In the current study, we evaluated the modular structure in participants with acquired dysgraphia (n=15, 4 females, age 61+/-10) resulting from a left-hemisphere

stroke (>1 year post-stroke), and examined the change of the modularity measure (Newman, 2006) in relation to intensive behavioral treatment for dysgraphia. FMRI data were collected while participants performed a spelling task before and after the intervention. We estimated the whole-brain functional connectivity (lesioned regions excluded) for each participant at each time-point, and calculated modularity based on a modular structure derived from an age-matched, healthy control group performing the same scanner task. Results We found a significant increase in modularity from pre- to post-treatment ($p<0.01$). Regression analysis demonstrated that higher modularity scores before treatment were related to less severe deficits ($p<0.05$) and greater treatment gains ($p<0.1$), suggesting that higher modularity scores index a system with higher functionality which might, in turn, retain greater re-learning capacity. The effects were similar in both the ipsilesional (LH) and contralesional hemispheres (RH). To investigate the underlying bases for the observed modularity increases, we identified the global and local hubs from the control data and examined their connectivity properties in the lesioned brains. The global hubs (i.e., inter-module connectors) exhibited no differences between the lesioned and the control group, neither at pre nor post-treatment. In contrast, the local hubs (i.e., within-module connectors) exhibited lower within-module density in the lesioned participants and, furthermore, these values increased significantly from pre to post-treatment. These results indicate that the lesions primarily affected the within-module connectivity that was strengthened by the treatment, supporting the observed improvements in spelling. Conclusion We used modularity, a graph-theoretic measure, to assess the neural integrity of the functional connectivity of participants with chronic stroke-induced dysgraphia before and after behavioral treatment. We found that modularity indexed deficit severity and extent of re-learning such that an increase in modularity was associated with behavioral improvement. Consistent with other network-based connectivity studies (e.g. Gratton et al., 2012), our findings demonstrate that modular structure is an important organizing principle of the brain and that modularity can be a useful tool for evaluating post-stroke neural re-organization.

B41 Receptive but not expressive language relates to age-equivalent of auditory event-related potentials in children with autism spectrum disorder

Elaine Kwok[1], Edwin Dovigi[2], Janis Oram Cardy[1]; [1]University of Western Ontario, [2]Rush University Medical College

Introduction: One contributing factor to language impairment is proposed to be immature cortical processing of sounds (McArthur & Bishop 2004). Bishop et al. (2011) and Kwok et al. (2018) demonstrated the utility of estimating age-equivalents for auditory event-related potentials (AEP) to study its relation with language ability. To do so, intra-class correlation (ICC) was calculated between a child's AEP waveform with a range of normative AEP grand averages across different age bins. The normative grand average waveform that yielded the highest ICC, indicating the highest correlation/resemblance with the child's AEP, was taken as the AEP-age-equivalent (AEP-age) for this child. In previous work, we tested this new index of cortical maturation in children with developmental language disorder (DLD, also known as specific language impairment, SLI). AEP-age not only explained 31% of variance in the language ability in children with DLD, it predicted receptive, but not expressive language ability (Kwok et al., in press). This finding suggests that the maturity of sound perception, as reflected by AEP-age, may support the development of language comprehension, whereas other cognitive processes may influence the development of language production. In children with autism spectrum disorder (ASD), the role of AEP-age across the domains of language has not been explored. This study asked whether AEP-age relates to expressive, receptive or both domains of language. Methods: AEPs in response to 225 trials of a 50ms, 490Hz tone were recorded using a 128-channel EEG system from 98 children aged 7-11 years (typical development: N=78, ASD: N=21). All children scored within the typical range (i.e. >85) on the non-verbal IQ portion of the Wechsler Abbreviated Intelligence Scale and completed the core language subtests of the Clinical Evaluation of Language Fundamentals – 4. Children with typical development scored within normal range on the language test. Based on chronological age, the AEPs from children with typical development were used to create four normative grand averages of 7-, 8-, 9- and 10-years old (N= 20, 21, 22, 15 respectively). Using ICC, the AEP waveforms of each child with ASD were compared to each of these four normative grand averages at frontal electrodes (F3, Fz, F4) to estimate AEP-age. Correlation analysis was used to explore the relation between AEP-age and an expressive language subtest (i.e., Recalling Sentences) and a receptive language subtest (i.e. Concepts and Following Directions). Results: Children with ASD had an average age of 9.1 years (SD = 1.6), non-verbal IQ of 109 (SD = 18) and language standard score of 91 (SD = 17). The average AEP-age was 8.2 years (SD= 1). AEP-age related to receptive language ($r = 0.46$, $p = 0.04$) but not expressive language ($r = 0.23$, $p = 0.33$). Conclusion: Maturity of auditory cortical processing, estimated using AEP-age, may underlie receptive but not expressive language ability in ASD. Future work should explore the mechanism by which auditory cortical maturation may impact receptive language development.

B42 Neurofunctional correlates of overall language function in aphasia

Jillian M. Lucanie[1], Sarah M. Schneck[1], Dana K. Eriksson[2], Melodie Yen[1], Deborah F. Levy[1], Ian Quillen[1], L. Taylor Davis[1], Wayneho Kam[1], Howard S. Kirshner[1], Michael de Riesthal[1], Stephen M. Wilson[1]; [1]Vanderbilt University Medical Center, [2]University of Arizona

Aphasia is caused by damage to left hemisphere language regions, but language function in individuals with aphasia is the product not of the damage itself, but of the network of surviving regions. We used functional MRI in a diverse group of individuals with post-stroke aphasia to address two basic questions: (1) Which brain regions are involved in language processing in aphasia? (2) Are there any brain regions where functional activity is predictive of better overall language function? Critically, we addressed these questions using an adaptive semantic matching paradigm, which we have previously shown to be feasible, reliable and valid for identifying language regions in people with and without language impairments. Thirty-four individuals with subacute or chronic post-stroke aphasia took part in the study (age: 55.6 ± 15.0 years (range 24–80 years); 20 male, 14 female; 32 right-handed, 2 left-handed; time post onset 18 days–11 years). Aphasia was characterized with our Quick Aphasia Battery (QAB), and varied widely in severity: QAB overall score (out of 10) = 6.4 ± 2.5, range = 0.9–9.7. Random effects analyses were thresholded at voxelwise $p < 0.005$, then corrected for multiple comparisons using Gaussian random field theory. We found that as a group, people with aphasia recruited strongly left-lateralized inferior frontal and posterior temporal regions to perform the adaptive semantic matching task ($p < 0.001$), very similar to the previously reported pattern in neurologically normal participants. This suggests that surviving left hemisphere language regions continue to be responsible for language processing in post-stroke aphasia. We then correlated task-induced signal change with overall language function (QAB overall score). Two regions showed positive correlations between activation and overall language function. One was the left posterior superior temporal sulcus (pSTS) (2.46 cc, $p = 0.046$), which was one of the regions involved in the group average map described above. This finding was not surprising, since this is a critical language area where structural damage or dysfunction is known to impact language processing. The other region where activity correlated positively with language function was the homotopic area in the right pSTS (3.18 cc, $p = 0.013$). Comparison to data from neurologically normal participants showed that this correlation did not reflect reorganization of language to the right pSTS, since signal change in patients with better overall language did not exceed the normal range. Rather, the correlation may reflect either variable premorbid capacity of the right hemisphere to partially support language processing, or it may be a downstream consequence of the damage or dysfunction of the left pSTS. In sum, our findings suggest that most individuals with aphasia largely continue to process language using surviving left frontal and posterior temporal regions, of which only the latter are predictive of overall language function. There is little evidence for wholesale reorganization to the right hemisphere, but some evidence that the pre-existing linguistic capacity of the right hemisphere may be relevant for predicting outcome when left hemisphere language regions are damaged.

B43 Predicting naming responses based on pre-articulatory electrical activity in individuals with aphasia

Janina Wilmskoetter[1,2], John Delgazio[2], Lorelei Phillip[3], Roozbeh Behroozmand[3], Ezequiel Gleichgerrcht[2], Julius Fridriksson[3], Leonardo Bonilha[2]; [1]Department of Health Sciences and Research, College of Health Professions, Medical University of South Carolina, Charleston, SC, [2]Department of Neurology, College of Medicine, Medical University of South Carolina, Charleston, SC, [3]Department of Communication Sciences and Disorders, University of South Carolina, Columbia, SC

Background: Anomia – trouble with naming – is among the most common symptom of language processing due to neurological disorders, including post-stroke aphasia. Virtually all individuals with aphasia, independently of aphasia type or syndrome, present word-finding deficits with varying degrees. Importantly, naming errors are unpredictable and vary across testing sessions. Thus, they are not item specific, but likely relate to the insufficient emergence of appropriate patterns of neural activity. In the study presented here, we sought to investigate whether pre-articulatory neural activity can be systematically used to predict individualized naming error responses in individuals with aphasia. Methods: We performed 64-channel high density electroencephalography (EEG) on one individual with chronic post-stroke aphasia (59 year old male, 13 years since stroke) during naming of 80 concrete images. Time between image (stimulus) presentations was 8 seconds and the subject's responses were audio-recorded, transcribed and classified into correct and incorrect responses. Using Curry 8, we pre-processed the EEG signal and calculated stimulus-locked event-related potentials (ERPs) for a time range of 0ms to 1500ms after stimulus presentation. We applied deep machine learning with recurrent convolutional neural networks to predict correct and incorrect responses. Results: After preprocessing of the EEG signal, 69 of the 80 stimuli met the criteria to be included for analysis. Of those, the patient named 49 correctly and 20 incorrectly. Using the pre-articulatory EEG signal, we were able to predict correct and incorrect responses with an accuracy of >70%. Conclusions: Our findings indicate that it is possible to predict correct and incorrect naming responses based on pre-articulatory neural activity. Future research is needed to improve prediction accuracy, and extend applicability to other individuals with aphasia. We believe that that this line of research has the potential to guide the development of new treatment approaches that take neural activity into consideration.

B44 Data-driven Aphasia Sub-Typing using Lesion-Symptom Mapping and Community Detection Analysis

Jon-Frederick Landrigan[1], Daniel Mirman[2]; [1]Drexel University, [2]University of Alabama at Birmingham

Models of aphasia sub-types typically focus on the distinction between the production and comprehension of speech. However, recent studies suggest that this fails to account for the full spectrum of deficits associated with aphasia and there is inconsistent relationships between lesion site and aphasia sub-type. The accumulation of data from people with aphasia in publicly available databases, combined with the development of advanced analytical techniques, provide a new opportunity to investigate the neural correlates of aphasia and language processing. The current project consisted of two parts, each of which combined two analysis methods: lesion-symptom mapping and community detection analysis (CDA), a clustering technique from network science that attempts to uncover groups of nodes in a network that are densely connected to each other and sparsely connected to other groups. The first used CDA to cluster 134 patients based on their behavioral deficit profiles across 20 different language assessments and identified three clusters: patients in cluster 1 had relatively mild deficits as compared to those in clusters 2 and 3. Patients in cluster 2 had primarily phonological deficits and patients in cluster 3 had primarily semantic deficits. Voxel-based lesion-symptom mapping (VLSM) comparisons were used to identify the lesion correlates of each cluster. Cluster 1 was associated with damage to a number of areas spanning from frontal to parietal regions. Cluster 2 was primarily associated with damage to the supramarginal gyrus extending anteriorly into the postcentral gyrus and cluster 3 was primarily associated with damage to frontal areas. The second part worked in the opposite direction. First VLSM analyses were used to identify the lesion correlates of deficits on the same 20 measures of language performance, including a general aphasia assessment (WAB), measures of speech production and comprehension, and semantic processing. These results were mapped to the Human Connectome Project template of 180 left hemisphere regions within the lesion territory. Then CDA was run to find clusters of neural regions that showed similar associations between lesion status and behavioral performance. This CDA identified 3 distinct clusters of neural regions. Cluster 1 primarily consisted of frontal regions and was associated with deficits on measures of verbal semantics (e.g., semantic errors in picture naming, synonym judgments). Regions in cluster 2 were typically found in peri-Sylvian and parietal areas and were associated with phonological processing and cluster 3 was comprised of frontal regions that were associated with deficits on visual semantics and/or semantic control (Camel and Cactus Test). Importantly, the results of these two analyses align at both the behavioral and neural level: the primary distinction was between semantic and phonological processing, with frontal regions critical for the former and peri-Sylvian regions critical for the latter. These results suggest that models of language processing and aphasia should focus first on semantic and phonological processing and then their downstream affects on speech production and comprehension.

B45 The progression of leukoaraiosis and the integrity of perilesional tissue predict changes in language abilities

Alexandra Basilakos[1], Lisa Johnson[1], Leonardo Bonilha[2], Brielle Stark[1], Chris Rorden[1], Grigori Yourganov[1], Julius Fridriksson[1]; [1]University of South Carolina, [2]Medical University of South Carolina

The presence of leukoaraiosis in stroke survivors may be an indicator of worse recovery outcomes. Leukoaraiosis is the result of macrostructural changes in the brain's white matter attributed to ischemic changes, artherosclerotic disease, and reductions in cerebral blood flow. Although lesion volume often accounts for the greatest amount of variance in aphasic outcomes, no study has investigated the concomitant effect of leukoaraiosis in long-term outcomes in chronic post-stroke aphasia. Accordingly, this study investigated the extent that the progression of leukoaraiosis, in addition to changes in perilesional grey and white matter (GM, WM), predict changes in language abilities. Methods: Behavioral testing and neuroimaging data from 38 participants (11F, mean age at first test=58.1,SD=10) in the chronic stage of stroke recovery were obtained from two time points (mean months post-onset, MPO, at time 1=40.6,SD=50; MPO at time 2=70.5, SD=60). The Western Aphasia Battery (WAB) aphasia quotient (AQ) was used to measure aphasia severity at both time points, and proportional change in WAB AQ and WAB subscores (spontaneous speech, repetition, naming, comprehension) served as the primary dependent measures for all analyses. All participants had T1 and T2 scans from the time of behavioral testing. The Fazekas scale was used to rate leukoaraiosis in the contralesional hemisphere on all T2 scans. Raters were blind to time point and participant test scores. GM and WM volumes were obtained from all T1 scans using SPM12's unified segmentation-normalization procedures. An in-house script estimated perilesional tissue, with the following procedures: i) hand-drawn lesions were dilated 5mm in each dimension, and the original lesion was subtracted from the dilated volume, leaving a "shell" 5mm in thickness; ii) a brain mask was constructed so only voxels inside the brain were analyzed; iii) GM and WM volumes inside each 5mm shell were estimated for each participant for each scanning session. Changes in overall Fazekas scores and perilesional GM and WM volumes between scanning sessions were entered as independent variables in a series of stepwise multiple regression analyses predicting language changes. Analyses were controlled for months between scanning sessions. Results: Regression models were significant for predicting proportional changes in spontaneous speech [F(2,37)=6.7, p=0.003, adjusted R2=.24], comprehension [F(2,37)=5.3,p=0.01, adjusted R2=.19], repetition [F(1,37)=4.9,p=0.03, adjusted R2=.10], and naming [F(1,37)=9,p=0.008, adjusted R2=.16]. The model predicting change in AQ was not significant. Increased perilesional GM in ventral stream areas (B=0.56,p=0.001), together with increased perilesional WM (B=0.38, p=0.22),

were the best predictors of improvements in spontaneous speech. The progression of leukoaraiosis (B=-0.49,p=0.005), along with increased perilesional GM in dorsal stream areas (B=.40, p=0.029) accounted for the greatest amount of variance in changes in comprehension. The progression of leukoaraiosis was the only significant predictor of declines in repetition (B=-0.35, p=0.33) and naming performance (B=-0.43,p=0.008). Conclusions: Results suggest that in addition to perilesional changes, the progression of leukoaraiosis accounts for a significant amount of variance in aphasic performance over time. Future studies that relate brain damage to impairments should consider including measures of white matter integrity, as overall brain health contributes to lesion-symptom predictions.

Language Development

B46 Developmental differences in the neural mechanisms supporting natural sentence comprehension

Julie Schneider[1], Mandy Maguire[1]; [1]Callier Center for Communication Disorders, University of Texas at Dallas

Introduction: Language comprehension requires millisecond level processing of semantic and syntactic information, yet children seem to integrate and comprehend all of this information with relative ease. Although this is done effortlessly, developmental differences exist in the speed by which children process speech (Bates, Dale & Thal, 1995; Nippold, 1988). By understanding how variation in the developmental time-course of semantics and syntax may contribute to individual differences in language comprehension, we may lay a foundation to better understand how language develops in atypical populations (Thomas & Karmiloff-Smith, 2005). This study uses electroencephalography (EEG) to investigate how early school-age children, late school-age children, and adults process semantics and syntax in naturally paced sentences. Methods: Children ages 8-9 years 9 (Mage=9.1, SDage=.60), 12-13 years 13 (Mage=12.8, SDage=.58), and adults (Mage=22.2, SDage=3.9) listened to 160 semantically and syntactically correct and incorrect naturally-paced sentences and were asked to complete an acceptability judgment task. All sentences included an inanimate noun paired with a modal verb and action verb. Grammatically incorrect sentences included either the intrusion or omission of a present participle (-ing) form of the verb (i.e., will baking, will be bake). The semantic violation introduced an unsuitable pairing of actions with agents (i.e., hose-bake). Analysis: EEG data was epoched from 500 msec before to 1500 msec after the target verb onset. Only trials in which participants responded to correctly were included in the analysis. ERPs. The mean amplitude of the pre-stimulus interval (-100 to 0 msec) was subtracted from each time point in the post-stimulus interval. Single trials were averaged together to obtain a stable waveform ERP for each condition and each electrode for every subject. Time-Frequency. The mean ERSP was computed for all data channels (3-30 Hz) and a morlet wavelet was applied to each epoch. The mean baseline power at each electrode and frequency was subtracted. Statistical significance was determined using a monte-carlo permutation analysis similar to that used by Maris and Oostenveld (2007). Results & Conclusions: When processing a semantic error, there were no developmental differences in the N400; however, increases in theta, related to semantic processing, were greater for 8-9 year olds than 12-13 year olds and adults. Therefore, the N400 may be too gross a measure to identify more subtle aspects of semantic development that are ongoing in early school-aged children. Consistent with previous research, syntactic errors resulted in a larger P600 and greater beta decrease than correct sentences (Bastiaansen et al., 2010; Davidson & Indefrey, 2007; Hagoort, Brown & Groothusen, 1993), but the location of the P600 and the amplitude of beta decreases differed as a function of age. These findings suggest specialization of syntactic skills is ongoing through adolescence and children may recruit an alternative neural process to identify a syntactic error, which beta is not sensitive to. Discussion: Our findings suggest the neural substrates underlying semantic processing reach adult-like levels at a younger age, while syntactic skills develop over a protracted time course and may require recruitment of additional neural mechanisms to support comprehension of natural language.

B47 Does grapheme knowledge or phonological awareness determine detailed speech perception in preliterate children?

Anne Bauch[1], Claudia K. Friedrich[1], Ulrike Schild[1]; [1]University of Tuebingen, Germany

Literacy acquisition might modulate implicit aspects of speech recognition: Reading children might exploit more acoustic detail and/or might command more fine-grained word form representations than children who are not able to read yet (Schild, Röder, & Friedrich, 2011). Here we test whether letter knowledge or phonological awareness mediate more elaborated speech processing. German preschoolers (5 to 6 years old) participated in three different types of training: One group received a phonological-only training, in which we instructed participants about how selected German phonemes sound and vary. A second group with the same phonological training additionally learnt about the letters that correspond to these selected German phonemes (phonological-orthographic training). A control group received a training on early numerical skills. All children completed tests on explicit phonological awareness and letter knowledge before and after the training. After intervention, children additionally conducted an auditory word onset priming experiment. Prime-target combinations either matched in the initial phoneme (Identity condition, e.g., “Ki - Kino”), differed in the initial phoneme’s voicing feature (Variation condition, e.g., “Gi - Kino”) or were unrelated (Control condition, e.g., “Ba - Kino”). We recorded children’s lexical decision latencies and event

related potentials (ERPs) to the target words. We expected training effects for both phonological groups in the explicit phonological awareness measurements, and a training effect for letter knowledge in the combined phonological-orthographic group. In general, we took facilitated responses and ERP amplitude differences (compared to the control condition) as indices of facilitated lexical access exerted by the primes. In particular, we took responses to target words in the variation condition as indicating the phonemic detail that listeners use for lexical access. If phonological awareness modulates implicit aspects of spoken word recognition, mismatching phonemic detail should restrict lexical access in both phonological training groups. If letter knowledge modulates implicit aspects of spoken word recognition, mismatching phonemic detail should restrict lexical access especially in the phonological-orthographic group. While all groups improved over time in explicit phonological awareness and letter knowledge, both phonological training groups gained more scores in a standardized phonological awareness test compared to the control group. Moreover, the phonological-orthographic training group gained more knowledge in trained letters that the other two groups. Analyses of the response latencies revealed faster reaction times in the Identity condition compared to the Variation and Control condition for all groups. ERPs showed facilitated processing of the Identity condition compared to the Variation condition for both phonological groups but not for the control group. Both phonological groups differed in ERP morphology: Children receiving phonological-orthographic training showed left-anterior amplitude differences. Taken together the results indicate that phonological awareness rather than grapheme knowledge might modulate the accuracy of speech processing. However, grapheme knowledge might contribute to the development of adult-like left-lateralized implicit speech perception. Schild, U., Röder, B., & Friedrich, C. K. (2011). Learning to read shapes the activation of neural lexical representations in the speech recognition pathway. Developmental Cognitive Neuroscience, 1, 163□174.

B48 Tracking the time course of statistical learning in pre-lingual infants: online evidence from neural entrainment

Laura Batterink[1,2], Dawoon Choi[3], Alexis Black[3], Ken Paller[1], Janet Werker[3]; [1]Northwestern University, [2]University of Western Ontario, [3]University of British Columbia

Both linguistic processing and implicit learning can be tracked via endogenous brain rhythms that synchronize to exogenous stimuli (Ding et al., 2016; Batterink and Paller, 2017). Statistical learning (SL) refers to the ability to detect structure in the environment and is one of the mechanisms by which infants may learn to segment words from a continuous stream of speech sounds (Saffran, Aslin, & Newport, 1996). Although statistical learning in infants has been demonstrated behaviourally through offline looking-time measures, these measures are influenced by memory retrieval processes and other peripheral factors, and are unable to track learning directly. To begin to bridge this gap, we used electroencephalography (EEG) to track SL in 6-month-old infants. Twenty-four infants (12 female) were exposed to a continuous stream of four repeating tri-syllabic nonsense words. SL was assessed by comparing neural entrainment at the frequency of the hidden embedded words relative to that of individual syllables. Importantly, this EEG neural entrainment measure is obtained during rather than after exposure to structured input, reveals the time course of learning, and tracks learning directly, without requiring offline tests that are additionally influenced by subsequent memory retrieval processes. Consistent with prior work in adults (Batterink & Paller, 2017), infants' neural entrainment increased at the word level and decreased at the syllabic level as a function of increasing exposure, indicating that entrainment is a viable means of tracking SL in infants. We further characterized and directly compared infants' and adults' individual learning curves, as reflected by the progression of neural entrainment over the exposure period. Interestingly, neural entrainment to words reached a plateau in infants more quickly than in adults. Whereas infants and adults showed similar learning progressions during early phases of the exposure period (first ~90 s), only adults continued to exhibit further increases in word-level entrainment with additional exposure. These results suggest a briefer sampling period of environmental statistics in infant learners, which may arise from constraints on attention. This briefer environmental sampling in infants may represent an adaptive mechanism that prevents the overspecification of linguistic representations. More generally, monitoring EEG entrainment in infants provides a promising new avenue to assess the online course of SL, and may provide new insights into individual or population-level (e.g., developmental) differences in learning.

B49 Better phase-locking to song than speech in difficult listening conditions

Christina Vanden Bosch der Nederlanden[1], Marc Joanisse[1], Jessica Grahn[1]; [1]Western University

A growing body of literature suggests that children who struggle with reading also show poorer phase-locking to the slow, syllable-level, rhythms of speech. In particular, phase-locking in the delta (1-4 Hz) and theta (4-8Hz) frequency band has been linked to poor reading performance, such as in children with dyslexia. It is possible that manipulating speech to better mark the syllable onsets in speech, would allow children with poor reading skills phase-lock the delta and theta band speech information just as well as their typically developing peers. Music has multiple spectral and temporal characteristics that could highlight syllable-level rhythms in an utterance when it is sung. For instance, the beat, metrical structure, and discrete movements in pitch might help listeners better predict when the next syllable might occur, leading to better phase-locking to the same sentence when it

is sung compared to spoken. 20 adults and 22 children participated in several behavioural measures, including IQ, reading/language ability (CTOPP, TOWRE, RAN), musical beat production and perception (Beat Alignment Test) and a passive EEG task. We measured brain activity while listeners heard the same utterances spoken and sung and, for a more difficult listening condition, we also time-compressed these same utterances by 50%. We indexed phase-locking by characterizing how aligned the phase of the neural data was with the amplitude envelope of each utterance using a measure called cerebro-acoustic phase-coherence. We found that adults phase-locked equally well to speech and song in the uncompressed condition, but adults were better at phase-locking to song than speech in the compressed speech condition in the theta band. This finding suggests that the regularities of music may aid in tracking the low-frequency information in language. Preliminary data from children show a similar pattern of results, but analyses are still ongoing. All data will be discussed in terms of the relationship between phase-locking, language outcomes, and musical beat processing.

B50 Exploring 9-year-old children's brain activity during verbal irony processing using Event-Related Potentials *Hugo Corona-Hernández[1], Gloria Avecilla-Ramírez[1], Karina Hess Zimmermann[1], Silvia Ruiz-Tovar[1], Lucero Díaz-Calzada[1], AV Carrillo-Pena[2], Josué Romero-Turrubiates[1]; [1]Autonomous University of Queretaro, [2]Neurobiology Institute, National Autonomous University of Mexico*

Verbal irony production and comprehension are two phenomena which consolidate during late language development. Through different approaches, research on verbal irony has provided evidence about social, cognitive, and linguistic abilities that might make children able to progressively both convey and grasp ironic intended meanings. Focused on searching for N400 and P600 effects, Event-Related Potentials (ERPs) have been used to study verbal irony processing in adults using reading paradigms. However, this subject remains unexplored in children. Furthermore, none of the existing ERP studies on verbal irony comprehension has ever attempted to explore whether or not the N400 and P600 effects are differently modulated by word position while reading a sentence that receives and ironic or a non-ironic interpretation according to its context. Based on evidence showing that 9-year-old children are going through an important period of pragmatic comprehension development, the aim of this study is to explore brain activity during irony processing in a group of healthy Mexican children. ERP data from a group of 9-year-olds (n=17), all of whom had to satisfy inclusion criteria, were collected and analyzed. Each child completed the ERP experiment in a single individual session. Participants also took a general reading comprehension test and a test to measure his or her non-verbal IQ. A total of fifty brief stories (twenty ironic, twenty non-ironic and ten fillers) were used for the ERP paradigm. Each story has a context and a target sentence. Each target sentence has two target words that represent the stimuli which ERPs were synchronized with: the critical word (always the second word of the sentence), whose ironic or literal meaning depends on context, and the final word of the sentence. No N400 effect was observed in any of the word positions (critical and final). This result supports previous findings in adults, suggesting that no semantic integration difficulty arises during ironic comprehension. The ERPs' visual analysis revealed a late positivity consistent with the P600 component in response to the ironic critical word compared with the literal critical word. For the word in final position, a larger sustained positivity in response to the ironic condition compared to the literal one was observed. Independent repeated measures ANOVAs, with four within-subject factors (2 Positions x 2 Conditions x 8 Scalp Regions x 2 Hemispheres), were carried out for a 550-850 msec window. The analysis showed a main effect of condition, and interactions between position and region as well as between condition and region. Specific analysis showed significant differences between conditions for the word in the final position, but no differences for the critical word. These findings suggest that verbal irony interpretation has not been achieved yet by the time 9-year-old children read the ironic sentence critical word; instead, it seems that they are still processing information, and that it is until they read the ironic sentence's final word when they achieve the verbal irony integration process.

Multilingualism

B51 Neural plasticity of speech and reading networks associated with language learning *Kshipra Gurunandan[1], Manuel Carreiras[1,2], Pedro M. Paz-Alonso[1]; [1]BCBL - Basque Center on Cognition, Brain and Language, San Sebastián, Spain, [2]Ikerbasque - Basque Foundation for Science, Bilbao, Spain*

Learning a new language offers an excellent window to study neural plasticity. Functional and structural changes have been documented across the lifespan in studies of language-learning and literacy acquisition. Monolingual adults typically exhibit well-integrated speech and reading networks, an effect that is thought to be universal across highly contrastive languages (Rueckl et al., 2015). While language networks in monolinguals tend to be left-lateralized (Pujol et al., 1999), bilinguals exhibit less consistent lateralization patterns in their language networks due to variability in the age of acquisition, exposure and proficiency in their second language (L2). Little is known, however, about the neural changes associated with the process of learning a new language in adulthood. More specifically, it is still unknown whether bilinguals exhibit the convergence between speech and print networks characteristic of monolinguals, or whether cortical representations within and between languages change as a function of L2 proficiency. The present study was aimed at investigating functional changes associated

with learning a new language during adulthood. We examined: 1) the convergence of speech and reading networks in L1 and L2, 2) the laterality of the language networks at different stages of learning a new language (intermediate and advanced), and 3) the effect of acquiring an L2 in the coupling of the primary auditory cortex and primary visual cortex with the speech and reading networks. Thirty-four adult (mean age = 46.5 years; 17 male) native speakers of Spanish, either at the intermediate or advanced levels of learning Basque, underwent functional MRI scanning while performing an animacy judgment task with spoken and print stimuli in their L1 and L2. Behavioral results showed a group by language interaction, with equal accuracy in the L1 and differential accuracy in the L2 between the intermediate and advanced language-learning groups. fMRI results revealed 1) a high level of convergence between speech and reading networks in both L1 and L2; 2) greater right-lateralization of the L2 in advanced relative to intermediate learners; and 3) between-group differences in the laterality of whole-brain functional connectivity with sensory areas for speech and reading, suggesting an effect of L2 learning on these networks. In sum, our study revealed considerable plasticity of the language networks in the adult brain, with increasing right lateralization of the L2 networks corresponding with concomitant proficiency increases.

B52 Network selectively responding to bilingual sentence comprehension vary as a function of the L2 age of acquisition

Sandra Gisbert-Muñoz[1], Ileana Quiñones[1], Manuel Carreiras[1,2]; [1]Basque Center on Cognition, Brain, and Language, 20009 Donostia, Spain, [2]Ikerbasque, Basque Foundation for Science, 48013 Bilbao, Spain

Bilingual individuals prove that the human brain is capable of acquiring more than one language. However, how different languages are represented in the bilingual brain remains an open question. Previous studies on language processing in bilingual aphasics and neurotypical bilingual individuals have suggested that there is a single brain system underlying language, but that it can modulated by both age of second language acquisition and language proficiency. However, there are also studies that propose differential and functionally independent neuroanatomical substrates for the first and second language. To study if the neural substrate for language is shared in the bilingual brain, three groups of highly proficient Spanish-Basque bilinguals were recruited for our study. Basque and Spanish are both highly transparent languages that share a writing system and most phonemes and, while the sentence canonical order is different (SOV for Basque and SVO for Spanish) both languages accept both orders as correct. The three groups differed only on age of acquisition of Basque: in Group 1 (N=17) they were simultaneous bilinguals; in Group 2 (N=19), early bilinguals that acquired Basque at 3 years of age; and in Group 3 (N=13), late bilinguals with ages of acquisition for Basque ranging from 5 to 26. The three groups performed a grammaticality judgement task in Spanish and Basque in which they were asked to press a button with their right or left hand to indicate if the sentence was correct or if it contained an agreement violation. There were 180 sentences in Basque and 150 in Spanish, with sentence length ranging from 5 to 10 words. For each language, sentences were presented in three separate runs in a word by word paradigm. As predicted, a common network emerged for both Spanish and Basque sentence processing. The conjunction analysis for all correct sentences in both languages showed a bilaterally distributed network, involving the inferior frontal gyrus (triangularis and opercularis), insula, precentral and postcentral gyri, supplementary motor area, middle cingulum, middle and superior temporal gyri and inferior occipital lobe. When comparing Basque correct sentences to Spanish correct sentences, differences arouse between the three groups, with Group 1 showing greater activation than Group 2 and 3 in the calcarine sulcus and superior parietal lobe for Basque sentences and in the left fusiform and the left parahippocampus for Spanish sentences. Activations in the bilateral caudate, cerebellum, thalamus and left putamen were also modulated by Basque age of acquisition, showing a similar pattern in Groups 1 and 2 when compared to Group 3 in Basque sentences; and in the right angular gyrus and the middle and superior temporal gyri for Spanish sentences. These results support the existence of a common neural substrate for language that is modulated by age of acquisition. The differences between the two languages include not only the IFG described in previous literature or regions involved in L1 processing, but also other areas that seem more related to semantic than syntactic processing.

B53 The Impact of Semantic Context and Age of Acquisition on Bilingual Speech Perception in Noise: An ERP Study

Kristina Coulter[1,4], Annie C. Gilbert[2,4], Shanna Kousaie[2,4], Shari Baum[2,4], Vincent Gracco[2,3,4], Denise Klein[2,4], Debra Titone[2,4], Natalie A. Phillips[1,4]; [1]Concordia University, [2]McGill University, [3]Yale University, [4]Centre for Research on Brain, Language, and Music

Speech perception often occurs in suboptimal listening conditions (e.g., background noise or multiple talkers). In these noisy listening conditions, listeners benefit from cues such as semantic context while listening in their native language (L1). However, the extent to which bilinguals can use semantic context while perceiving speech in noise in their second language (L2) is unclear. Therefore, we examined speech perception in noise in bilingual speakers of English and French, with varying levels of L2 proficiency and L2 age of acquisition. Participants included 15 simultaneous bilinguals, 19 early and 16 late sequential bilinguals, matched on L1, age, sex, and verbal fluency in L2. Participants performed an adapted version of the Revised Speech Perception in Noise Task and event-related potentials (ERPs) were analyzed. In this task, participants listened to English and French sentences varying in sentential constraint. High constraint sentences led to a

predictable final word whereas low constraint sentences led to an unpredictable final word (e.g., high constraint: "The lion gave an angry roar."; low constraint: "He is thinking about the roar."). Sentences were presented in a quiet condition and a noise condition with a 16-talker babble mask. Participants were asked to repeat the final word of each sentence. As expected, participants showed higher accuracy in quiet compared to noise and on high constraint compared to low constraint sentences. While there was no difference in accuracy between L1 and L2 for simultaneous and early sequential bilinguals, late bilinguals were more accurate in L1 compared to L2. In addition, a trending interaction was observed such that simultaneous bilinguals appear to perform with higher accuracy than early and late sequential bilinguals in both L1 and L2 in noise. ERP analyses revealed overall larger N400 amplitudes in L2 compared to L1, suggesting more effortful processing in L2 compared to L1. A larger and later N400 was observed for low constraint sentences compared to high constraint sentences across all groups and in L1 and L2, indicating more effortful processing of low compared to high constraint sentences. Additionally, high constraint sentences elicited larger N400 amplitudes in L2 compared to L1 while low constraint sentences elicited similar N400 amplitudes in L1 and L2. These findings indicate that, although bilinguals benefit from semantic context during speech perception in both their languages, bilinguals appear to benefit from semantic context to a lesser extent in their L2 compared to L1. Additionally, age of second language acquisition does not seem to influence processing of speech in noise as indicated by similar N400 amplitudes and latencies across all groups. Future directions include investigating the role of second language proficiency on bilingual speech perception in noise.

B54 Bilingual language control: MEG evidence of inhibition in word production *Judy D. Zhu[1,2], Robert A. Seymour[1,2,3], Paul F. Sowman[1,2]; [1]ARC Centre of Excellence in Cognition and its Disorders, Sydney, Australia, [2]Macquarie University, Sydney, Australia, [3]Aston University, Birmingham, United Kingdom*

Bilinguals have a remarkable ability to control which language to speak at any given time, and to switch between languages seamlessly. It has been suggested that bilinguals rely on inhibitory control to suppress the non-target language to ensure speech output occurs in the desired language. Previous electrophysiological studies report mixed findings as to when inhibition occurs in language switching. One possible reason for this discrepancy in findings is that previous experimental designs have not been well controlled in regards to confounding factors and trial-sequence effects. We addressed these issues in the current MEG study, employing the classical language-switching paradigm with an improved design. We tested sixteen Mandarin-English bilinguals in the MEG. We specifically recruited unbalanced bilinguals (all dominant in L1 Mandarin) so that we could examine how relative language proficiency modulates inhibition. Participants were instructed to name the digit they saw on each trial in either Mandarin or English, as indicated by the language cue (face of interlocutor, either Chinese or Caucasian). To eliminate the possible confound of cue-switching (i.e. cue changes whenever the language changes), which is present in most language-switching studies, we used two faces for each language and ensured that the cue changed on every trial. We generated well-controlled trial sequences by ensuring that there were no consecutive switch trials (previously shown to have a stacking effect on switch cost). A filler trial was inserted after every switch trial, so that no critical trial ever followed a switch trial. To examine language control in distinct stages of processing (preparation stage following cue onset, and naming stage following target onset), we separated cue onset and target onset by an interval of 750ms, which has been shown to be sufficient for optimal preparation. Behavioural naming latencies were submitted to linear mixed-effect modelling with language (Mandarin/English) and switch (stay/switch) as factors. An interaction was found between language and switch, replicating the well-known switch cost asymmetry in unbalanced bilinguals (i.e. it takes longer to switch back to L1 after naming in L2 than vice versa). Preliminary analysis of MEG data in the time domain using cluster-based permutation tests revealed a main effect of switch between 425-550ms following cue onset, and a main effect of language 200-300ms following target onset, which is typical of inhibitory control. These effects suggest that there are control processes involved at both stages. Upon seeing the face cues, bilinguals perform shifting and updating of task goals, biasing their language selection towards the required language. These processes are only required on switch trials, therefore an effect of switch is present in the cue window. Upon seeing the naming target, bilinguals inhibit the non-target language in order to produce speech in the target language. This happens on all trials, but speaking L2 requires stronger suppression of L1 than vice versa. Therefore, the effect of language, displaying signatures of inhibitory control, is present in the target window. Implications for models of bilingual language control will be discussed.

B55 Short exposure to a foreign accent impacts subsequent cognitive processes. *Alice Foucart[1,2], Hernando Santamaría-García[3,4,5], Robert J. Hartsuiker[1]; [1]Ghent University, [2]Universitat Pompeu Fabra, [3]Pontificia Universidad Javeriana, [4]Instituto de Neurociencia Cognitiva y Traslacional, [5]Hospital San Ignacio*

Although speaking a foreign language is undoubtedly an asset, foreign-accented speakers are usually perceived negatively. It is unknown, however, to what extent this bias impacts cognitive processes. Here, we used ERPs and pupillometry to investigate whether the negative bias generated by a short exposure to a foreign accent influences the overall perception of a speaker, even when the person is not speaking. We compared responses to

written sentence comprehension, memory and visual perception, associated with native and foreign-accented speakers with high and low social status. First, participants were introduced to speakers that differed in their accent (native or foreign accent) and social status (high or low status, based on achievements), to ensure that accent was not automatically associated with lower social status (e.g., lower education level). Participants then played a visual discrimination game with these speakers, and always ended up in the middle rank. This hierarchy phase identified two high-status speakers (native and foreign accent) and two low-status speakers (native and foreign accent). Participants were then presented with sentences containing true, false or unknown information ('One of the colours of the French/Gabonese flag is blue/green), along with the photo of one of the speakers. Their task was to assess the veracity of the statement (true, maybe true, maybe false, false, don't know). Importantly, sentences were presented visually to investigate the impact of a short exposure to a foreign accent on subsequent cognitive processes, not the online impact of linguistic fluency (e.g., phoneme distortion). Finally, participants were presented with some of the sentences they had read and had to indicate which of the four speakers had said it. Although no differences were observed at behavioural level, early (N400) and late (P600) neural responses revealed differences across speakers, suggesting that the reduced credibility generated by a short exposure to a foreign accent subsequently impacts sentence processing. The memory task revealed a tendency to remember better a statement when associated with the high-status native speaker than with the other speakers. As an exploratory measure, we looked at the physiological responses to the presentation of the speakers' photos. A larger early ERP component, similar to that reported for different social groups and races, was found for the foreign-accented speaker compared to the native speakers. Pupil diameter also varied across speakers, suggesting an influence of both social status and accent. Overall, measures associated with the foreign-accented speaker consistently fell in-between those associated with the high-status native speaker and the low-status native speaker. This study is the first physiological demonstration that short exposure to a foreign accent impacts subsequent cognitive processes, and that foreign-accented speakers seem to be considered less reliable than native speakers, even with equally high social status. Awareness of this bias is essential to avoid discriminations in our multilingual society.

B56 ERP correlates of picking up new foreign-language words in dialogue *Kristin Lemhöfer[1], Julia Egger[1,2], James McQueen[1]; [1]Radboud University, [2]Max-Planck-Institute for Psycholinguistics*

A lot of applied research has been devoted to identifying suitable methods to teach people new words in a second language (L2). However, many (especially immersed) L2 speakers improve their vocabulary spontaneously and 'in the wild', i.e. in natural communicative situations, rather than in the classroom. Investigating this kind of word learning, also termed 'incidental learning', in the laboratory has proven difficult, especially with respect to concealing the learning character of the study from participants. In a recent line of research, we developed an experimental method of incidental L2 word learning in a dialogue-like situation that turned out to be highly successful in that respect. This paradigm entails that the participants are made to believe that the study is about price judgments and their consistency. In the current study, we adapted this paradigm for an ERP context, to investigate the electrophysiological signatures of picking up new words from a dialogue partner. Native Dutch speakers first completed a pre-test on the experimental set of target and filler objects in their L2 English, supposedly because the experimenter did not speak Dutch. They had to name the objects and to give a price estimate (e.g., "a fridge costs 200 Euros"). Unbeknownst to the participants, the real aim of this pre-test was to test initial word knowledge on the experimental target items which were typically unknown to this L2 population (e.g., whisk), while the fillers were typically known (e.g., fridge). After that, participants alternately made price comparisons of pairs of depicted objects (e.g., "a whisk is cheaper than a fridge"), or listened to and judged those by a virtual partner (voice recordings). Critically, the target items were always produced by the virtual partner first, providing learning-relevant input to the participant. After a fixed number of trials, the same object re-appeared in the participant's trial, revealing whether or not she had learned the word from the input. In a second block, all words were presented in the same fashion again to provide a second opportunity for learning. As in our previous studies, only few participants suspected the study to be about word learning. On average, 36% of the previously unknown words were learned after the first, and another 20% after the second exposure. In the ERPs, we failed to find the expected larger N400 for unknown (target) vs. known (filler) words that is normally observed for pseudowords in sentences, and found a late positivity instead. This suggests that new to-be learned words in a meaningful context are encoded differently than meaningless pseudowords. Furthermore, there was a late positivity for later learned vs. forgotten words, showing that the neural processes during encountering a new L2 word in a natural situation are predictive of subsequent learning. Finally, newly learnt words became indistinguishable in their ERP signature from previously known filler words in the second block, i.e. after only one exposure, indicating that incidental word learning can operate surprisingly fast. This study is the first to reveal neural correlates of incidental learning and memory for new L2 words.

B57 Is semantic processing language-dependent? Evidence from bilingual aphasia *Marco Calabria[1], Nicholas Grunden[1,2], Mariona Serra[1], Carmen García Sánchez[2], Albert*

Costa[1,3]; [1]Center for Brain and Cognition, Pompeu Fabra University, Barcelona, Spain, [2]Hospital de la Santa Creu i Sant Pau, Barcelona, Spain, [3]Institució Catalana de Recerca i Estudis Avançats (ICREA), Spain

Introduction. Individuals with aphasia frequently show lexical retrieval deficits due to increased interference amongst competitors during word selection. This has been demonstrated in tasks where this competition originates at a semantic level, such as naming pictures grouped by semantic category. These deficits are explained in terms of impaired semantic control, a set of abilities to some extent dependent on executive control. To what extent these abilities can be affected in a second language (L2) has not been extensively explored and findings in healthy individuals are not conclusive about the extent to which semantic processing is shared between languages. In this study we explore the effect of brain damage on semantic processing by comparing the performance of bilingual individuals with aphasia in tasks tapping semantic control in word production and comprehension. Methods. We investigate the naming performance of bilinguals with fluent aphasia and age-matched healthy controls in a semantically blocked cyclic naming task for the two languages (Catalan and Spanish). This task allows to measure the semantic interference as a difference in naming latencies between pictures grouped by the same semantic category or different categories. Also, we explore whether lexical deficits extend to comprehension by testing participants in a word-picture matching task during a mixed language condition. All the participants were early bilinguals and high proficient in Catalan and Spanish with a balanced use of the two languages. Results. In the semantically blocked cyclic naming task, the semantic interference effect was similar in bilingual patients with aphasia and healthy controls when required to perform the task in their first language (L1). However, bilingual patients showed a larger semantic interference effect than controls when naming stimuli in their L2. Similarly, in the word-picture matching task, patients suffered larger switch costs when required to switch from L1 into L2 than vice versa as compared to healthy controls. Conclusions. Taken together, these results suggest that lexical retrieval may be selectively impaired in bilinguals during those conditions in which semantic competition is higher as L2, possibly explained by an excessive inhibition. Moreover, these lexical deficits extent to those conditions when words are not intentionally retrieved for production and both languages are involved.

Signed Language and Gesture

B59 Picture naming in American Sign Language: an ERP study of the effects of iconicity and alignment *Meghan McGarry[1], Megan Mott[1], Katherine J. Midgley[1], Phillip J. Holcomb[1], Karen Emmorey[1]; [1]San Diego State University*

Growing evidence suggests that iconicity may play a role in the recognition and/or production of signs in American Sign Language (ASL). Iconic signs have a motivated resemblance between their form and meaning, whereas non-iconic signs have a more arbitrary mapping between their form and meaning. The present study investigated the effects of iconicity and picture-alignment on sign production (see below for description of alignment). Specifically, we compared the production of iconic and non-iconic signs in a picture-naming task. In addition, for the iconic signs we compared an aligned picture condition in which a visually salient feature of the picture aligned with the iconic feature of the sign (e.g., the ASL sign BIRD depicts a bird's beak and aligns with a picture of a bird with a prominent beak) and a non-aligned picture condition (e.g., a picture of a bird in flight where the beak is not visible). Deaf ASL signers named 176 pictures: 88 were named with non-iconic signs and 88 were named with iconic signs. Half of the 88 iconic signs were in the picture-aligned condition and half were in the non-aligned condition. The order of the pictures was counter-balanced across participants. Naming latencies did not differ for iconic and non-iconic signs, and picture-alignment had no effect on naming latencies for the iconic signs. EEG was also recorded, and Event-Related Potentials (ERPs) were time-locked to picture onset and averaged offline. We investigated whether iconicity and/or picture-alignment modulated the N400 component, a negative going component that peaks around 400ms after stimulus onset and is associated with both the processing of the form and the meaning of the stimulus. Our results show that the N400 amplitude for iconic signs was more negative than for non-iconic signs, with significant differences in mean amplitude beginning around 200ms and offsetting around 600ms. This finding suggests that the retrieval of iconic signs may activate additional perceptual or sensory-motor features compared to retrieval of non-iconic signs, resulting in increased negativity. The ERPs to iconic signs in the picture-aligned condition also showed reduced N400 negativity compared to iconic signs in the non-aligned condition, with significant differences beginning around 200ms and offsetting around 650ms. The reduced negativity for iconic signs in the aligned condition may constitute a unique priming effect that occurs when the visible features of an iconic sign and the to-be-named picture overlap. A right anterior scalp distribution was observed across the epoch for both the picture-aligned vs. nonaligned contrast and for contrast between iconic and non-iconic signs. Overall, the results indicate that retrieval of iconic signs in a picture-naming task involves more elaborate processing than retrieving non-iconic signs, resulting in increased negativity for iconic signs. This effect of iconicity may be akin to the increased N400 negativity observed for concrete words. In addition, the results indicate that the structural alignment between

visual features of a to-be-named picture and an iconic sign facilitates lexical retrieval compared to when there is no visual feature overlap.

B60 Sensorimotor EEG indicates deaf signers simulate tactile properties of ASL signs when reading English

Lauren Berger[1], Lorna C. Quandt[1]; [1]Gallaudet University

When a deaf bilingual reads a word in English, the corresponding ASL sign is also activated lexically (Shook & Marian, 2012), in a process called crossmodal, cross-linguistic translation. Emerging evidence suggests that when deaf signers read English, they recruit the brain's sensorimotor system to automatically simulate the movements required to produce the corresponding ASL signs (Quandt & Kubicek, 2017). We expand upon that work to ask whether somatosensory (e.g., tactile and proprioceptive) properties of ASL signs, in addition to motor properties, are simulated when deaf signers read. Here, we examined neural activity during reading of words whose ASL translations involve Contact between the hand and body (e.g., POLICE; C words) and words whose ASL translations involve No Contact (e.g., BAG; NC words). We hypothesized that there would be greater activation in the somatosensory regions of the sensorimotor system when deaf signers read C words as compared to NC words, and that this effect would not be present for hearing non-signers. We collected EEG data from 23 hearing non-signers and 24 deaf fluent signers while they passively read English words with ASL translations that are either C or NC. For each EEG electrode within our central ROI, we performed time-frequency analyses across all alpha and beta frequencies from word onset at 0 to 1000 ms. Additionally, we conducted full-scalp analyses from all 64 electrodes that provided us with a map of alpha and beta power across the analysis epoch. In the deaf group, we found more lower beta desynchronization (14-17 Hz) from 250-500 ms following onset of NC words compared to C words. The significant effects were observed at four adjacent electrodes overlying a left centro-parietal region. Full scalp analysis revealed no significant difference between NC and C words for hearing participants, indicating there was no effect of simulating ASL signs in this group. Our ROI analysis at central electrodes overlying the somatosensory cortex revealed more lower beta and upper alpha desynchronization in response to reading NC words. Further analysis revealed that this effect was present in two clusters, with five electrodes in the right fronto-central region, and four electrodes in the left centro-temporo-parietal region. Together, these results demonstrate significant differences in somatosensory EEG activity when deaf signers read English words whose ASL translations have different tactile and proprioceptive properties. Following the idea that deaf ASL users simulate ASL signs when reading English words, our findings of a post-movement beta rebound (PMBR) in response to reading NC words reveal that this simulation also includes the somatosensory features of ASL signs. PMBR is an oscillatory phenomenon that occurs after the offset of a movement, displayed by a sharp increase in beta power, reaching full power over the sensorimotor cortex (Parkes, Bastiaansen, & Norris, 2006), indicative of the involvement of somatosensory processing areas. We demonstrate that Deaf readers simulate the tactile and proprioceptive properties of ASL signs corresponding to the English words they read, and that this simulation invokes a greater post-movement beta rebound for no-contact signs than for contact signs.

B61 Examining the effect of language experience on plasticity in superior temporal cortices in deaf and hearing signers

Tae Twomey[1], Dafydd Waters[1], Cathy Price[1], Mairéad MacSweeney[1]; [1]University College London

It has been clearly demonstrated that parts of the superior temporal cortex (STC) are activated more in deaf than hearing people. In particular, these differences are reliably observed when sign language stimuli are used. It follows from this therefore that the duration of experience with sign language might also influence the extent of plasticity observed in STC. Here we manipulated sign language experience by testing participants who acquired British Sign Language (BSL) at difference ages. We predicted that in addition to a main effect of hearing status in the STC (deaf > hearing) during perception of sign language, there would be a hearing status X age of BSL acquisition interaction. Specifically we predicted a greater effect of deafness in STC (D >H) in early learners than late learners of BSL. A second question relates to the impact of early language experience in deaf people only. We have previously reported greater activation in left inferior frontal gyrus (IFG) in deaf late than deaf early signers during BSL phonological judgment using picture stimuli (MacSweeney et al., 2008). We investigated whether the same effect was observed during a task, which unlike the BSL phonological judgement, did not require meta-linguistic analyses and visuospatial working memory. We tested deaf and hearing signers who learnt BSL either early (native) or late in life (after the age of 15 years): four groups, N=52 in total. The groups were matched on performance on a BSL grammaticality judgment test (Cormier et al., 2012). We collected fMRI data as they detected a semantic anomaly in BSL sentences; and a target (the signer touching the nose) in strings of nonsense gestures. As predicted, a main effect of hearing status (deaf > hearing) was found in the STCs bilaterally, replicating previous findings. This effect was centred on Heschl's gyrus and extended to planum polare anteriorly and planum temporale posteriorly. Relative to rest, hearing signers showed deactivation whereas deaf signers showed activation. However, these responses within each group were not significantly different from rest. Interestingly, when the nonsense gesture stimuli were used as a baseline, the group difference disappeared. This was because STC responses to BSL and gesture within deaf signers (activation) and hearing signers (deactivation)

showed a very similar pattern (BSL>gesture). Moreover, contrary to our predictions, the interaction between hearing status and age of BSL acquisition was not significant, irrespective of baseline. With regard to our second question, there were no significant differences in left IFG activation between deaf late and deaf early signers. This suggests that the previously observed effects of late sign language acquisition in deaf signers, are likely to be task-dependent. The current study demonstrates the importance of the baseline in testing for crossmodal plasticity: an obvious but often overlooked point. Our findings also suggest that plasticity in the parts of STCs identified here is primarily driven by deafness and it not influenced, to any great extent, by age of sign language acquisition or linguistic status of the input.

B62 Single-parameter phonological priming in American Sign Language: An ERP study

Natasja Massa[1], Gabriela Meade[1,2], Brittany Lee[1,2], Katherine J. Midgley[1], Phillip J. Holcomb[1], Karen Emmorey[1]; [1]San Diego State University, [2]University of California, San Diego

In spoken language, phonology refers to the individual sounds that make up words. In sign language, phonology refers to visual-manual parameters, including handshape and location. Here, we used event-related potentials (ERPs) to investigate how phonological relatedness influences the processing of signs in American Sign Language (ASL). Deaf signers and hearing non-signers viewed prime-target pairs of ASL signs that were phonologically related or unrelated. The phonologically related pairs were in one of two conditions: handshape-only overlap (e.g., LOUSY-ROOSTER; both signs produced with a 3-handshape) or location-only overlap (e.g., COLOR-WHO; both signs produced on the chin). ERPs were recorded and time-locked to target video onset. Participants pressed a button when both signs within the pair were identical (14% of trials, not analyzed). Our analyses centered around the N400 as previous studies on spoken language have found phonological priming effects within that window: spoken target words (e.g., cake) elicit smaller amplitude N400s following phonologically related prime words (e.g., take-cake) compared to targets following unrelated prime words (e.g., lost-cake). Similarly, we found N400 priming effects in the same direction with ASL prime-target pairs in the deaf signers. Moreover, for deaf signers, handshape priming was significantly larger and more widespread compared to location priming. This result suggests that deaf signers are more attuned to handshape than location, which is likely due to its linguistic importance. In contrast to location, handshape is processed categorically by signers (Emmorey, McCullough, & Brentari, 2010), which may lead to stronger phonological priming effects during lexical access. In the hearing non-signers, we found small priming effects for both handshape overlap and location overlap that were not significantly different in size. However, these effects occurred substantially later than the N400 window (600-800ms). We conclude that the priming we see in the deaf signers arises during lexical access and is phonologically driven (handshape having a special status in their linguistic system), while the priming we see in the hearing non-signers is likely due to perceptual as opposed to linguistic mechanisms.

Methods

B63 The superior longitudinal fasciculi or refining the fronto-parietal connectivity patterns between specific language regions

Elise B. Barbeau[1,2,3], Denise Klein[1,2,3], Michael Petrides[1,2,3,4]; [1]Cognitive Neuroscience Unit, Montreal Neurological Institute, McGill University, Montreal, [2]Department of Neurology and Neurosurgery, McGill University, Montreal, [3]Center for Research on Brain, Language and Music (CRBLM), Montreal, [4]Department of Psychology, McGill University, Montreal

The Superior Longitudinal Fasciculus (SLF) connects the parietal cortex with language related cortical areas in ventrolateral frontal cortex. In standard reconstructions of language tracts with diffusion imaging tractography, the SLF is often mixed up with the arcuate fasciculus that connects the posterior temporal cortex with the frontal cortex. In macaque monkey gold standard tract tracing studies which involve the injection of radioactive tracers, the exact origin of the SLF in parietal cortical areas, the precise course of its axons and the exact termination in ventrolateral frontal areas has been established (Petrides and Pandya, 2009). This research demonstrated two distinct branches originating from the inferior parietal lobule: One branch (SLF II) links posterior parietal cortex (corresponding to the angular gyrus (ANG) in the human brain) with the frontal cortex (specifically BA 45), and another branch (SLF III) links the anterior part of the inferior parietal cortex (corresponding to the supramarginal gyrus (SMG)) with inferior frontal cortex (specifically BA 44). Our study aimed to use this critical information from experimental anatomical studies on macaque monkeys to reconstruct in vivo these two branches of SLF using diffusion tractography. We then used resting-state functional connectivity to support the distinct pattern of connectivity, and refine the connectivity within the parietal and frontal regions of interest. Thirty-seven right-handed healthy volunteers (mean age 24.5, range 18-34) were scanned with MRI (diffusion, anatomical and resting state). The diffusion MRI images were preprocessed using FSL and the tracts were reconstructed with Diffusion Toolkit and Trackvis using Regions of Interests (ROIs) drawn on the diffusion and coregistered anatomical scans. SPM conn toolbox was used to preprocess the resting state data as well as to perform whole brain ROI-to-Voxel and ROI-to-ROI second-level analyses. These two branches of the SLF could be reconstructed and clearly separated from the connections originating from the posterior temporal region, i.e. the arcuate fasciculus. The resting state analyses showed that the ANG was significantly more connected

than the SMG to BA45 and the SMG showed more connectivity to BA 44, consistent with predictions from the macaque monkey data.

B64 Restricted Diffusion Imaging (RDI) as a measure of axonal packing density in children and adults

Anthony Dick[1], Dea Garic[1]; [1]Florida International University

Restricted diffusion imaging (RDI) is a novel diffusion-weighted neuroimaging metric that is proposed to measure cellular and axonal density (Yeh et al, 2016). This metric has been shown to be sensitive to tumors and inflammation within the rat brain, but it has never been tested to measure axonal density within the developing human brain. Our study aimed to use this in vivo imaging method to replicate the anterior-to-posterior distribution of axonal density in the corpus callosum, which is well-established in post-mortem tissue (Aboitiz et al, 1992). We hypothesized that, because it was designed to be sensitive to cellular density, relative to established diffusion metrics, this novel RDI metric would be specifically sensitive to the pattern of axonal packing density in the human corpus callosum. Our participants were 840 adults from the human connectome project (HCP) database (undisclosed exact ages, age range= 20-40 years) and 129 infants, children, and adolescents (M= 8.67 years) from the C-Mind database. In both samples, we were able to match the histological density patterns seen in post-mortem tissue. Specifically, contrast analyses showed a high degree of fit between the density patterns from the Aboitiz model and our adult sample, $t(839) = 167.99$ $p < .001$, and developing sample, $t(126) = 227.4$, $p < .001$. We also showed that the pattern was only apparent for RDI. The anterior-posterior distribution of other metrics, which included generalized fractional anisotropy (GFA), quantitative anisotropy (QA), fractional anisotropy (FA), radial diffusivity (RD), axial diffusivity (AD), and mean diffusivity (MD), did not match the pattern revealed in post-mortem tissue. These findings provide preliminary evidence in support of the RDI metric's sensitivity to cellular density and could potentially have wide-reaching implications for future clinical assessments.

B65 An in-depth examination of the morphology of two sulci of the frontal language zone and comparisons to cytoarchitectonic Brodmann areas 44 and 45

Trisanna Sprung-Much[1,2], Michael Petrides[1,2]; [1]McGill University, [2]Montreal Neurological Institute

The sulcus diagonalis and the anterior ascending ramus of the lateral fissure are located within the posterior ventrolateral frontal cortex, otherwise known as the frontal language zone in the language dominant hemisphere. On the surface of the cortex, the anterior ascending ramus divides the inferior frontal gyrus into the pars opercularis, posteriorly, and the pars triangularis, anteriorly. The sulcus diagonalis is a relatively-vertically oriented sulcus located within the pars opercularis. We labeled voxels within the sulcus diagonalis and the anterior ascending ramus in 40 in-vivo MRI (1.5T) volumes (i.e. 80 hemispheres) that had been linearly registered to the Montreal Neurological Institute (MNI) stereotaxic space, in order to determine the morphological patterns formed by these two sulci. Our results demonstrate that the sulcus diagonalis is a fairly superficial sulcus that is less frequent than the anterior ascending ramus. The latter is a much more reliable sulcus that consistently extends medially to reach the insula. Furthermore, we were able to identify four major morphological patterns formed by these two sulci, which we classify here as Types I-IV. In Type I, the sulcus diagonalis was absent, and the anterior ascending ramus lay directly anterior to the inferior precentral sulcus. Type II consisted of those hemispheres in which both the anterior ascending ramus and the sulcus diagonalis could be easily identified on the surface of the hemisphere. In Type III, the sulcus diagonalis was present but joined superficially with either the anterior ascending ramus (Type IIIa), the inferior precentral sulcus (Type IIIb), or the inferior frontal sulcus (Type IIIc). In Type IV, a third anterior branch of the lateral fissure could be identified, that is, in addition to the anterior ascending ramus of the lateral fissure and its counterpart, the horizontal ramus of the lateral fissure. This third branch tended to form a 45° angle to the ascending and horizontal rami and always extended medially to reach the insula. Finally, we compared the average location of the anterior ascending ramus, generated across all 40 subjects, with the location of cytoarchitectonic Brodmann areas 44 and 45 based on data freely available in the open-access pipeline FreeSurfer. The results illustrate what traditional cytoarchitectonic maps suggest, namely that, posterior to the anterior ascending ramus lies Brodmann area 44 on the pars opercularis and, anterior to it, lies Brodmann area 45, on the pars triangularis. Establishing a thorough understanding of the sulcal morphology of this region will enhance the anatomical accuracy of functional imaging studies investigating language.

B66 How distributed processing produces false negatives in voxel-based lesion-deficit analyses

Andrea Gajardo-Vidal[1], Diego Lorca-Puls[1], Jennifer Crinion[1], Jitrachote White[1], Mohamed Seghier[1,2], Alex Leff[1], Thomas Hope[1], Philipp Ludersdorfer[1], David Green[1], Howard Bowman[3,4], Cathy Price[1]; [1]University College London, [2]Emirates College for Advanced Education, [3]University of Kent, [4]University of Birmingham

Introduction: In this study, we hypothesized that if the same deficit can be caused by damage to one or another part of a distributed neural system, then voxel-based analyses might miss critical lesion sites because preservation of each site will not be consistently associated with preserved function. Methods: Patients were selected from the Predicting Language Outcome and Recovery After Stroke (PLORAS) database (Seghier et al., 2016) according to the following criteria: (i) left-hemisphere stroke attested by a clinical neurologist and defined by an automated lesion identification algorithm (Seghier et al., 2008); (ii) patients with lesions larger than 1 cm3; (iii) native speakers of English; (iv) right-handed prior to their

stroke; and, (v) more than 3 months since stroke. These criteria were met by 359 left-hemisphere stroke patients, aged between 21 and 90 (mean age 59.4). The first part of our investigation used voxel-based multiple regression analyses of data from 359 right-handed stroke survivors to identify brain regions where lesion load is associated with picture naming abilities after factoring out variance related to object recognition, semantics and speech articulation so as to focus on deficits arising at the word retrieval level. Results: A highly significant lesion-deficit relationship was identified in left temporal and frontal/premotor regions. Post-hoc analyses showed that damage to either of these sites caused the deficit of interest in less than half the affected patients (76/162 = 47%). After excluding all patients with damage to one or both of the identified regions, our second analysis revealed a new region, in the anterior part of the left putamen, which had not been previously detected because many patients had the deficit of interest after temporal or frontal damage that preserved the left putamen. Conclusions: Our results illustrate how: (i) false negative results arise when the same deficit can be caused by different lesion sites; (ii) some of the missed effects can be unveiled by adopting an iterative approach that systematically excludes patients with lesions to the areas identified in previous analyses; (iii) statistically significant voxel-based lesion-deficit mappings can be driven by a subset of patients; (iv) focal lesions to the identified regions are needed to determine whether the deficit of interest is the consequence of focal damage or much more extensive damage that includes the identified region; and, finally; (v) univariate voxel-based lesion-deficit mappings cannot, in isolation, be used to predict outcome in other patients.

Computational Approaches

B67 Evaluating the functional neuroanatomy of language represented across 11,406 neuroimaging studies: a multivariate meta-analysis

Alex Teghipco[1], Gregory Hickok[1]; [1]University of California, Irvine

Models of the functional neuroanatomy of language are predominantly based on informal evaluations of the literature or formal but domain-specific (e.g., speech production, syntax) meta-analyses. This standard approach fails to consider the relations between functional networks; for example, a "syntax" network might include areas involved in articulatory rehearsal. However, large-scale datasets accumulating neuroimaging findings have made it possible to gauge the selectivity of functional networks by considering how often the same brain areas activate across many different functions (Poldrack, 2011). This development aligns with a growing interest in organizing a cognitive ontology that represents the many-to-many mappings between brain areas and cognitive functions (Price & Friston, 2006; Poldrack & Yarkoni, 2016). To this end, we take a purely data-driven approach to organize and evaluate the language processes embedded in Neurosynth (Yarkoni et al., 2011). We build on prior work describing unique brain networks across task paradigms (Smith et al., 2009; Laird et al., 2011; Yeo et al., 2016) and studies (Poldrack & Yarkoni, 2016), by capturing the core networks underlying a broader class of functional features (i.e. task paradigms, brain areas, methodologies, and cognitive functions attached to studies) while accounting for the selectivity of brain areas that are associated with each feature. Using Independent Principal Component Analysis (IPCA; Yao et al., 2012), we reduce 3,107 meta-analyses of features to 145 networks. This approach generates highly interpretable feature groupings (e.g. memory subsystems, motor control/representation, attentional, emotion/social, and perceptual processes) that are sensitive to subtle dissociations- for instance, phonemic perception and phonological processing dissociate on the basis of involvement in auditory and reading networks. The language-specific networks we uncover include those loading onto lexical-semantics, reading, speech production, auditory perception, and comprehension. With a bootstrap analysis, we show that these networks are amongst the most stable, and can be extracted reliably. Although there is substantial overlap across the language-specific networks, especially in posterior superior temporal sulcus (pSTS) and inferior frontal gyrus, we find strong preferential relations between reading and the fusiform gyrus (FG); lexical-semantics and the inferior temporal gyrus and posterior middle temporal gyrus (pMTG); comprehension and area 55b and pSTS; speech production and ventral premotor cortex as well as pars opercularis; and speech perception and primary/association auditory cortex. We also find that lexical-semantics is considerably more selective for areas of the ventral FG, that reading is selective for anterior portions of the pMTG, and that both auditory and speech production networks are strongly associated with an area in the posterior planum temporale. Further, comprehension exhibits some preference for the anterior temporal lobe, lexical-semantics for anterior pars triangularis and orbitalis, and reading for the paracingulate gyrus and superior parietal lobule. We find that the majority of areas that constitute language-specific networks do not participate considerably in non-language networks. Taken together, these findings highlight a network broadly tuned for language, but comprised of areas that preferentially respond to certain aspects of language function. Moreover, they demonstrate that meta-analytic datasets can be a robust testing ground for theories about the functional organization of language.

B68 A cognitive psychometric model of picture naming improves lesion-symptom maps

Grant Walker[1], Julius Fridriksson[2], Gregory Hickok[1]; [1]University of California, Irvine, [2]University of South Carolina

A lesion-symptom map (LSM) can be used to infer brain function from brain damage, correlating behavioral symptom measures with measures of stroke lesions derived from modern neuroimaging. The interpretability

of an LSM especially depends on good measurement models for symptoms. We recently developed a cognitive psychometric model to assess picture naming abilities in aphasia derived from 8 response type categories based on lexical status and semantic and phonological relations with the target (Walker, Hickok, & Fridriksson, 2018). We used a multinomial processing tree (MPT) to separate lexical selection errors from phonological selection errors, and we used item response modeling to separate the effects of participant abilities and item difficulties on the probability of successful selections. Here, we test the validity of the ability estimates by comparing them with 3 other ways of modeling picture naming deficits that neglect item information: 1) response type frequencies, 2) connectionist model weights (Foygel & Dell, 2000), and 3) varimax-rotated principal components of normalized error frequencies. We examined the generalizability of these measures to independent data, both behavioral and neurological. First, we examined correlations between the naming measures and scores on 3 word and picture matching tests and scores on 3 speech repetition tests from 127 people with aphasia. We found that the MPT abilities had the strongest correlations for 4 out of 6 tests (R=.64-.69), including 2 matching and 2 repetition tests. The other tests had slightly stronger correlations with the frequency of correct responses and the 1st PC of error frequencies (mainly Omission, Unrelated, and Abstruse Neologism), measures of general severity that do not distinguish between different types of mental computation. Next, we generated voxelwise LSMs for each naming measure from 81 people with aphasia using multivariate PLS regression. We used cross-validation (training n=70, testing n=11; arbitrary split) to evaluate generalizability, comparing MPT ability predictions using LSMs with predictions using lesion volume and with other naming measure predictions using LSMs. MPT abilities were better predicted by LSMs than volume (about 3% more variance accounted for with LSM) and were better predicted by LSMs than other measures of separate latent processes (i.e., connectionist weights or error frequencies). Next, we examined associations between stroke volume and MPT abilities in 61 brain regions of the JHU atlas, using multivariate OLS regression to control for damage outside of the region. Permutation of lesion-behavior pairings (n=10,000) was used to test for significance, and bootstrap resampling (n=10,000) was used to test for robustness. Lexical abilities were associated with damage in lateral temporal regions, while phonological abilities were associated with damage to the parietofrontal network, consistent with functional neuroanatomy models. Finally, we tested whether participants with apraxia of speech were influencing LSMs; excluding these participants dramatically changed the LSM for phonological ability but not lexical abilities, by reducing cross-validation prediction error and shifting associations to the posterior superior temporal gyrus. The results demonstrate that the MPT model measures cognitive abilities that depend on separable neural substrates and improves the interpretability and generalizability of measurements to independent behavioral and neurological data.

B69 Quantitative Assessment of Cognitive Models with Neuroimaging Data

Frank H Guenther[1], Ayoub Daliri[2], Alfonso Nieto-Castanon[1], Megan Thompson[1], Jason A Tourville[1]; [1]Boston University, [2]Arizona State University

Advances in neuroimaging techniques such as functional magnetic resonance imaging (fMRI) and electrocorticography (ECoG) over the past two decades have resulted in a greatly improved understanding of the neural mechanisms underlying human sensory, motor, and cognitive capabilities, leading to increasingly sophisticated neural models of these functions. Within the domain of speech, we have developed and refined a large-scale neurocomputational model, called the Directions into Velocities of Articulators (DIVA) model, which provides a unified mechanistic account of acoustic, kinematic, and neuroimaging data on speech [for a detailed review see Guenther (2016) Neural control of speech, MIT Press]. Functional neuroimaging has been a powerful means for evaluating and refining such models. To date, however, these evaluations have been almost exclusively qualitative. Quantitative evaluations have been hampered by the absence of a general computational framework for (i) generating predicted functional activation from a model that can be directly and quantitatively compared to empirical functional neuroimaging data, and (ii) testing between models to identify the model that best fits experimental data. Here we present a general computational framework to overcome these issues. Within this framework, the brain network responsible for a task is broken into a set of computational nodes, each of which is localized to an MNI stereotactic coordinate in the brain. Associated with each node is a computational load function that links the node's activity to a computation involving quantifiable measures from the task. The instantaneous neural activity at each location in the brain (e.g., each voxel of an fMRI image or each electrode of an ECoG array) is then calculated by summing the contributions of all model nodes at that location, with each node treated as a Gaussian activity source centered at the node's location. The parameters of the Gaussians (i.e., spread and magnitude of activation) are optimized to produce the best fit to the functional data. Model comparisons are based on the overall fit level and number of free parameters using the Akaike Information Criterion (AIC). This framework was used in conjunction with a large fMRI database of speech production studies (116 speakers) to illustrate the DIVA model's ability to provide a unified account for whole-brain activity patterns seen during speech production under normal and perturbed conditions. Additionally, the activation foci from two prior meta-analyses of speech production neuroimaging experiments [Turkeltaub et al. (2002) NeuroImage, 16: 765-780; Brown et al. (2005) Hum Brain Mapp, 25:105-117] were used to construct two new,

simplified models of speech production which were fit to the same dataset to illustrate how easy it is to create a quantitative model for fitting fMRI data. All models were then compared using the AIC, with the results highlighting the advantages of functional models like DIVA in accounting for data from multiple speaking conditions. [Supported by NIH grants R01 DC002852, R01 DC007683.]

B70 How event probability impacts sentence processing: Modeling N400 amplitudes during reversal anomalies

Milena Rabovsky[1], James L. McClelland[2]; [1]Freie Universitaet Berlin, [2]Stanford University

Introduction. Traditional accounts hold that during sentence processing, syntax is used to build a linguistic structure, and retrieved word meanings are placed into syntactically specified slots within this structure to derive a compositional representation of sentence meaning. However, accumulating evidence calls this perspective into question. For instance, comprehenders sometimes interpret canonical role-reversed sentences (e.g., "The dog was bitten by the man.") in line with event probabilities instead of syntactic conventions (Ferreira et al., 2003). Another piece of evidence comes from the N400 component which is typically increased in sentences with semantic anomalies, but has been found to be small in sentences with reversal anomalies (e.g., "The fox on the poacher hunted."; literal translation from Dutch; Van Herten et al., 2005). Such findings have been taken to indicate a temporary "semantic illusion" (of the poacher hunting the fox) consistent with event probabilities. Methods. We use a neural network model implementing a fundamentally different perspective on sentence comprehension to simulate a broad range of N400 effects (Rabovsky, Hansen, & McClelland, 2016). Specifically, in the Sentence Gestalt (SG) model (St. John & McClelland, 1990), word meanings are not retrieved from memory prior to semantic integration; instead incoming words serve as 'cues to meaning', updating a probabilistic representation of sentence meaning which is jointly constrained by event probability and syntax, and where syntactic cues may be overridden when event probability constraints are strong. The model's N400 correlate is the semantic update, i.e. the update in the representation of sentence meaning induced by the new incoming word. To simulate the kind of reversal anomalies described above, we trained the model with sentences presented in Dutch word order, and extended the training environment with scenarios set up to align with the characteristics of the materials used in the target experiment. Results. When presenting the model with sentences corresponding to those in a reversal anomaly experiment, it captures the empirical N400 data. Specifically, simulated N400 amplitudes are only slightly increased in reversal anomaly sentences ("the fox on the poacher hunted.") as compared to the corresponding control sentences ("the poacher on the fox hunted.") while they are considerably larger in incongruent sentences ("the poacher on the fox planted."). Probing the model's internal representations during the processing of the reversal anomalies reveals that the small N400 effect does not indicate a clear-cut "semantic illusion". Instead, the conflict between the constraints imposed by word order and event probability induces a state of uncertainty, which begins at the presentation of the second noun and is not resolved by the presentation of the verb. Discussion. Our results reveal a new way of thinking about the small N400 effect in reversal anomalies, shedding light on the possible unresolved state of mind in the initial processing of such sentences. Subsequent controlled processes, possibly reflected in P600 amplitudes, may be required to resolve the conflict between competing cues.

Poster Session C

Friday, August 17, 10:30 am – 12:15 pm, Room 2000AB

Control, Selection, and Executive Processes

C1 The critical role of interference control during novel metaphor comprehension

Hee-Dong Yoon[1], Min-Suk Kang[2], Tae-Hyun Yoo[1], Hyeon-Ae Jeon[1,3]; [1]Daegu Gyeongbuk Institute of Science and Technology (DGIST), Daegu, Republic of Korea, [2]Sungkyunkwan University, Seoul, Republic of Korea, [3]Partner Group of the Max Planck Institute for Human Cognitive and Brain Sciences, DGIST, Daegu, Republic of Korea

Use of figurative language such as metaphors enriches our communication and it requires considerable cognitive efforts for choosing the adequate meaning of words (Bohrn et al., 2012). Specifically, altering familiarity of metaphors (Columbus et al., 2015) and context in which metaphoric utterance is used (Prat et al., 2012) imposes additional processing demands on executive functions (Carriedo et al., 2016). Therefore, we aimed to investigate the effect of familiarity and context on metaphor processing, emphasizing the influence of individuals' executive functions measured by various neuropsychological tests. Participants read 120 two-sentence pairs in Korean. The first sentence was used as either supporting or opposing context, while the second sentence had a metaphoric expression in the form of "X is a Y" (e.g., "She is a night owl."). We had four experimental conditions: a supporting context with a familiar metaphor (SC-FM) or a novel metaphor (SC-NM), and an opposing context with a familiar metaphor (OC-FM) or a novel metaphor (OC-NM). In result, accuracy data showed main effects in both context (more accurate in OC than in SC: [$F(1,19)=25.81$, $p<.001$]) and familiarity (more accurate in FM than in NM: [$F(1,19)=17.57$, $p<.001$]). A significant interaction was observed between familiarity and context [$F(1,19)=9.72$, $p<.01$], showing that the difference in accuracy between FM and NM was greater in SC than in OC. With respect to response time (RT), we found main effects in both context (faster in SC than in OC: [$F(1,19)=25.03$, $p<.001$]) and familiarity (faster in FM than in NM: [$F(1,19)=75.79$, $p<.001$]). A significant interaction was observed between the familiarity and the context [$F(1,19)=4.65$, $p<.05$],

demonstrating that the difference in the RT between FM and NM was greater in OC than in SC. More interestingly, we found a significant correlation between scores of the Stroop test and the RTs in SC-NM condition [r=.45, p<.05]. This indicates that people showing high performance in the Stroop test, compared to low performers, inhibit conventional meanings of words more effectively when processing novel metaphors. Taken together, these results suggest that the interference controlling mechanisms that operate in the Stroop test play an important role in processing a novel metaphor by inhibiting its familiar meaning and choosing a less familiar meaning that is contextually more appropriate. Key Topic: metaphor, familiarity, context, executive function

C2 Pre-output language monitoring in sign production

Stephanie Ries[1], Soren Mickelsen[1], Linda Nadalet[1], Megan Mott[1], Katherine J. Midgley[1], Phillip J. Holcomb[1], Karen Emmorey[1]; [1]San Diego State University

A domain-general monitoring mechanism is proposed to be involved in overt speech monitoring. This mechanism is reflected in a medial frontal component, the error negativity (Ne), present in both errors and correct trials (Ne-like wave) but larger in errors than correct trials. In overt speech production, this negativity starts to rise before speech onset and is therefore associated with inner speech monitoring. Here, we investigate whether the same monitoring mechanism is involved in sign language production. Twenty Deaf signers (ASL dominant) and sixteen hearing signers (English dominant) participated in a picture-word interference paradigm in ASL. Distractor words could be semantically-related, identical, or unrelated to the picture name. As in previous studies, ASL naming latencies were measured using the keyboard release time (any manual hesitations after keyboard release were removed from the data). The analysis comparing the Ne to the Ne-like wave included only the participants who produced more than 5 errors overall (12 Deaf signers, 11 hearing signers). EEG results revealed a medial frontal negativity peaking within 15 ms after keyboard release in the Deaf group. This negativity was larger in errors than correct trials, as previously observed in spoken language production. No clear negativity was present in the hearing group. We then analyzed the effect of the distractor type on behavior and on the amplitude of the Ne-like wave over all Deaf participants (N=20). Semantically-related distractor-word pairs and identical distractor-word pairs yielded faster reaction times than unrelated distractor-word pairs (p=.020 and p<.001 respectively). However, there was no effect of distractor type on the amplitude of the Ne-like wave. We therefore also conducted a post-hoc analysis in which we divided the semantically-related stimuli into categorically-related (e.g., truck and car, n=32) and associatively-related (e.g., king and crown, n=16) picture-word pairs. The associatively-related picture-word pairs yielded marginally shorter RTs (p=.062) and a marginally smaller Ne-like wave in comparison with the unrelated picture-word pairs (p=.082). There were no differences between the other conditions for Ne-like wave amplitudes, though RTs were also marginally shorter in the categorically-related versus unrelated conditions. Our results indicate that a similar medial frontal mechanism is engaged in pre-output language monitoring in sign and spoken language production. These results suggest that the monitoring mechanism reflected by the Ne/Ne-like wave is independent of output modality (i.e. spoken or signed) and likely monitors pre-articulatory representations of language. In particular, this medial frontal monitoring mechanism may be sensitive to lexical access difficulty, as indexed by the marginal facilitation effect for associatively-related compared to unrelated picture-word pairs. Differences between groups may be linked to several factors including differences in language proficiency, with more variable lexical access to motor programming latencies for hearing signers, and lower error awareness in hearing signers compared to Deaf signers.

Speech Motor Control and Sensorimotor Integration

C3 The Role of Primary Motor Cortex in Second Language Word Recognition

Beatriz Barragan[1], Kazumasa Uehara[1], Marissa Miller[1], Yuto Tauchi[2], Marco Santello[1], Julie Liss[1]; [1]Arizona State University, [2]Okayama University

The involvement of primary motor cortex (M1) activity is a common feature in speech perception tasks that involve difficult listening conditions (Adank, 2012; Devlin & Aydelott, 2009; Nuttall et al., 2016). Moreover, this M1 activity has shown to be linked to improved performance on those tasks. It has been therefore hypothesized that recruitment of M1 facilitates perception. Learning a second language (L2) can be thought of as a specific instantiation of listening in difficult conditions because it involves additional processing and cognitive-perceptual resources to distinguish among the new language sounds. If this is the case, M1 activity during L2 word recognition is expected. The purpose of this study was to investigate the role of M1 representation of the lip orbicularis oris (OO) muscle in processing acoustic inputs in the native language (L1) and L2. A repetitive Transcranial Magnetic Stimulation (rTMS) protocol was employed with a double-blinded, sham-controlled and crossover design, to selectively alter neural activity in M1 in twenty-four healthy English/Spanish bilingual participants. The performance on a bilingual listening word-to-picture matching task was measured before and after the rTMS and sham conditions. rTMS was applied for 15 minutes at 0.6Hz frequency, and 100% of active motor threshold intensity, whereas sham was applied without magnetic pulses as a control condition. Single-pulse TMS-induced motor evoked potential (MEP) from the OO muscle was used to assess the effect of rTMS on M1. This manipulation revealed high variability in the aftereffect of the rTMS protocol among participants; although inhibitory changes in M1 were expected (Cirillo

et al., 2017, Möttönen et al., 2014), approximately 50% of participants exhibited inhibitory changes, whereas the other 50% had facilitatory changes. This observation suggests that rTMS led to complex influences on M1 excitability and relying on grand-average results can obscure important individual differences in rTMS physiological and functional outcomes. We found evidence of motor support to word recognition in L2. Participants who showed inhibitory changes in M1 by rTMS were significantly slower and less accurate in L2 word recognition after rTMS compared to the sham condition. This result suggests that the rTMS-induced disruption of M1 associated with speech articulators interfered with L2 speech recognition. On the other hand, the participants who exhibited facilitatory changes on M1 by rTMS were more accurate compared to the sham condition. Reaction time in pre- and post-rTMS performance was comparable, suggesting that a similar speed performance was associated with more accurate speech recognition for L2 after rTMS-induced facilitation. In both groups of participants (inhibitory and facilitatory changes on M1 by rTMS) no effect of rTMS was found on L1, where accuracy and speed were quite similar after sham- and real-rTMS. Together, our results provide substantial support for the role of M1 on L2 word recognition, and revealed a functional relation between M1 modulation and word recognition. These results suggest that M1 excitability contributes to L2 speech perception, and that sensorimotor integration is important for L2 neural information processing within the brain.

C4 Cortico-striatal tractography: Structural connectivity of the left inferior frontal gyrus along the rostrocaudal length of the putamen *Simone Renée Roberts[1,2,3], Anastasia Bohsali[4,5], Stella Maria Tran[1,2,3], Jonathan Harris Drucker[1,2], Steven Hirschmann, Tricia Z. King[3], Lisa C. Krishnamurthy[1,2,3], Venkatagiri Krishnamurthy[1,2], Thomas Mareci[5], Bruce Crosson[1,2,3]; [1]Center for Visual & Neurocognitive Rehabilitation, US Department of Veterans Affairs, Atlanta, GA, [2]Emory University, [3]Georgia State University, Atlanta, [4]Brain Rehabilitation Research Center, US Department of Veterans Affairs, Gainesville, FL, [5]The University of Florida, Gainesville, FL*

The left inferior frontal gyrus (IFG) is widely acknowledged for its domain-specific, functional contributions to the human language network. In contrast, the basal ganglia are not believed to maintain domain-specific language functions, but rather to provide domain-general or executive support that influences behavior and development. The putamen of the basal ganglia is primarily considered to be specialized for motor and sensory support, in consideration of extensive, rostrocaudally distributed projections from motor and sensory cortices. However, accumulating evidence implicates the putamen for substantial language network involvement as well. For instance, putaminal lesions are associated with speech articulation changes. Volumetric studies have correlated native-proficiency bilingualism with greater putaminal volume, while functional MRI research has demonstrated that non-native, bilingual speech production may activate regions along the rostrocaudal length of the left putamen. Structurally, ex vivo neuronal tracing studies in non-human primates have demonstrated that the anterior putamen receives white matter projections from cortices homologous with all three regions of the IFG. In vivo, white matter tractography from diffusion-weighted MRI has similarly demonstrated anterior putaminal connectivity in humans, for Broca's area of the left hemisphere's IFG (i.e. pars opercularis and pars triangularis). The present study replicates and extends previous tractography research by demonstrating structural connectivity of Broca's area and the putamen in the left hemisphere, evaluating the presence of similar projections from the left IFG's pars orbitalis, and visually mapping within-putamen white matter topography for all left IFG projections. Diffusion-weighted images were acquired from 11 healthy, young adult volunteers. High-angular, deterministic streamline tractography was generated using a mixture of Wisharts signal attenuation model and spherical deconvolution. Structural networking eliminated streamline vectors that did not directly connect nodes of interest in order to filter data for relevance, while retaining all fiber estimations within nodes to permit visualization of within-putamen connectivity. Resulting networks replicated previous findings of Broca's area's structural connectivity with the left anterior putamen and suggested the presence of similar projections originating from pars orbitalis. Across IFG cortices, projections along the rostrocaudal length of the putamen were also observed. Streamlines that entered the midsection and posterior of the left putamen passed through the external capsule and terminated medially. Comparable external capsule projections have been reported previously for non-human primates and rats, however not for fibers originating in the IFG. Thus, these findings may in part represent a species-specific structural connectivity pattern. The presence of rostrocaudally distributed putaminal fiber projections from the IFG suggests a unique and possibly integrative role for the putamen in cognitive processing. Is the human putamen structurally equipped to orchestrate executive coordination of language/motor integration? If so, this study's findings might in part illustrate why humans are able to perceive and program the extraordinarily diverse set of speech sounds and combinations that characterize human verbal communication. Moving forward, broader conceptualization of the putamen as a dual language/motor structure and further vetting of human putaminal connectivity might lead to novel insights regarding the substrate, development, and execution of language acquisition and speech articulation.

Phonology and Phonological Working Memory

C5 Does alphabetic orthography influence sound variation and change? Evidence from Hong Kong Cantonese

Yubin Zhang[1], Kisa Sze Wai Chan[1], Caicai Zhang[1,2]; [1]The Hong Kong Polytechnic University, [2]Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences

Sound change is a complex process driven by many factors. In Hong Kong Cantonese (HKC), several sound pairs, e.g., l-/n-, g-/gw-, k-/kw-, ng-/0- (zero initial), ng/m, -n/-ng, -t/-k, high-rising/low-rising tone, mid-level/low-level tone, low-falling/low-level tone, are in the process of variation and merging. In this study, we aim to examine the influence of learning an alphabetic script on sound variation and change in HKC. The official writing system in Hong Kong is Chinese, a logographic script, which maps signs (i.e., Chinese characters) onto spoken words at the syllabic level, without revealing fine-grained phonemic information. Nonetheless, some Cantonese speakers have mastered Jyutping, a Romanization system of Cantonese, in adulthood. We attempt to test the hypothesis that Jyutping expertise is associated with more accurate production and perception of potential sound mergers, possibly via improved phonemic awareness and representations. Twelve Cantonese speakers with Jyutping proficiency and 12 matched controls were recruited. Their production and perception of potential mergers were tested by an elicited production task and a discrimination task. In the production task, they were required to read aloud monosyllabic Chinese characters, representing minimal pairs that contrast the merging sounds, within a carrier sentence. The accuracy and goodness of their production were assessed by two independent phoneticians. In the discrimination task, they had to judge whether the two words in a minimal pair were the same or not. Their reaction time and sensitivity index (d') were analyzed. We found that the Jyutping group achieved significantly higher accuracy in their production of g-, ng-, and n- than the control group, whereas they made more errors for 0-, presumably due to their overcorrection of 0- to ng-. The Jyutping participants obtained higher rating scores in their production of g-, gw-, l-, n-, ng, and -ng than the controls, while their production of 0- again received lower scores. As for the discrimination, there was a non-significant trend that the Jyutping group obtained higher d' than the control group for all the potential mergers. The results indicated that learning an alphabetic orthography could influence sound variation and change to some extent, consistent with previous findings that alphabetic orthography reorganizes and enhances spoken language processing. Interestingly, Jyutping expertise appeared to exert more effects on distinctions involving the presence or absence of a certain segment or a static feature, e.g., g-/gw-, 0-/ng-, and l-/n-. In contrast, its influence on sounds that utilize dynamic acoustic information, like formant transitions in -n/-ng and -t/-k, and suprasegmentals like tones, seemed to be limited. We argue that the alphabetic orthography may influence sound variation and change by providing general orthographic labels of speech categories, but it may benefit less phonological distinctions that rely on the richness of fine-grained acoustic details. These findings imply that the acoustic-orthographic-phonological interaction might need to be incorporated into models that deal with cognitive components of sound change (e.g. Ohala, 1990).

C6 Does the modified Sternberg task measure verbal working memory function? Evidence from experimental pharmacology

Christopher Barkley[1], Zhenhong Hu[2], Ann Fieberg[1], Lynn Eberly[1], Susan Marino; [1]University of Minnesota, [2]University of Florida

The modified Sternberg has been widely adopted for use as a verbal working memory (VWM) task (e.g. Ruchkin, 1991). However, there is an important structural difference between the currently used version of the task and the original (Sternberg, 1966): almost universally, subjects are no longer asked to perform serial recall at the end of each trial. The absence of a requirement to encode and recall serial order information is a fundamental difference between the modified Sternberg and other VWM tasks (e.g. reading span; Daneman & Carpenter, 1980); this raises the possibility that the modified Sternberg may not be an unambiguous test of VWM. In the current study, we investigated the widespread cognitive side effects associated with two commonly prescribed drugs: Topiramate (TPM), a broad-spectrum anti-seizure drug used to treat a range of conditions including epilepsy, obesity, and migraine; and lorazepam (LZP), a benzodiazepine used to treat anxiety and sleep disorders. In addition to further characterizing the incidence and severity of these drug-induced impairments, this study allowed us to assess the construct validity of the modified Sternberg as a test of VWM. Twenty-nine subjects received TPM (100, 150, or 200 mg), LZP (2 mg), and PBO in a randomized, double-blind, crossover study design. Four hours after drug administration, subject's accuracy and reaction time (RT) were recorded while they completed the modified Sternberg (three memory loads: 1, 3, 5 syllables); .5, 2.5, and 6 hours after drug administration they completed a neuropsychological (NP) battery containing tests of: VWM (digit span), verbal fluency (semantic, phonemic), and visual information processing and psychomotor speed (Trails A and B; SDMT). The severity of drug-induced impairment was calculated by comparing each treatment to PBO ((drug-PBO)/PBO) to generate relative change scores, thus normalizing across individual differences in unimpaired performance. Linear mixed effects models of relative change scores were constructed for all VWM and NP measures and adjusted for age, gender, education, treatment order, session number, and TPM dose group. TPM caused decreases in accuracy (but not RT) on the modified Sternberg ($p<.0001$) and impaired performance on all NP measures ($p<.0001$).

LZP caused decreases in accuracy (p<.0001) and increases in RT (p<.0001) on the modified Sternberg, and impaired performance on Trails A and B, and SDMT (all p<.01). There was no significant difference between LZP and PBO on digit span or verbal fluency tasks. These LZP data suggest that, absent the serial recall requirement, the modified Sternberg may not be a true VWM task. If it were, one would expect impairments on the modified Sternberg to co-occur with deficits on VWM tasks (digit span) and declines in verbal fluency. Instead, performance on these tasks was spared, while LZP caused pronounced impairments on tasks that require the rapid processing of visual information (Trails A and B, SDMT). These data are consistent with the view that the modified Sternberg should perhaps be viewed as a visual recognition memory task rather than a test of VWM. If so, modified Sternberg data and the conclusions drawn from it should be interpreted with caution.

C7 Phonological rule application recruits left inferior frontal gyrus

Mathias Scharinger[1,2,3], Johanna Steinberg[3,4], Frank Zimmerer[5], Jonas Obleser[6]; [1]Phonetics Research Group, Department of German Linguistics, Philipps-University Marburg, Germany, [2]Center for Mind, Brain and Behavior, Philipps-University Marburg, Germany, [3]Cognitive and Biological Psychology, University of Leipzig, Germany, [4]AGAPLESION Diakonieklinikum Rotenburg GmbH, Rotenburg (Wuemme), Germany, [5]Language Science & Technology, Saarland University, Germany, [6]Institute for Psychology, University of Luebeck

Auditory processing in speech follows a trajectory emanating from primary auditory cortices towards anterior and posterior locations. With increasing abstraction from acoustic-phonetic stimulus details, processing areas are further away from primary auditory locations. Corroborating phonological theory positing such abstraction from acoustic-phonetic detail, recent research has established superior temporal sulcus and inferior frontal gyrus as possible phonological processing areas. However, most studies referred to "phonology" by rather simple definitions, therefore leaving some gaps between theoretical phonology and cognitive neuroscience. To this end, we re-visited a well-known and well-researched phonological process, namely, final devoicing in German. Final devoicing is a phonological rule that changes voiced consonants such as [d] into voiceless [t] if they occur in syllable-final position. We reasoned that native German speakers have tacit knowledge of this rule, such that ambiguous consonants in syllable-final position are automatically interpreted as voiceless. This process may require additional resources. Ambiguous consonants were constructed by parametrically changing acoustic cues to voicing in German, resulting in an 11-step continuum of consonants, reaching from transparently voiced to transparently voiceless members. Consonants embedded in syllable-initial and syllable-final position of pseudo-words were presented in an alternative forced-choice task during which participants had to identify the voiced or voiceless consonants. From this task, we selected the consonants with chance-level accuracy and used them as ambiguous consonants in a functional magnetic resonance imaging (fMRI) study. Therein, a 2 x 2 design of position (syllable-initial, syllable-final) and ambiguity (ambiguous, transparent) was employed. Results revealed a main effect of position in a typical auditory speech network, showing stronger BOLD signals in bilateral superior temporal gyri and sulci, left inferior frontal gyrus, left thalamus and left inferior parietal cortex for syllable-final compared to syllable-initial position. Next, we identified a main effect of ambiguity with stronger BOLD signals in left inferior frontal gyrus and left precentral cortex for ambiguous than for transparent consonants. Finally, there was an interaction of the effects of position and ambiguity in the pars triangularis of left inferior frontal gyrus (IFG). This interaction was driven by a stronger BOLD signal for ambiguous voicing in syllable-final position than in syllable-initial position. No such difference was seen for transparent voicing. We take this interaction to reflect the left IFG's role in supporting the phonological rule application of final devoicing in German. This interpretation is corroborated by previous studies that established the IFG's role for sequencing in phonological processes. We thus show that left IFG may indeed support proper phonological processes that go beyond mere syllable counting.

Perception: Speech Perception and Audiovisual Integration

C8 Brain activity predicts future learning potential in intensive second language listening training

Mayumi Kajiura[1], Hyeonjeong Jeong[2], Natasha Y. S. Kawata[2], Shaoyun Yu[1], Toru Kinoshita[1], Ryuta Kawashima[2], Motoaki Sugiura[2]; [1]Nagoya University, [2]Tohoku University

In second language (L2) listening, mapping sound to meaning is important, especially for learners who learn better when they read than when they listen. Reading a transcript before listening might be an effective method for these learners to map sounds to their meanings (Kajiura, 2016). In the present study, brain activity that was associated with mapping sound to meaning was examined to determine if it can predict the future effects of intensive L2 listening training. To determine the brain area involved in the function of mapping sound to meaning, the brain activities in different L2 listening conditions (TR: faster-rate listening after transcript reading and NTR: faster-rate listening without transcript reading) were compared. The study hypothesis was that individual patterns of brain correlated more with individual learning effects (training-induced score increase) in intensive L2 [2.5 h × 5 days] listening training in the TR condition compared with the NTR condition. The subjects were 19 healthy right-handed Japanese learners of English (mean age, 20.7; 13 males, 6 females; informed consent obtained). The stimuli were 40

fast-rate (faster than 340 wpm) short L2 (English) passages (counterbalanced, randomly presented, natural voice recordings of native speakers, easily read but difficult to listen to because of the speech rate). The participants read the transcripts of half of the stimuli and then listened to the passages (half were read before and the other half were not read) while undergoing functional magnetic resonance imaging (fMRI). After the fMRI scans, the participants underwent intensive (2.5 h × 5 days) L2 listening training using transcript reading and faster-rate listening. Different versions of Standard English proficiency tests [i.e., Test of English for International Communication (TOEIC®)] were used as the pre- and post-tests to assess their improvements which were used to analyze the correlation of the score change with brain activity. The fMRI data were analyzed using flexible analysis of variance using SPM12 (http://www.fil.ion.ucl.ac.uk/spm/software/spm12/). The results showed listening proficiency levels improved significantly [paired t (18) = -7.8866, $p < 0.001$) after intensive L2 training. Significant changes in brain activity in the TR condition were found in the left angular gyrus (AG) and middle temporal gyrus (MTG; t = 4.74, family-wise error $p < 0.05$ for the cluster level), which suggested the association of these brain areas with the integration of sound and previously read information. The L2 training-induced TOEIC score increases positively correlated with AG/MTG activity, which was associated with the integration of sound and meaning) in the TR condition [Spearman's ρ (rho) = 0.52, p = 0.023). Individuals with a highly active left AG/MTG in the TR condition tended to be more successful at this training. Thus, these results indicated that AG/MTG activity predicted the effects of learning in intensive L2 listening training only in the TR condition and suggested that learners with greater activation of the AG/MTG were able to map sound and meaning while listening, which contributed to the effects of this training. Kajiura, M. (2016). JACET Journal, 60, 117-135

C9 Do you see what i am saying? An EEG study about the perception of visual speech.

Maëva Michon[1], Gonzalo Boncompte[1], Vladimir López Hernández[1]; [1]Pontifical Catholic University of Chile, School of Psychology

The current study examines the electrophysiological correlates of the perception of linguistic versus non-linguistic orofacial mouvements and investigates the role of automatic mimicry in the processing of visual speech. To this end, participant's were recorded with a 64-Channel EEG device while they attentionally observed or imitated short videos displaying 4 types of orofacial mouvements (i.e., still mouth, syllables, backward played syllables and non-linguistic mouth mouvements) and non-biological mouvements. In order to study the role of automatic mimicry the very same experiment was repeated and participants were asked to hold an effector depressor horizontally between their teeth. The ERP results showed a significant effect for the perception of visual speech. Namely, the amplitude was decreased in N1 component and increased in P2 component for syllables versus non-linguistic mouvements. Interestingly, this effect was no longer significant when imitative behavior was disrupted by effector depressor. These findings are in line with behavioral studies reporting an important contribution of visual cues and automatic mimicry for speech perception and comprension.

C10 Talker-anchoring deficit in lexical tone processing in Cantonese-speaking congenital amusics: Evidence from event-related potentials

Jing Shao[1,2], Rebecca Yick Man Lau[1], Caicai Zhang[1,2]; [1]The Hong Kong Polytechnic University, [2]Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences

Congenital amusia (amusia hereafter) is a neurodevelopmental disorder that impacts the perception of music negatively. Previous studies have found that amusics are also impaired in lexical tone perception; importantly, amusics are more impaired in taking advantage of low acoustic variation (i.e., syllable and talker variation) in lexical tone perception, suggesting a deficit in anchoring to acoustic constancy (i.e., a constant syllable or talker) in perception. However, a fuller understanding of the neural mechanism underlying such anchoring impairment in tone perception remains to be achieved. To pinpoint the deficiency neural mechanism, we examined the event-related potentials (ERPs) in 24 Cantonese-speaking amusics and 24 controls in an active oddball paradigm. ERPs were recorded during tone change detection in Cantonese tone pairs with small pitch differences (mid level-low level, or T3-T6) vs. large pitch differences (high level-low level, or T1-T6) presented in blocked-talker vs. mixed-talker conditions. In the blocked-talker condition, tone stimuli from each of four talkers were presented within a separated block (i.e., low talker variation); in the mixed-talker condition, tone stimuli from the four talkers were mixed within one block (i.e., high talker variation). All stimuli were presented in an oddball paradigm. Higher talker variability in the mixed-talker condition requires greater attentional resources to process the talker voice idiosyncrasies and form a stable tonal "template", thus making the detection of the deviant much more demanding in this condition. It is predicted that in general the P300 activities will be reduced in the mixed-talker condition. Given that amusics have deficits in anchoring to the acoustic constancy, amusics were expected to show reduced P300, especially in the blocked-talker condition. The results demonstrated that in the time-window of P3a (350-450 ms after auditory onset), the P3a amplitude was enhanced in the blocked-talker condition relative to the mixed-talker condition, but the effect size was smaller in the amusic group; moreover, the amusic group exhibited significantly reduced P3a amplitude compared to the control group in the blocked-talker condition, but the group difference was not significant in the mixed-talker condition. In the time window of P3b (500-800 ms after auditory onset), the amusic

group showed overall reduced P3b amplitude than the control group, irrespective of blocked- and mixed-talker presentation manners. The P3a results suggested that the amusic brain was impaired in consciously processing the novelty of lexical tone changes, with reduced attentional switch to such changes when the talker variation was low. This implies that the attentional resources to attend to a constant talker may be reduced in the amusic brain, which presumably underlies the anchoring deficit observed in amusics. As the P3b is associated with stimulus categorization, the reduced P3b in amusics may imply that the amusic brain was overall impoverished in the ability to categorize lexical tone changes, irrespective of low and high variation conditions. This is consistent with the previous finding that amusics are impaired in consciously detecting and categorizing lexical tone differences. Altogether, these findings shed some light on the neural underpinnings of amusia in lexical tone perception.

C11 Neural evidence of voice processing: the distinction between familiar and unknown voices *Julien Plante-Hébert[1], Boutheina Jemel[2], Victor Boucher[1]; [1]Laboratoire de sciences phonetiques de l'Universite de Montreal, [2]Laboratoire de recherche en electrophysiologie cognitive, Hopital Riviere-des-Prairies*

From an evolutionary perspective, familiar voice recognition, an ability humans share with many other species, was crucial to distinguish individuals representing a potential menace. However, discrimination amongst unknown voices presents a more general ability. On this basis, research has suggested that separate processes may underlie the recognition of familiar voices and the discrimination of unknown voices. It remains, however, unclear whether these two abilities present differing neural correlates. The primary objective of our study is to identify the EEG correlates associated with listeners' recognition of a familiar voice and discrimination of unknown voices. In the present study, the ERPs of 13 participants were recorded as they passively listened to a set of 12 similar voices (same dialect, average F0 within 1 semitone, etc.). Within this set of voices, only one speaker was very familiar to the participants (e.g. the voice of a family member, a close friend, a partner, etc.) while 11 other voices were unknown. The ERPs were recorded over four blocks of 240 trials, each block representing a four-syllable utterance. The familiar voice and one unknown voice ("frequently heard voice" condition) were each presented on 33% of trials and the remaining 10 unknown voices ("rarely heard voice" condition) were each presented on approximately 3% of trials. Significant differences were observed between the familiar voice and both types of unknown voices (frequently and rarely presented) on a component peaking between 200 and 250 ms on right central electrodes (FC4, C4 and CP4). The familiar voice was also found to be significantly different from all the unknown voices on later-occurring components between 450 and 850 ms. Within this time window, the strongest differences were observed on most right temporal and left parietal sites between 550 and 650 ms. Analysis also revealed significant differences between the frequently presented voice and the rarely presented voices on most left frontal and right parietal sites only between 300 and 350 ms. We interpret the timeline of ERP responses as reflecting a two-step process of familiar voice recognition. First, as shown in the 200–250 ms time window, listeners recognize a voice as being familiar, compared to unknown voices. Second, as illustrated by the results of the later-occurring components (450–850 ms), listeners identify the voice by accessing a speaker-voice representation in long-term memory, which requires more processing time in more brain regions. Our results also support the idea that the process of unknown voice discrimination is distinct from familiar voice recognition. Indeed, the only significant difference between the frequent and the rare voices was observed in a different time window (300–350 ms). This difference suggests that listeners processed the frequent voice and the rare voices separately. However, since no contextual information about the frequent speaker was accessible to the listener, the voice remained unknown and yet remembered. Taken together, the results offer neurophysiological evidence of a complex processing of familiar voices as well as the presence of a parallel process implicated in unknown voice discrimination based on the creation of exemplars in memory.

C12 Orofacial somatosensory inputs improves speech sound detection in noisy environments *Rintaro Ogane[1,2], Jean-Luc Schwartz[1,2], Takayuki Ito[1,2,3]; [1]GIPSA-lab, CNRS, Grenoble Campus, BP46, F-38402 Saint Martin D'Hères Cedex, France, [2]Univ. Grenoble Alpes, 38400 Saint Martin D'Hères, France, [3]Haskins Laboratories, New Haven, CT*

Noise in speech communication reduces intelligibility and makes it more difficult for the listener to detect the talker's utterances. Seeing the talker's facial movements aids the perception of speech sounds in noisy environments (Sumby & Pollack, 1954). More specifically, it has been demonstrated in psychophysical experiments that visual information from facial movements facilitated the detection of speech sounds in noise (audiovisual speech detection advantage, Grant & Seitz, 2000; Kim & Davis, 2004). Besides visual information, the somatosensory information also intervenes in speech perception. The somatosensory information has been shown to modify speech perception in quite (Ito et al., 2009; Ogane et al., 2017), but it might also be useful for the detection of speech sounds in noisy environments. The aim of this study is to examine whether orofacial somatosensory inputs facilitate the detection of speech sounds in noise. We carried out a detection test involving speech sounds in acoustic noise and examined whether the detection threshold was changed by somatosensory stimulation associated with facial skin deformation. In the auditory perception test, two sequential noise sounds were presented through headphones. A target speech sound

/pa/, which was recorded by a native French speaker, was embedded inside either of the two noise stimuli, at a random position in time (0.2 or 0.6 s after noise onset). Participants were asked to identify which noise sound contained the speech stimulus by pressing a keyboard key as quickly as possible. We tested 10 signal-to-noise ratio (SNR) levels between the target speech sound and the background noise (from -8 dB to -17 dB). The percentage of correct detection response was obtained at each SNR level, providing the estimation of psychometric functions. The detection threshold level was defined as the point at 75 % correct detection in the estimated psychometric function. We compared the detection threshold in two experimental conditions: in a pure auditory condition and in a condition in which somatosensory stimulation was added. In the somatosensory condition, facial skin deformation generated by a robotic device was applied in both noise intervals. The somatosensory stimulation timing was matched with the timing of the target speech sound onset (burst onset). The two experimental conditions contained all SNR levels with 20 occurrences per SNR level (hence 200 responses per condition), and the 400 stimuli (grouping the two conditions) were presented in a randomized order. We found that the detection threshold level was lowered when somatosensory stimulation was applied (with a 0.6 dB decrease in SNR at threshold). This "audio-somatosensory detection advantage" shows the role of somatosensory inputs for processing speech sounds even in noisy environments, and is consistent with the idea that the somatosensory information is part of the speech perception process.

C13 Brain oscillations and speech rate variations: cortical tracking of syllable rate and fundamental frequency in children and adults

Véronique Boulenger[1], Guiraud Hélène[1], Hincapié Ana-Sofia[2,3], Jerbi Karim[2]; [1]Laboratoire Dynamique Du Langage, CNRS/Université de Lyon UMR5596, Lyon, France, [2]Département de Psychologie, Université de Montréal, Canada, [3]Pontificia Universidad Católica de Chile, Santiago de Chile, Chile

Understanding speech is undoubtedly challenging for the listener's brain, especially given the large variability of the speech signal. For efficient decoding, the continuous acoustic stream has to be parsed into shorter units that can be mapped onto linguistic representations. In this regard, the (quasi-)rhythmicity of speech is fundamental as it offers temporal structure that allows the listener to make predictions about the incoming signal. Cortical oscillations are thought to play a crucial role in the tracking of speech rhythm : by aligning to speech at multiple timescales, oscillations in the gamma, theta and delta frequency bands would sample the signal into phoneme-, syllable- and word-sized packets. Although increasing evidence, mostly in adults, points to such brain-to-speech synchronization, previous studies have barely examined the case of speech rate variations, despite being ubiquitous, and when they did, they used time-compressed speech (i.e. artificially accelerated speech). We here tackled the issue of natural speech perception by investigating changes in the properties of cortico-acoustic coupling when speech naturally shifts from normal to fast rate using magnetoencephalography (MEG). We examined, both in adults and in typically-developing children, cortical tracking of syllable rate as well as of speech fundamental frequency (F0), as changes in this parameter have been reported with increasing speech rate. Brain activity of 24 adults and 14 children (all French native, right-handed speakers with normal hearing) was recorded using a 275-channel MEG CTF system while they listened to sentences naturally produced at a normal rate (~6 syllables/s, mean F0 = 78.6 Hz) or at a fast rate (~9 syllables/s, mean F0 = 88.1 Hz). We estimated coherence between MEG source time-series and 1) amplitude envelope of the speech signal for brain coupling to syllable rate, and 2) the raw acoustic signal for coupling to speech F0. Our results in the two groups indicated entrainment of neuronal oscillations in a widely distributed cortical network, but peaking over the right auditory cortex. In adults, increased coherence was found between cortical oscillatory activity and speech envelope in frequencies centered on the syllable rate, namely 5-7 Hz for normal speech and 8-10 Hz for natural fast speech. In children, although such brain-to-speech alignment was observed in the normal rate condition, the shift in coupling frequency to fast rate speech did not occur. Interestingly, results in both children and adults also revealed stronger cortico-acoustic coupling at pitch frequency, which shifted up with the changes in F0 associated with faster speech rate (76-80 Hz for normal rate speech and 86-90 Hz for fast rate speech). In other words, cortical oscillations synchronized to the speech signal in a higher frequency band to follow the F0 increase that accompanied natural rate acceleration. Overall, our findings provide new evidence for brain alignment to natural speech in adults but also in children for whom evidence is still scarce. They suggest that cortical oscillations display task-specific coupling with the speech signal at frequencies that reflect syllable rate (at least in adults) and pitch.

Perception: Orthographic and Other Visual Processes

C14 The neurobiology of Braille reading beyond the VWFA

Judy Sein Kim[1], Erin Brush[1], Shipra Kanjlia[1], Marina Bedny[1]; [1]Johns Hopkins University

According to the cultural recycling hypothesis, the neural basis of culturally acquired skills is scaffolded on evolutionarily older neural mechanisms (Dehaene & Cohen, 2007). Reading, for instance, is believed to "recycle" elements of the visual object recognition and language systems. What aspects of reading determine which older systems get co-opted? To gain insight into this question, we examined the neurobiology of reading by touch in proficient blind readers of Braille. Previous

studies suggested that like sighted readers of print, blind Braille readers develop a "visual word form area" (VWFA) in the ventral object-processing stream (Reich et al., 2011). Contrary to this hypothesis, we recently showed that in congenitally blind individuals, the anatomical location of the "VWFA" responds to the grammatical complexity of spoken sentences (Kim et al., 2017). These results raise several questions. What are the neural systems that support Braille reading? Are there any specialized neural responses to Braille orthography? If so, are these responses localized in the somatosensory, visual, or fronto-temporal language network? To look for candidate Braille-specific regions, we examined data from a group of blind individuals (9F/1M) who took part in three experiments (Braille word reading, auditory sentence processing, and Braille letter priming). In Experiment 1, participants read Braille words, consonant strings, tactile shapes, and listened to auditory words and words played backwards (from Kim et al., 2017). In Experiment 2, participants listened to sentences with a syntactic difficulty manipulation as well as to nonword lists (from Lane et al., 2015). In Experiment 3, strings of single letters and strings of shapes were presented, where strings either had low variance (letters/strings repeated) or high variance (all different letters/strings). Braille word reading relative to listening to backward speech (Experiment 1) activated a wide set of regions in the left hemisphere, including the ventral occipito-temporal, early visual, somatosensory, parietal, and frontal cortices (FDR corrected, $p<0.05$). A smaller subset of the same regions were found in the right hemisphere. The letter strings > shape strings contrast (Experiment 3) activated the angular gyrus, which has previously been implicated in orthographic working memory (Rapp et al., 2016). Nearly all Braille word-responsive regions both in fronto-temporal cortices and in "visual" cortices displayed sensitivity to high-level language: Braille words > Braille consonant strings > tactile shapes, auditory words > backward sounds, and grammatically complex > grammatically simple sentences. Interestingly, the left somatosensory cortex displayed a different profile: (Braille words = consonant strings) > tactile shape strings, auditory words = backward sounds, and auditory sentences = nonwords lists (t-tests, significant if $p<0.05$). The right somatosensory cortex only showed preference for tactile over auditory stimuli. These findings suggest that there are important differences in the neural bases of reading in sighted versus blind readers. We hypothesize that both the modality of word recognition (visual vs. tactile) as well as prior visual experience (congenital blindness vs. growing up with sight) shape the neurobiology of reading. This research provides insights into how experience interacts with innate predispositions to shape the neural basis of cultural systems.

C15 Word Inversion Sensitivity as a Marker of Word Identification Style and Visual Word Form Area Lateralization *Elizabeth Hirshorn[1], Brandon Carlos[2], Corrine Durisko[3,4], Charles Perfetti[3,4], Julie Fiez[3,4], Marc Coutanche[3,4]; [1]SUNY New Paltz, [2]University of Houston, [3]University of Pittsburgh, [4]Learning Research and Development Center*

Background: Skilled visual word identification is a critical component of skilled reading. However, there is more than one underlying mechanism that enables word identification. In an alphabet like English, words can be coded orthographically using different sized visual units (e.g., individual letters, letter clusters, or whole word). By comparison, individual Chinese strokes are not independently meaningful and must be coded more at the whole word-level (i.e., holistic visual processing). Such differences in orthographic coding have been shown to lead to distinct word identification styles in bilingual English readers with different L1 writing systems (Chinese vs. Korean, an alphabet), with Chinese-English bilinguals favoring lexical coding and Korean-English bilinguals favoring sublexical coding. An area in the mid-fusiform gyrus (mFG), the "visual word form area" (VWFA), is associated with visual word identification. The VWFA usually exhibits strong left-lateralization for orthographic stimuli in skilled readers of English, whereas relatively greater bilateral VWFA activation has been observed in Chinese and artificial orthographies that focus on holistic/lexical decoding. Because English has the flexibility to use different types of orthographic coding, the current study examined individual differences in word identification style and VWFA laterality within a native English population. Behavioral Methods & Results: To identify individual differences, a measure of holistic orthographic coding was borrowed from the face processing literature: inversion sensitivity. Participants with high and low visual word inversion sensitivity, but no differences in reading skill, completed a battery of tests of reading sub-skills and an overt word reading test, where words varied along many lexical and sublexical measures (e.g., frequency, bigram frequency, imageability, etc.). Results revealed that greater inversion sensitivity (i.e., greater holistic orthographic coding) was associated with a reading style that relies more on lexical-level processing, and a word representation that relies less on sublexical phonological decoding. fMRI Methods & Results: We used a new multivariate method that used machine learning to assess functional lateralization within the visual word form area (VWFA) and its right hemisphere homologue (rVWFA). We then examined the relationship between individuals' lateralization results (i.e., differential classification accuracy for alphabetic stimuli in each hemisphere) and their corresponding inversion sensitivity scores. We found a significant relationship between individual differences in neural lateralization and inversion sensitivity, such that individuals with greater inversion sensitivity had greater bilateral VWFA classification accuracy. Conclusions: We conclude that proficient native readers of English exhibit differences in reading style and VWFA lateralization,

which has significant implications for reading behavior. Parallels to Chinese-style of reading and a proposed alternative route to skilled reading will be discussed.

C16 Tracking the time course of letter visual-similarity effects during word recognition: A masked priming ERP investigation *Eva Gutierrez-Sigut[1,2], Ana Marcet[1], Manuel Perea[1,3]; [1]University of Valencia, [2]University College London, [3]Basque Center on Cognition, Brain, and Language*

Visual similarity effects during early stages of word processing have been consistently found for letter-like digits and symbols. However, despite its relevance for models of word recognition, evidence for letter visual-similarity effects is scarce and restricted to behavioral experiments. In a masked priming experiment, we measured ERP responses to words preceded by an identical (dentist-DENTIST), visually similar (dentist-DENTIST), or visually dissimilar prime (dentgst-DENTIST) to track the time course of the effects of letter visual-similarity during word processing. In the 230-350 ms time window, the ERPs in the visual dissimilar condition showed larger negative amplitudes than in the visual similar condition, which in turn behaved like the identity condition. The difference between the similar and dissimilar condition disappeared later in processing (400-500 ms time window), whereas there were larger negativities in the visually similar than in the identity condition. This pattern of findings can be accommodated within those theoretical models of word recognition that assume uncertainty concerning letter identities early in word processing that is ultimately resolved.

C17 ERPs reveal early orthographic and phonological selectivity during single word reading. *Laurie S. Glezer[1], Katherine J. Midgely[1], Karen Emmorey[1], Phillip J. Holcomb[1]; [1]San Diego State University*

Previous fMRI research provides evidence for a hierarchical organization in the ventral visual pathway for the visual word form, which has led to the proposal that running posterior to anterior neurons are tuned to increasingly complex word features. There is also evidence to suggest that there is a region at the top of this processing hierarchy that contains neurons that are selectively tuned to the written form of whole real words. However, due to the poor temporal resolution of fMRI, it is unclear at what time point this selectivity occurs. The Bimodal Interactive Activation Model (BIAM, Grainger and Holcomb, 2009), which is based on findings from behavioral and ERP research using priming paradigms, supports the idea that single word reading is accomplished in a mostly hierarchical, feedforward fashion and that orthographic and phonological whole word recognition is achieved by 325 ms. In this model it is proposed that an earlier component (N250) reflects mapping of sublexical features onto lexical representations. However, the evidence to support the sublexical nature of the N250 component is largely based on nonword to real word priming paradigms, which may not fully probe lexical processing. We conducted two experiments using real words in both the prime and target positions and systematically altered the orthographic and phonological similarity to examine precisely when selectivity to orthography occurs. For Experiment 1 there were three conditions of interest: (1) "same" (S), in which the same stimulus was presented twice (as prime and target; e.g., coat-coat); (2) "one letter difference" (1L), in which the prime and target differed by only one letter (e.g., boat-coat); and (3) "different" (DIFF), in which the target shared no letters with the prime (e.g., fish-coat). In Experiment 2, there were three conditions of interest: 1) S, (e.g., hair-hair); 2), a homophone of the target (H), (e.g., hare-hair); and 3) a different word from the target (Control), (e.g., hear-hair). For Experiment 1, in posterior left hemisphere electrodes we find that both 1L and DIFF have similar negative going waves in comparison to the S condition. In addition, we find the same thing for Experiment 2 with H and Control exhibiting similar negative going waves in comparison to the S condition. This was not the case in these electrodes during the N400 window. These results suggest that no priming was present in left posterior electrodes during the N250 window for real words that had overlapping orthography and phonology. That is, even though these items shared sublexical features, there was no attenuation of the signal in the N250 window, suggesting that the full lexical representation was being encoded during this time frame. Our results provide evidence that when using a short SOA and real word stimuli, a whole word lexical response can be identified within the N250 window.

Grammar: Syntax

C18 Subject and Object Asymmetry in Korean Scrambling: An ERP Study *Oh Eunjeong[1], Wonil Chung[2], Myung-Kwan Park[2], Sanghoun Song[3], Euhee Kim[4]; [1]Sangmyung University, [2]Dongguk University, [3]Incheon National University, [4]Shinhan University*

This study examines the effects of scrambling either a subject or object associated with ('floating') numeral classifiers ((F)NCs) in Korean by using the event-related potentials (ERP) paradigm. The experimental materials consisted of 360 sets of 12 items, which vary in terms of three factors such as (i) the grammatical role S(ubject) vs. O(bject) that (F)NCs associate with, (ii) the type of Case/F(ocus) particle marker on FNCs (Case-less vs. N(om)/A(cc) Case-marked vs. F-particle-marked), and (iii) the (non-)application of subject or object scrambling, with FNCs schematically represented in English below. i) [park-in dog-Nom bread-Acc 2-FNC ate] I heard. ii) [park-in dog-Nom bread-Acc 2-FNC-Nom ate] I heard. iii) [park-in dog-Nom bread-Acc 2-FNC-Foc ate] I heard. iv) [park-in bread-Acc dog-Nom 3-FNC ate] I heard. v) [park-in bread-Acc dog-Nom 3-FNC-Acc ate] I heard. vi) [park-in bread-Acc dog-Nom 3-FNC-Foc ate] I heard. Using the materials, we investigated the following two

questions. First, is there a difference between 'scrambling-less adjacent' and 'post-scrambling stranded' versions of NCs? Second, is there a difference between Case-less, Case-marked, and F-particle-marked FNCs in light of the effects of 'post-scrambling stranded', compared to 'scrambling-less adjacent', versions of NCs? Twenty Korean speakers (male: 12, mean age: 22; range:19-28) participated in the ERP experiment. The ANOVA results on the descriptive data of the offline acceptability task showed that in the Subject/Object condition there are significant main effects of such factors as displacement ($F(1,25)=14.13, p<0.001$); ($F(2,50)=11.93, p<0.001$) and Case/F-particle ($F(2,50)=11.67, p<0.001$); ($F(1,25)=11.93, p<0.001$). ERPs were measured at the NC in each condition. In overall ANOVA, in the subject condition there are significant effects of displacement at the 50-200 ms and 500-630 ms interval, while in the object condition there are marginally significant effects of Case/F-particle at the 50-200 ms and 300-450 ms interval. We found that, first, the Caseless FNCs in S/O scrambling sentences relative to those in scrambling-less ones elicited P600, besides N100 and LAN only in the subject condition. The Case-marked FNCs registered P600 in the subject, but not in the object condition. By contrast, the F-particle-marked FNCs in scrambling sentences elicited N100 and P600 in the subject condition, and marginal P600 for the object condition. First, our ERP results point to a robust subject vs. object asymmetry (Saito 1985). As this asymmetry gave rise to P600 effects, it is taken to be a reflection of a syntactic anomaly. Second, our ERP results also point to a Nom Case-less FNC vs. Nom Case-marked FNC asymmetry, only in the subject condition. Nonetheless, FNCs in all the three levels of subject condition induced P600 effects, relative to 'scrambling-less adjacent' NCs. By contrast, FNCs in all the three levels of object condition evoked no significant P600 effects, relative to 'scrambling-less adjacent' NCs. Third, there were N100-like effects in the Nom Case-less or F-particle-marked subject condition. These effects are also known to overlap with the mismatch negativity (MMN; Nataanen, Gaillard, & Mantysalo, 1978) effects. These effects apparently arose when the subject-related FNC is not matched with the subject NP in terms of Case.

C19 Syntactic and semantic specialization in 5-6 year-old children during auditory sentence processing

Jin Wang[1], Mable Rice[2], James Booth[1]; [1]Psychology and Human Development Department, Vanderbilt University, [2]College of Liberal Arts and Sciences-Speech-Language-Hearing, The University of Kansas

Previous studies have found specialized syntactic and semantic processes in the adult brain during language comprehension. The left inferior frontal gyrus (IFG) opercularis and posterior superior temporal gyrus (STG) were found to be associated with syntactic processing, whereas the left inferior frontal gyrus (IFG) triangularis and middle temporal gyrus (MTG) were found to be associated with semantic processing (Price, 2012; Frederici, 2012). However, it remains an open question when syntactic and semantic specialization emerges in the developing brain. 5-6-year-old children have obtained sophisticated semantic and syntactic aspects of language, so they should show specialization in these processes. Yet many previous functional magnetic resonance imaging (fMRI) studies on 5-6-year-old children failed to detect this specialization, possibly due to the experimental design and analytical methods. Most of these studies used anomalous sentences that were likely to intermix syntactic and semantic processes. Moreover, all studies used univariate analysis which may be insensitive to subtle differences in the brain because they average across voxels. In current fMRI study, we designed a syntactic task and a semantic task to dissociate these two processes. Twenty-nine participants from 5.6-6.5 years old completed both tasks. The syntactic task included four conditions: plurality violation, finiteness violation, grammatically correct and perceptual control conditions. Participants were asked to make a grammatical judgment, i.e. "does the way she speaks sound right". The semantic task also included four conditions: strongly congruent, weakly congruent, incongruent, and perceptual control conditions. Participants were asked to make a plausibility judgement, i.e. "does the way she speaks make sense". In addition to conventional univariate analysis, Representational Similarity Analysis (RSA) was used to examine the correlation of patterns within a task (between runs) versus across tasks. Only grammatically correct and strongly congruent sentences were used in the analysis because they both required a yes response, allowing us to examine normal sentence comprehension processes. Consistent with previous studies using univariate analyses, we only found the opercularis portion of left inferior frontal gyrus (IFG) was significantly activated in the syntactic task compared to semantic task, but no area was found in the reverse contrast. However, we found a double dissociation by using RSA analysis, where the left opercularis IFG and superior temporal gyrus (STG) showed more similar patterns within the syntactic task compared to across tasks, whereas there was no difference in the correlations within the semantic task compared to across task in these regions. In contrast, the left triangularis IFG and middle temporal gyrus (MTG) showed more similar patterns within the semantic task compared to across tasks, whereas there was no (smaller) difference in the correlation within the syntactic task compared to across task in these regions. These results suggest that 5-6-year-old children have already started to show semantic and syntactic specialization in the brain. This study has implications for neurocognitive models of language comprehension and developmental language disorder.

C20 Abstract rules versus abstract representation: A neural decoding analysis of localized representation in an artificial grammar task

Adriana Schoenhaut[1], Anne Marie

Crinnion[2], Ahlfors Seppo[1,3], Gow David[1,3,4]; [1]Massachusetts General Hospital, [2]Harvard University, [3]Athinoula A. Martinos Center for Biomedical Imaging, [4]Salem State University

Introduction: What kind of representations support learner's ability to generalize in artificial grammar paradigms? Marcus et al. (1999) argued that infants' ability to generalize simple syllable repetition rules (e.g. ABB "wo fe fe" versus ABA "wo fe wo") to tokens outside of the training set reflects reliance on abstract "algebraic" rules. Another possibility is that this ability may reflect simple associative mechanisms acting on abstract representations of hierarchical structure such as those posited in autosegmental accounts of harmony, assimilation or Semitic morphological processes. To examine this hypothesis, we applied neural decoding techniques to determine whether abstract syllable repetition patterns could be discriminated in ROI-based spatiotemporal activation data in a phonologically and acoustically balanced training set. Methods: MEG/EEG data were collected simultaneously during the task. Adult subjects were exposed to a stream of tri-syllable nonsense utterances (e.g. "tah dih dih") corresponding to one of three syllable repetition grammars (AAB, ABB, or ABA). They were then presented with individual utterances of the same structure featuring different syllables, and told to choose whether said utterances corresponded to the same artificial language as the exposure speech stream. All syllables occurred an equal number of times in each position across the three rule conditions. Results: Subjects were able to perform the task with high accuracy. MR-constrained minimum norm reconstructions of MEG/EEG data were created for each trial, and automatically parcellated into ROIs including regions associated with wordform representation (supramarginal gyrus) and rule learning and application (left inferior frontal gyrus). We extracted activation timeseries from these ROIs, and submitted them to support vector machine (SVM) analyses for classification by rule. Analyses showed better classification performance by wordform areas than by rule application areas. Conclusion: These results suggest that wordform representations may include abstract syllable patterning information that could support either rule-based or form-based generalization mechanisms.

C22 Processing linguistic complexity in Japanese scrambled sentences: an fMRI study

Hyeonjeong Jeong[1], Kaoru Koyanagi[2], Fuyuki Mine[2], Yoko Mukoyama[3], Hiroshi Ishinabe[4], Haining Cui[1], Kiyo Okamoto[1], Ryuta Kawashima[1], Motoaki Sugiura1[1]; [1]Tohoku University, Sendai, Japan, [2]Sophia University, Tokyo, Japan, [3]Musashino University, Tokyo, Japan, [4]Higashiosaka Junior College, Osaka, Japan

Japanese is one of the languages that grammatically allows for flexible word order between the subject (S) and object (O). Processing scrambled sentences (e.g., OSV) is considered to enhance higher syntactic computation such as movement, and higher demand for linking syntactic and semantic information than processing their canonical counterparts (e.g., SOV). Previous neuroimaging studies have reported greater activation in the left inferior frontal gyrus and posterior superior temporal gyrus to process scrambled sentences (e.g., Ben-Shachar et al., 2004; Kim et al., 2009). However, the role of each area has not been clarified, being the focus of this research. The current fMRI study attempted to reveal which brain areas are sensitive to syntactic movement and complexity of argument structure for Japanese auditory sentence processing. We hypothesized that processing scrambled sentences with complex argument structure (e.g., a ditransitive verb, which assigns two objects) induce more demanding linguistic computation than processing scrambled simple transitive sentences that assign one object. Participants in this study were 20 healthy, right-handed Japanese native speakers (mean age: 21.95±1.78, 10 females). They were asked to perform a semantic-plausibility judgment task with auditory-presented Japanese sentences during fMRI scanning. We manipulated verb types (transitive: T vs. ditransitive: D) and word order types (canonical: C vs. scramble: S). As a result, 168 simple Japanese sentences were created with 56 semantically implausible sentences as a filler condition. All canonical sentences (S-O-V for T and S-IO-DO-V for D) were created as scrambled sentences (O-S-V for T, IO-S-DO-V or DO-S-IO-V for D). After dividing two sets of stimuli, we counterbalanced canonical and scrambled sentences among the participants. We modeled four regressors of TC, TS, DC, and DS conditions with only correct trials of plausible sentences in each condition. We tested the main effect of the word order type (i.e., scrambling ([TS+DS]–[TC+DC]) and the interaction effect between verb type and word order type as linguistic complexity ([DS–DC]–[TS–TC]). Statistical analyses were performed with SPM12 using a random effects model (corrected to $p<0.05$ by cluster size). Two major findings emerged. First, analyses of the main effect of scrambling ([TS+DS]–[TC+DC]) revealed significantly greater activation in the left inferior frontal gyrus and supplementary motor area. Consistent with findings of the previous studies (Kim et al., 2009), ours suggest that the left inferior frontal gyrus plays a pivotal role in processing syntactic movement (e.g., scrambling effect) in both transitive and ditransitive sentence conditions. Second, as for the interaction effect (i.e., linguistic complexity) between verb type and word order type, significantly larger differential activation in the bilateral posterior part of superior temporal gyri was found in the [DS–DC] than in the [TS–TC]. This interaction result provides further evidence that syntactic complexity induced by scrambling of more arguments of sentences (i.e., scrambled ditransitive sentences) requires additional involvement of the posterior part of the language area due to the high cognitive demand to link syntactic and semantic information.

C23 ERP responses reveal differences in how subject-verb agreement violations are resolved based on the grammatical class of the words involved

Carrie Jackson[1], Patricia Schempp[1], Janet G. van Hell[1]; [1]Pennsylvania State University

Cross-linguistically, agreement can mark structural relations between constituents in a sentence. Most research on subject-verb agreement, whereby the subject noun and verb must agree in number, has investigated how number marking on the subject noun phrase (NP) influences the subsequent processing of verb-number marking (see Molinaro et al., 2011, for review). Event-related potential (ERP) research has revealed that cross-linguistically, readers exhibit a P600 effect when encountering a verb that mismatches in number with the preceding subject NP (e.g., Tanner et al., 2014). Less research has investigated the reverse situation, in which number-marked verbs appear prior to the subject NP (but see Hagoort et al., 1993; Roehm et al., 2005). Moreover, most ERP research on subject-verb agreement has had participants make grammaticality judgements, even though such metalinguistic tasks may not reflect how readers process language in more naturalistic contexts. The present ERP study investigates how native German speakers process subject-verb agreement violations when comprehending German wh-questions, in which the number-marked verb appears before the subject NP, in the absence of making grammaticality judgements. Thirteen native German speakers read 36 sentences in each of the conditions outlined in (1)–(2) below. After each sentence, participants saw two pictures and chose which picture best represented the action of the target sentence. In masculine/plural conditions, like (1a) and (1b), subject-verb agreement was disambiguated as grammatical or ungrammatical on the definite article, as the definite article for masculine and neuter nouns in German (derMASC-SG or dasNEUT-SG "the") is unambiguously singular in nominative case. In feminine/plural conditions, like (2a) and (2b), subject-verb agreement was not disambiguated as grammatical or ungrammatical until the noun (e.g., Frau "woman"), as the definite article for feminine singular and all plural nouns in German is the same (diePL/FEM-SG "the") in nominative case. (1a) In welchem Bild kauftSG derMASC-SG Mann eine Tomate? (gram-masc/neut) (1b) *In welchem Bild kaufenPL derMASC-SG Mann eine Tomate? (ungram-masc/neut) "In which picture buys/*buy the man a tomato?" (2a) In welchem Bild spieltSG diePL/FEM-SG FrauSG die Gitarre? (gram-fem/plural) (2b) *In welchem Bild spielenPL diePL/FEM-SG FrauSG die Gitarre? (ungram-fem/plural) "In which picture plays/*play the woman the guitar?" For masculine/neuter sentences, ERPs timelocked to the definite article revealed a P600 effect in the 500-800ms time window for ungrammatical versus grammatical sentences, paralleling subject-verb agreement studies involving ungrammaticalities revealed via number-marked verbs (e.g., Tanner et al., 2014). On feminine/plural sentences, ERPs timelocked to the noun revealed a frontal positivity in the 500-800ms time window for ungrammatical versus grammatical sentences. This suggests that ERP responses for subject-verb agreement violations result in P600 effects traditionally associated with syntactic reanalysis (e.g., Osterhout & Holcomb, 1992), when such violations appear post-verbally on function words. However, when such violations initially appear on post-verbal subject nouns, the corresponding ERP response is better characterized as reflecting the revision of previous expectations regarding whether the subject noun will be singular or plural (e.g., Federmeier, 2007). Together, these results reveal subtle differences in how morphosyntactic dependencies are resolved during real-time language processing based on the grammatical class of the words involved.

C24 Korean English L2ers' sensitivity to information structure: An ERP study

Wonil Chung[1], Myung-Kwan Park[1]; [1]Dongguk University

Cowles, Kluender, Kutas, and Polinsky (2007) found two types of ERP response in answers to wh-questions. One is that all words in focused position showed a large positivity understood as characteristic of sentence-final elements, and in fact the sentence-final words of the sentences containing them did. They suggested that focused elements might trigger integration effects, like those in sentence-final position. The other is that inappropriately-focused referents showed a right negativity. They suggested that this N400-like effect was elicited by comprehending structurally-encoded focus cues and discourse-level restrictions. Along the line of Cowles et al (2007), we are also to investigate ERP responses to violations of information structure (IS) in answers to wh-questions in Korean English speakers, where focus structure is incorrectly aligned in 'it'-clefts. To this aim the experimental materials for our ERP study consisted of 60 sets with two types of stimuli (congruent and incongruent), adopted from Cowles, et al. (2007). Each trial contains a set-up context with the introduction of three discourse participants, and then a wh-question consisting of one participant as an agent and two participants as an undergoer of an event, and a target sentence that was constructed as an it-cleft, with its pivot marked for focus with a congruent or incongruent participant, schematically represented below. (1) set-up: Who did the queen silence with a word, the banker or the advisor? (2) congruent target: It / was/ the banker/ that/ the queen/ silenced/. (3) incongruent target: It /was/ the queen/ that/ silenced/ the banker/. Twenty Korean English L2ers with a high level of English proficiency participated in this experiment. ERPs were measured at the critical phrase (a cleft pivot: 'the banker' or 'the queen') and all the following expressions (i.e. words/phrases) in a sentence. We found that, first, all the expressions in cleft-pivot focus position registered a large positivity. Likewise, the final expressions in the congruent condition recorded a positivity, but those in the incongruent condition didn't. Second, the expressions in cleft-pivot focus position in the incongruent

relative to the congruent condition elicited N400 at right anterior regions and widespread P600, namely, a bi-phasic RAN-P600. The word immediately after the pivot (e.g., 'that') in the incongruent relative to the congruent condition elicited an ELAN, and the sentence-final expressions in the incongruent relative to the congruent condition evoked a sustained negativity. We take the results in this experiment to indicate that the N400 evoked at the cleft pivot in the incongruent condition reflects a violation of IS called for by the congruence between the preceding wh-question and its answer in a given context, and the P600 at the same position is a signature of syntactic integration difficulty due to the misfit of a non-focused constituent in a syntactic position reserved for focused expressions. At the same time, we suggest that the sustained negativity at the sentence-final elements in the incongruent condition is a neural correlate of increased syntactic complexity owing to the IS-wise mis-alignment of syntactic constituents.

Meaning: Lexical Semantics

C25 Lower Beta Suppression during Early Verb Learning

Emma K. Tharp[1], Yvonne Ralph[1], Julie M. Schneider[1], Mandy J. Maguire[1]; [1]University of Texas at Dallas

Introduction: Processing language requires activation and integration of sensorimotor and semantic features. For example, reading text that contains action sentences (Elk, M. Van, et al., 2010) and/or action verbs (Maguire et al. 2015; Middleton, Schneider & Maguire, 2017) often results in suppression of the beta band activity. This suppression is similar to what is observed when performing or viewing others perform actions (Weiss & Mueller, 2012.) The role of semantic embodiment varies between word classes, but little has been done to investigate this within the context of word learning. Specifically, when learning new verbs using only the surrounding linguistic context, do we observe decreases in beta band activity? To address this question, we compared the changes in neural oscillations that occur when learning new nouns and verbs from linguistic contexts. Methods: Thirty-six right-handed, English speaking college aged adults had their EEG and behavioral responses recorded while performing a word learning task. Stimuli were sentence triplets where the final word of each sentence was a pseudoword that represented a real noun or verb. Each sentence was presented one word at a time on a computer monitor. After the presentation of all sentences within the triplet, participants were asked to name the final word they felt best fit all three sentences. Although this is different from creating a new semantic concept when learning an entirely novel idea, new words are often learned as a nuanced meaning for a concept one already has a name for, anchoring the unknown word's meaning to a known word, then identifying differences between the known and unknown words' meanings across exposures (Waxman & Senghas, 1992). This study addresses this first step in word learning. Further, this design ensures that none of the participants knew the words prior to the study. Analysis: EEG data was epoched from 500 msec before to 1500 msec after the target word onset. Only trials in which participants responded to correctly were included in the analysis. Time-Frequency analysis was utilized. The mean ERSP for the lower beta frequency (13-19 Hz) was computed for all data channels and a morlet wavelet was applied to each epoch. The mean baseline power at each electrode and frequency was subtracted. Statistical significance was determined using a monte-carlo permutation analysis similar to that used by Maris and Oostenveld (2007). Results: There was a significant interaction in lower beta between word class and presentation over the posterior region (all p's < 0.05). Specifically, when learning verbs, compared with nouns, participants exhibited a significant decrease in lower beta between 0-200 msec only on the last (third) presentation. This was not observed in nouns. Conclusion: These findings add to current theories of semantic embodiment by revealing that beta suppression is evident in the early stages of word learning and even when the learners use only linguistic (not visual or motor) cues to learn the word's meaning. These results have implications for understanding the role of semantic embodiment in word learning.

C26 Evaluating experiential models of word semantics relative to distributional and taxonomic models

Leonardo Fernandino[1], Lisa Conant[1], Colin Humphries[1], Jeffrey Binder[1]; [1]Department of Neurology, Medical College of Wisconsin

Automatic semantic priming in lexical decision is an objective measure of how similar the brain perceives the meanings of the prime and the target word to be. We have previously shown that a model of concept representation based on a set of experiential attributes (CREA) predicts automatic semantic priming for nouns (Fernandino et al., 2016). Here, we replicate that result with different prime-target combinations and evaluate the predictive power of two CREA models relative to models based on word co-occurrence (LSA and HAL) and on taxonomic relations (WordNet). Twenty-six subjects completed the study. Targets consisted of 210 English nouns and 210 matched pseudowords. Primes were 630 real nouns (some nouns also appeared as targets in different trials). All target nouns and their respective primes were previously rated on a set of 65 experiential attributes through Amazon Mechanical Turk (Binder et al., 2016). Words and pseudowords were matched for letter length, bigram and trigram frequency, and orthographic neighborhood size. Primes and targets were matched for word length. Forward associationpriming effects were precluded by excluding any pairs with nonzero values in the USF Free Association Norms. The study consisted of two sessions, approximately one week apart. Each target word was presented once in each session, each time preceded by a different prime. The priming effect for a given target word was calculated as the difference in response times between the two sessions.

Each trial started with a central fixation cross (duration jittered 1-2 sec), followed by the prime (150 ms), a mask (hash marks, 50 ms), and the target (2 sec). The prime was presented in lowercase and the target in uppercase letters. Trials were presented in a different pseudorandomized order for each participant, and the order of presentation of the 2 primes for a given target was counterbalanced across participants. Participants were instructed to ignore the prime and make a speeded lexical decision on the target. For each model, semantic similarity between prime and target was estimated as the cosine between the vector representations of the two words. Prime-target pairs represented a continuous distribution of word similarity values ranging from 0 to 1. We evaluated two versions of the experiential attributes model, one including all 65 attributes (CREA-65) and one including only 12 (CREA-12) attributes. We compared these models with LSA, HAL, and three measures of word similarity based on WordNet (path length [WN-PL], Leacock-Chodorow [WN-LC], and Wu-Palmer [WN-WP). All models showed highly significant correlations with priming (all $p < .0001$, across trials and across participants). Pearson's r were as follows: CREA-65, .46; CREA-28, .46; LSA, .34; HAL, .37; WN-PL, .33; WN-LC, .35; WN-WP, .39. A repeated-measures T-test across participants showed that the mean correlation with priming was significantly higher for the CREA models than for LSA, HAL, WN-PL, and WN-LC (all $p < .005$). These results indicate that experiential models of word semantics can predict semantic priming effects more accurately than several widely used models based on word co-occurrence patterns or in human-curated taxonomies, at least for nouns.

C27 Lexical access in reading vs. naming: MEG evidence from semantic priming and inhibition

Julien Dirani[1], Liina Pylkkänen[1,2]; [1]New York University Abu Dhabi, [2]New York University

INTRODUCTION. There is general consensus that lexical access in comprehension involves spreading activation of semantically related nodes. Support for this comes from lexical decision tasks, showing that reaction times are facilitated by semantically related primes. Interestingly, semantic priming has an inhibitory effect on object naming. This is demonstrated by the Picture-Word Interference paradigm and is taken as evidence for a conceptual search that involves a competition among activated concepts. To date no study has systematically compared these different priming effects and their neural correlates. It is thus unclear whether semantic access proceeds entirely differently in comprehension and production, or whether, for example, a facilitatory effect of semantic priming is observed for both in an early time window, followed by a late inhibition in naming. METHOD. Our aim was to contrast Object Naming to a task that is maximally similar but does not include a process of conceptual search. We therefore used Overt Reading as a comprehension task in comparison to Object Naming as a production task, thus manipulating the modality of the targets to be either a word or an image. Both tasks involved three levels of word-primes (semantically related, unrelated, and identical, e.g., the primes TABLE/DOG/CHAIR were followed by "chair" or a picture of chair), with primes and targets presented using four different stimulus onset asynchronies (SOAs; 150, 200, 250, 300ms). Magnetoencephalography (MEG) assessed the timing and localization of the priming effects. Specifically, for naming, the interference effect could happen at the early conceptual level, or later on at the lexical level or at the motor preparation level. RESULTS. The behavioral results replicated the previously identified semantic inhibitory effects in Object Naming, and showed a trending facilitatory effect in Overt Reading. We found no interaction of SOA and Prime Type. MEG data for Overt Reading showed that the activation pattern in the superior temporal gyrus (STG) at 165-375ms matched the behavioural results, with lowest amplitudes for the identity primes, followed by the semantically related primes, and then the unrelated primes. In contrast, in Object Naming, rather than following a stepwise effect of priming, the activation in the STG showed that the semantically related condition diverges from the other two at 300-500ms, suggesting a late interference effect. Crucially, this effect goes in opposite direction from the effect of the identity priming. Further, this interference pattern spreads to more posterior regions, in the inferior parietal lobe (IPL). CONCLUSION. The results present direct evidence supporting the conceptually driven, competitive process involved in object naming and the incremental, spreading activation in word comprehension. The opposing semantic priming effects in object naming and overt reading appear to partially co-localize within the STG. Specifically, the early facilitatory effect in reading is focused to the middle part of the STG as opposed to the later interference effect for naming, which covered the full STG and spread onto the IPL. This late interference effect presents evidence that the locus of semantic interference is not at the early conceptual level, but rather at the later lexical access level.

C28 The relation between alpha/beta oscillations and the encoding of sentence induced contextual information

René Terporten[1,2], Anne Kösem[2], Bohan Dai[1,2], Jan-Mathijs Schoffelen[2], Peter Hagoort[1,2]; [1]Max Planck Institute for Psycholinguistics, [2]Donders Centre for Cognitive Neuroimaging

A sentence's context dynamically and flexibly constraints the way semantics are inferred by a reader. This process is suggested to engage brain mechanisms that flexibly predict upcoming input based on the amount of information provided by past sentential context. Here, we put this to the test by focusing on the functional role of neuronal oscillations as marker for the effects of sentence context constraints onto brain dynamics. In this magnetoencephalography study, participants carefully read a word-by-word presentation of sentences. These sentences belonged to linguistically matched lists of

three levels of context constraints (high, medium and low context constraints), defined by the sentences' cloze probability. Oscillatory dynamics in the alpha/low-beta frequency band were investigated prior and after the display of a sentence's target word; amplitude modulations of the N400 component were obtained after target word onset. We predicted that the induced predictability of the target word by the different context constraints would gradually influence the amplitude of the N400 component. If alpha/low-beta power marks the buildup of contextual predictions, we hypothesized that it should monotonically relate to the levels of constraints and would therefore fit within a functional prediction account. Alternatively, alpha/beta oscillations could reflect the engagement of cognitive control operations during language processing. Such operations would not necessarily lead to the assumption of a monotonous relationship between alpha/beta power and context constraints. The results indicated that the N400 amplitude was monotonically related to the degree of context constraint, with a high constraining context resulting in the strongest amplitude decrease. On the contrary, alpha and beta power were non-monotonically related to context constraints. The power decrease was strongest for intermediate constraints, followed by high and low constraints prior to target word onset. These effects were source-localized to a set of parietal cortical areas. While the monotonous N400 modulation fits within a framework of prediction, the non-monotonous oscillatory results are not easily reconciled with this idea. Instead, it is suggested that the alpha and beta power modulations as well as their topography reflect the different demands put onto a domain general control machinery during sentence context encoding.

C29 Watching the brain during the acquisition of new words with rich and poor meaning: Electrophysiological evidence

Roberto Ferreira[1], Patricia Román[2], Ton Dijkstra[3]; [1]Universidad Católica de la Santísima Concepción, [2]Universidad Loyola Andalucía, [3]Donders Centre for Cognition, Radboud University

Words can have a more or less rich meaning. Amount of word meaning is referred to as semantic richness. It can be measured by semantic variables, such a concreteness, number of senses, and number of semantic features. Words with rich meaning are processed faster than semantically poor words in several tasks, including naming, lexical decision, and semantic categorization (Borowsky & Masson, 1996; Pexman et al., 2002; Recchia & Jones, 2012; Yap et al., 2012). However, ERP findings are mixed, with some studies showing higher N400 for words with low number of features (Kounios et al., 2009) and others displaying the opposite pattern (Rabovsky et al., 2012). Research has focused primarily on familiar word processing and much less on the effect of semantic richness on novel word learning. However, a word learning paradigm can clarify the mapping of new word forms onto available semantic information, and better control for confounding variables. We investigated the acquisition of novel words associated with many and few semantic features over successive presentations. Twenty-three proficient Dutch-English speakers were presented with English nonwords (e.g., hoaf, luspy) followed by a sentence that described their meaning using few semantic features (e.g., has leaves and branches) or many (e.g., is black, brown or white, and is domestic). Each novel word was presented seven times with simultaneous EEG-recordings. The number of semantic features (NoSF) of the novel words modulated word learning as reflected in N400 and LPC. N400 amplitude was higher for novel words associated with many semantic features during learning. This might reflect more effortful processing, harder access to meaning, or increased difficulty during semantic integration. LPC was reduced for words linked to many features. This may indicate more difficulty in conscious semantic access and evaluation of new words during learning. These findings suggest that semantic richness, as measured using NoSF, does not play a facilitatory role during novel word learning, but rather increases the challenge for the brain to map new word forms onto available semantic features.

C30 Neural correlates of automatic semantic priming revealed by an event-related fMRI

Maria Varkanitsa[1], Erin Meier[2], Yue Pan[2], David Caplan[1], Swathi Kiran[2]; [1]Massachusetts General Hospital, Harvard Medical School, [2]Boston University, Sargent College of Health & Rehabilitation Sciences

Introduction: Semantic priming occurs when a subject is faster in recognizing a target word when it is preceded by a related word-prime, compared to when it is preceded by an unrelated one (Neely, 1991). Previous fMRI studies (Copland et al. 2003; Rissman et al. 2003) have shown that automatic priming is reflected in reduced BOLD signal for related compared to unrelated prime-target pairs. In this study, we employed event-related fMRI to investigate brain activation associated with automatic semantic priming during a lexical decision (LD) task. Methods: Thirteen right-handed healthy subjects (5 female) participated in the study. Mean age was 60 years, with a range from 41 to 77 years. Participants were scanned while performing a LD. Auditory stimuli consisted of pairs of real words and nonwords, in which the first member of the pair is the prime and the second member is the target. There were three stimulus conditions. In the related condition, a real word target was preceded by a semantically related prime, which was a single word semantic feature (REL:32 trials). In the unrelated condition, a real word target was preceded by a semantically unrelated prime (UNREL:32 trials). In the nonword condition, a nonword target was preceded by a real word prime (NONW:64 trials). Each trial consisted of a 500ms fixation, the prime (~500ms), a 50ms interval, and the target (~500ms). T1 images were acquired with the following parameters: 176 sagittal slices, 1x1x1mm voxels, TR=2300ms. BOLD data were collected with the following parameters: 40 axial slices, 2x2x3mm voxels, TR=2570ms, TE=30ms. Functional images were

co-registered to structural images and normalized to MNI space. Given the tight contrasts of interest, a threshold of p<0.01 (uncorrected) and a minimum cluster size of 10 was adopted to enable the identification of activation patterns across the three conditions. Results: Participants showed faster RT latencies for REL (375.77ms) than UNREL (412.59ms) or NONW (460.94ms). Accuracy was high across conditions (between 97%-98% correct). Considering the imaging data, stimulus pairs with word (related and unrelated) targets elicited greater activation compared to stimulus pairs with nonword targets in regions including: a) left hemisphere superior and middle frontal gyrus, superior and inferior parietal lobule, superior temporal gyrus, inferior frontal triangularis and opercularis, and orbitofrontal cortex, b) bilateral inferior and middle temporal gyrus, cuneus, precuneus, paracentral lobule, middle cingulate, and c) right hemisphere angular gyrus, caudate, and posterior cingulate. The contrast between unrelated and related targets elicited greater activation for the unrelated targets in regions including left middle temporal gyrus, bilateral middle frontal gyrus and inferior frontal triangularis, and right rectus, right inferior frontal orbitalis, and lateral and posterior orbitofrontal cortex. Greater activation associated with related targets was found in left middle frontal gyrus and inferior frontal triangularis. Summary: A priming related decreased BOLD was observed in LMTG and bilateral IFG consistent with Copland et al. (2003). However, priming related increased BOLD signal was observed in LMFG and LIFGtri for related compared to unrelated targets indicating a potential semantic facilitation effect, a finding in opposition to previous studies.

C31 The neural correlates of semantic radicals in processing Chinese characters

Xiangyang Zhang[1], Fakun Chen[1], Rui Zhang[1], Jianfeng Yang[1]; [1]Shaanxi Normal University

The semantic processing engaged in visual word reading has received evidence from studies of behavior, neuropsychology, computer modeling, and cognitive neuroscience. The logographic property of the Chinese writing system provides an opportunity to directly examine the role of the semantic processing in visual word reading. However, the neural circuit of the semantic processing in Chinese character reading is far from clear. The current fMRI study aims to investigate the neural correlates of the processing of semantic radicals and its interaction with the whole characters' meaning. Participants performed a lexical decision task on characters or character-like stimuli comprised of two components: a phonetic and a semantic radical. All the phonetic and semantic radicals in the stimuli cannot be used as characters independently. The meaning of the semantic radicals was manipulated: a strong meaningful radical can indicate the semantic category for most of the characters in the same semantic family, whereas a weak meaningful radical cannot. Each type of semantic radicals was combined with a phonetic radical to create two types of stimuli: real and pseudo-characters. The BOLD signal showed a common brain network for processing real than pseudo characters in the left hemisphere including Middle Temporal Gyrus (MTG), Inferior Frontal Gyrus (IFG), and Anterior Temporal Lobule (ATL). The most interesting finding was that the strong meaningful semantic radicals involved more activities at left MTG than weak meaningful ones for pseudo-characters. Whereas for real characters, both the MTG and IFG were engaged more for strong than for weak meaningful semantic radicals. The finding indicated that the processing of the semantic radical relies on the engagement of the left MTG and its integration with the meaning of the whole character depends on the activity of the IFG. This study is the first examination of the neural correlates of the processing of semantic radicals. It shed a light on the further fMRI studies of the neural anatomical model of the Chinese character reading to reveal the cooperative division of labor between phonological and semantic processing neural circuits.

Meaning: Prosody, Social and Emotional Processes

C32 Decoding another's feeling of knowing from spoken language with multivariate pattern analysis on fMRI

Xiaoming Jiang[1,2], Ryan Sanford[3], Marc D. Pell[2,3]; [1]Department of Psychology, School of Humanity, Tongji University, China, [2]School of Communication Sciences and Disorders, McGill University, Canada, [3]Montreal Neurological Institute, McGill University, Canada

Recent neuroimaging studies in spoken language have examined the neural underpinnings of a listener when judging the speaker's feeling of (un)knowing based on the speaker's interpersonal stance (Jiang & Pell, 2015; 2016a; 2016b; 2017; Jiang, Sanford, Pell, 2017). However, the neural mechanisms of social judgment from multiple cues, such as verbal (factual vs. false statements) and nonverbal cues (confident vs. doubtful voice) remain unclear. In this fMRI study, we sought to investigate the brain activation patterns that underlie feeling knowing judgments from factual and false statements spoken in confident and doubtful tones. We used multivariate pattern analysis (MVPA) to decode the patterns of neural activity associated with speaker confidence and truth value from general knowledge statements within functionally significant anatomical regions and functional networks that have been shown to be important in decoding social information in spoken language. These anatomical regions included the left and right superior, middle and inferior temporal gyrus, while the functional networks included the default mode network, salience network, auditory network, language network and executive control network. Eighteen participants listened to true or false statements spoken in a confident or doubtful tone and judged whether the speaker knows what he is talking about. MVPA classified the level of confidence and truth value using a support vector machine. All classifications followed a leave-one-

run-out cross-validation scheme at the participant level. These analyses were performed across the areas of interest using the searchlight method. Significant brain activation patterns were identified with permutation testing using $p<0.05$ as the statistical threshold, followed by multiple comparison correction with a family-wise error rate of 0.01. We observed that the right superior temporal pole, and anterior cingulate cortex (ACC) and middle cingulate cortex (MCC), regions that were part of the default mode and salience network, respectively, significantly classified confident and doubtful expressions. When classifying the truth value, we observed significant activation patterns in the ACC, MCC, bilateral superior and middle temporal gyrus, precuneus, left middle frontal gyrus and right cerebellum. These regions were part of the default mode network, salience network, executive control network and language network. These results demonstrate multiple independent functional connectivity networks that underlie the decoding of how the speaker said and what was said, including those of detecting saliency of verbal and nonverbal cues and of integrating and reconciliation of the cue compatibility that support the abstraction of speaker meaning from these cues. [Reference] [1] Jiang, X., Sanford, R., Pell, D. M. (2017) Neural systems for evaluating speaker (un)believability. Human Brain Mapping, 38, 3732-3749. [2] Jiang, X. & Pell, D. M. (2017) The sound of confidence and doubt. Speech Communication, 88, 106-126. [3] Jiang, X. & Pell, D. M. (2016b). The Feeling of Another's Knowing: How "Mixed Messages" in Speech Are Reconciled". Journal of Experimental Psychology: Human Perception and Performance, 42, 1412-1428. [4] Jiang, X., & Pell, D. M. (2016a). Neural responses towards a speaker's feeling of (un)knowing. Neuropsychologia, 81, 79-93. [5] Jiang, X. & Pell, D. M. (2015). On how the brain decodes speaker's confidence. Cortex, 66, 9-34.

C33 Being in love changes brain activity during speaking

Clara Martin[1,2], Ileana Quinones[1], Manuel Carreiras[1,2]; [1]BCBL, [2]Ikerbasque

The main goal of this study was to explore how being in love modulates brain activity during language production. We know that brain activity is modulated by social context during perception and comprehension, but there is no evidence of such modulation during language production. Here, we present the first evidence of socially-mediated brain activity during language production, by showing that brain activity during speaking varies when facing a girl/boyfriend or an unknown person. Brain activity during singing in zebra finches differs depending on the social context. In zebra finches' brain, there is a posterior (direct) motor pathway necessary for song production and an anterior (indirect) pathway necessary for song acquisition. Interestingly, the activation of the anterior pathway varies when the male zebra finch sings facing a female (directed song) or not (undirected song; for learning and rehearsal). Thus, differential brain activity can indicate not only that a bird is singing, but also in which social context he is singing. Given the similarity of the anterior pathway (i.e., the "cortical – striatal – thalamocortical" loop) in birds and primates, we expected brain activity along this pathway to be socially-mediated in humans producing language as it is the case in birds producing songs. We created a socially-mediated language production task in which participants (N=32) had to recite a poem in the MRI scanner. They had to recite the poem 10 times while watching pictures of (1) their girl/boyfriend, (2) unknown women/men, (3) houses. In order to explore whether language production varies when facing a girl/boyfriend or another person, we compared brain activity in conditions (1) and (2). As predicted, a larger response when reciting the poem to a girl/boyfriend relative to an unknown person was found in a cortico-subcortical bilaterally distributed network. This network included a subcortical circuit linked to memory, the amygdala, OFM and dorsolateral prefrontal cortex associated to familiarity/acquaintance, the FFA linked to face perception, and the IFG, superior and middle temporal gyri associated to language processing. This study reveals for the first time that brain activity during language production varies depending on the social context (i.e., who the speaker is facing during poem recitation). Various brain regions associated to language and face processing, as well as memory and familiarity, are differentially activated depending on the person faced during language production. Thus, as it is the case in birds, differential brain activity in humans can indicate not only that a person is speaking, but also whether she is speaking to a lover or an unknown person.

C34 Individual differences in sarcasm perception: behavioral and eye tracking evidence

Kathrin Rothermich[1], Mathew Fammartino[2], Hana Kim[1], Gitte Joergensen[2]; [1]East Carolina University, Greenville, USA, [2]University of Connecticut, Storrs, USA

Social communication is usually complex and hardly ever straightforward. Often listeners must infer what speakers mean since what is said and what is meant can differ. Crucially, interpreting nonliteral language such as sarcasm or teasing involves complex cognitive skills such as the inference of mental states, the integration of paralinguistic cues, perspective taking, and empathy. Individual differences also play a role in a person's ability to understand and interpret sarcasm, its appropriateness, and whether a particular use of sarcasm was perceived as amicable or hostile. For the current study, we invited young adults (N=15; mean age = 18.6 years, SD = 0.73) to watch brief videos of dyadic social interactions in which responders' intentions were sincere or sarcastic. The videos were taken from a novel database (RISC; Rothermich & Pell, 2015) and include a multitude of cues such as prosody/intonation, body language, and facial expressions while keeping lexical information constant. Participants were also presented with several questionnaires assessing their social communication preferences (e.g., Sarcasm Self-Report Scale; Ivanko, 2004) and social anxiety (e.g., STATE-

TRAIT Anxiety Inventory; Spielberger, 2010). During the experiment, participants identified the sincerity of the responder (sincere/sarcastic) and rated their likeability and friendliness on a 5-point Likert scale. At the same time, eye movements were recorded using an Eyelink 1000Plus eye-tracking device. The results demonstrate that overall accuracy in identifying sincerity is well above chance (91.96 % correct, SD = 2.68). The Likert scale results show that actors using sincere responses were significantly rated as more friendly and likeable (likeability: M= 4.33, SD = 0.87; friendliness: M= 4.46, SD = 0.70), compared to when using sarcastic responses (likeability: M= 1.83, SD = 0.84; friendliness: M= 2.00, SD = 0.91). Because sincere and sarcastic interactions contain the exact same lexical content, these results reveal the influence of nonverbal signals and prosody on speaker impression. Additionally, a significant correlation was found between the Sarcasm Self-Report Scale and friendliness ratings for sarcastic responses ($R = .56$, $p < .05$), indicating that participants who report using sarcasm regularly rate these responses as more friendly than those participants who rarely use sarcasm. Finally, the eye-tracking results show that participants spent significantly more time fixating faces when processing sarcastic interactions (M = 698, SD = 12.72) compared to sincere interactions (M = 629, SD = 17.05). Interestingly, fixation duration was negatively correlated with measured TRAIT anxiety ($R = -.55$, $p < .05$), indicating that participants with higher levels of social anxiety spent less time viewing sarcastic scenes, as predicted by the hypervigilance-avoidance hypothesis (Mogg et al. 1997). Taken together, the present data speak for an influence of social communication preferences and personality factors on the processing of sarcasm.

C35 Neural processes of sarcasm interpretation: the role of tone of voice

Maël Mauchand[1], Jonathan Caballero[1], Xiaoming Jiang[1], Marc Pell[1]; [1]McGill University

The indirect nature of sarcasm renders it challenging to interpret: the actual speaker's intent can only be retrieved when the incongruence between the content and pragmatic cues, such as context or tone of voice, is recognized. The cognitive processes underlying the interpretation of irony and sarcasm, in particular, the effects of contextual incongruence on brain activity have recently been examined through event-related potential (ERP) techniques. The role of the tone of voice (prosody) in different stages of processing sarcastic speech, however, remains to be understood. This study aims to investigate this role by assessing differences in the processing of sarcastic and literal speech in the absence of context, when the tone of voice is the only cue to disambiguate the speaker's intent. Literal and sarcastic stimuli were created by recording verbal compliments (e.g., You are such an awesome driver) with different tones of voice to suggest a literal interpretation (perceived as friendly in a validation phase), or a sarcastic one (a veiled criticism, perceived as unfriendly in a validation phase). Later, these stimuli were presented to 21 subjects while their brain activity was recorded through EEGs during a friendliness rating task. ERPs were computed for each type of stimulus at the utterance onset, to compare the isolated effects of prosody, and at the onset of the critical word (i.e., awesome), to investigate the point at which tone of voice allowed listeners to confirm the literal intent of the compliment or its sarcastic interpretation and suggested criticism. At sentence onset, early differentiation of sarcastic versus literal utterances appeared at the N1/P2 complex over frontal-central electrodes. Compared to literal speech, sarcasm yielded a reduced amplitude at the N1, known to index discrimination of acoustic features, and a greatly reduced amplitude at the P2, a processing stage for marking the motivational salience of sounds. A later, long-lasting differentiation was characterized by higher positivity for sarcastic utterances around 600-1000ms, resembling a late positive component (LPC) over right central-parietal electrodes, implying differential and sustained cognitive analysis of the sarcastic prosody before semantic information is fully available. At the critical word onset, a negative shift for sarcastic vs. literal utterances at 600-800ms over frontal-central electrodes was detected, in a period suggested to index pragmatic (re)interpretation processes. Results show that, even in the absence of context, sarcasm can be differentiated from literal speech at the neurocognitive level. Discrimination of sarcastic intentions starts very early based on perceptual differences in the tone of voice (N1) and differences in how strategic attention reinforces and is allocated to prosodic distinctions underlying literal and sarcastic utterances as they emerge (P2-LPC). Neural processes that encode differences in the prosodic form of utterances, once integrated with the key word, then impact on late pragmatic interpretation processes when the incongruent nature of content and prosody in sarcastic messages has been made clear. Our preliminary results argue that the tone of voice plays a significant role at multiple processing stages during sarcasm perception, integration and interpretation.

Language Therapy

C36 Using local neural heterogeneity to both predict and track in language recovery

Jeremy Purcell[1], Robert Wiley[1], Brenda Rapp[1]; [1]Department of Cognitive Science, Johns Hopkins University, USA

Introduction Little is known about the changes in neural representations that support post-stroke recovery. Recent work suggests that the local differentiation of neural responses reflects representational integrity and learning, with differentiation increasing with expertise and learning (Jiang et al., 2013). We utilize a novel technique – Local-Heterogeneity Regression (Local-Hreg) Analysis - to quantify local neural heterogeneity (Purcell et al., under review). We apply this approach to examine neural representations both before and after behavioral training for acquired dysgraphia. We find that within

left ventral occipitotemporal cortex (vOTC), local Hreg values prior to training predict response to training and that pre-post training changes in Local-Hreg values in this area index training-based improvements in spelling performance. Methods Participants were 20 individuals with post-stroke, chronic dysgraphia. Individualized word sets were developed and participants were trained for approximately 3 months. All improved to above 90% accuracy levels. FMRI with a spelling task was carried out at pre- and post-training which included spelling with TRAINING words and a non-spelling CONTROL. A whole-brain, Local-Hreg searchlight analysis was performed. For each search space, it employed a general psychophysiological interaction regression-based analysis (gPPI; McLaren et al., 2012) that uses the neural response of the center voxel as the basis for predicting the surrounding voxels. Local-Hreg indexes voxel-to-voxel interactions within each searchlight thereby quantifying the relative similarity/dissimilarity of the task-specific BOLD responses across adjacent voxels: the lower the local cross-voxel interaction, the higher the local heterogeneity. A whole-brain local-Hreg and traditional GLM analyses were carried out comparing the neural responses to the TRAINING condition at pre-training versus post-training time-points. fMRI Results The whole-brain searchlight identified one Hreg cluster in the left vOTC (non-parametric permutation corrected $p = 0.12$). The Local-Hreg values from this cluster were used to examine the relationship of Local-Hreg to spelling behavior. 1) Using a linear mixed effects (LME) model including fixed variables (age, lesion volume, severity, deficit type) and random effects (participant, voxel), we found that local-Hreg values at pre-training significantly predicted the magnitude of training-based behavioral improvement. 2) Using the same LME with local-Hreg change as the dependent variable (i.e. Post Training – Pre Training), we found that local-Hreg change was significantly inversely related to the magnitude of performance change on the training items. Discussion Participants with the highest values of local neural differentiation prior to training were most likely to benefit from training, suggesting that those with the highest "orthographic tuning/integrity" prior to training benefited the most. In addition, participants who improved the most required the least amount of change in the neural differentiation of orthographic representations, presumably because of the relatively high level of integrity of their spelling systems to begin with. This work provides a novel approach for quantifying the local heterogeneity of orthographic representations, and reveals that this measure is can be used to both predict response to treatment and track neural changes in neural differentiation.

C37 Perilesional white matter microstructure and aphasia recovery *Emilie T. McKinnon[1], Jens H. Jensen[1], Chris Rorden[2], Alexandra Basilakos[2], Ezequiel Gleichgerrcht[1], Julius Fridriksson[2], Joseph A. Helpern[1], Leonardo Bonilha[1]; [1]Medical University of South Carolina, [2]University of South Carolina*

Language therapy has shown to be effective in chronic aphasia, although treatment responses are variable, and predicting outcomes remains challenging. Research has previously shown that left hemisphere perilesional areas contribute to therapy-induced neuroplasticity, but little is known about how perilesional white matter affects treatment outcome. The current study attempts to address this gap in knowledge by relating pretreatment residual perilesional white matter integrity to post-treatment changes in confrontational naming. Thirty-one subjects (age=57±11y; 9 females; MRI time post-stroke=36±32m) with chronic post-stroke aphasia underwent the Western Aphasia Battery Revised, multimodal MRI, and 15 sessions (5x/week) of self-administered computerized anomia treatment (45 min). Half of the participants received anodal tDCS (1mA) during the first 20 minutes, and the remaining half received sham stimulation. Aphasia severity ranged from severe to mild (WAB-AQ = [20-92]), with an average (± standard deviation) WAB-AQ of 52 (± 22). Structural (T1-w, T2-w) and diffusional kurtosis images (b=0, 1000, 2000 s/mm2) were acquired at baseline and diffusional kurtosis estimator was used to estimate diffusion and kurtosis tensors. A perilesional white matter mask was created by dilating lesion drawings (4 voxels) including only those voxels categorized as white matter (>90% probability) by enantiomorphic segmentation. Voxels dominated by cerebral spinal fluid (mean diffusivity > 2 μm2/ms) were excluded. Before treatment, subjects elicited an average of 24% (± 25%) correct responses during a confrontational naming test consisting of 80 objects. After treatment, participants demonstrated a significant proportional change in correct responses on trained items with an average improvement of 12% ± 19%. We found that both perilesional axial diffusivity and kurtosis significantly related to changes in correct response ($r=0.47$, $p<0.05$; $r=-0.49$, $p<0.05$) correcting for lesion size, pre-treatment aphasia severity and tDCS application. Perilesional fractional anisotropy, radial diffusivity and radial kurtosis did not reflect naming improvements ($r=0.2$, $p>0.05$; $r=0.28$, $p>0.05$; $r=-0.33$, $p>0.05$). In addition, axial diffusivity/kurtosis was associated with absolute changes in semantic but not phonemic paraphasias ($r=-0.49$, $p<0.05$; $r = 0.44$; $p<0.05$) in a subset of temporal lobe white matter voxels. This study shows preliminary evidence on the relationships between baseline perilesional white matter and language recovery, and demonstrates the possible role image analysis can play in predicting recovery potential from baseline neuroimaging data. If pretreatment MRI contains valuable information about treatment response, then imaging has the potential to become a useful tool for guiding clinical management of aphasia. Specifically, these results suggest it may be possible to tap into specific recovery potentials, such as comparing room for semantic and phonemic improvement.

C38 BDNF Genotype and tDCS Interaction in Aphasia Therapy

Julius Fridriksson[1], Jordan Elm[2], Brielle Stark[1], Alexandra Basilakos[1], Chris Rorden[3], Souvik Sen[4], Mark George[5,6,7], Leonardo Bonilha[7]; [1]University of South Carolina Department of Communication Sciences and Disorders, [2]Medical University of South Carolina Department of Public Health Sciences, [3]University of South Carolina Department of Psychology, [4]University of South Carolina Department of Neurology, [5]Medical University of South Carolina Department of Psychiatry, [6]Ralph H. Johnson VA Medical Center, Charleston, [7]Medical University of South Carolina Department of Neurology

Using a double blinded randomized controlled trial, we evaluated the extent to which brain stimulation (anodal transcranial direct current stimulation [A-tDCS]) applied during speech therapy, was a futile adjunctive intervention to improve speech production (naming) in individuals with chronic post-stroke aphasia. This futility design evaluated a null hypothesis of 'A-tDCS results in better treatment outcome than sham tDCS.' 74 patients with chronic aphasia (following left hemisphere stroke) received 3 weeks of speech-language therapy coupled with either A-tDCS or sham tDCS. Thirty-four subjects were randomized to receive A-tDCS (10 F; age, M=60±11yrs; education, M=15±3yrs) and 40 sham tDCS (12 F; age, M=60±10yrs; education, M=14±2yrs). The primary outcome was the ability to name common objects (performance on a sample of treated items [Naming 80] and the Philadelphia Naming Test [PNT]), assessed before and after therapy. Secondary outcomes included change in the number of correctly named items at 4- and 24-weeks post-treatment. We also acquired whole blood samples from participants (N=67) to identify how expression of the val66met polymorphism, reflecting atypical expression of blood derived neurotrophic factor (BDNF), modulated the effect of tDCS on naming ability post-treatment. If the null hypothesis was rejected at a one-sided significance level of 0.10, then A-tDCS would be unlikely to be effective for aphasia treatment and would not be considered for further study. We report results for outcomes adjusted for baseline aphasia severity, naming ability and treatment site. Immediately post-therapy, the A-tDCS group showed a mean adjusted improvement of 13.9 correctly named items and the sham tDCS group, 8.2 items (one-sided p=0.89). At 4-weeks post-treatment, the A-tDCS group showed an adjusted mean change from baseline of 16.8 correctly named items compared to the sham tDCS group's 9.4 correctly named items (p=0.94) and at 24-weeks post-treatment, the A-tDCS group showed an adjusted mean change from baseline of 14.9 items compared to the sham tDCS group's 7.1 items (p=0.90). Those without the val66met polymorphism (N=37) were significantly less severe at baseline than those expressing the Met allele (N=30) (p=0.01) but the groups did not significantly differ on other demographic factors. We therefore included aphasia severity as a cofactor in a general linear model of fixed effects, where our dependent factor was proportional change (actual change as a proportion of possible change) on the naming measures at immediately post-treatment, 4-weeks post and 24-weeks post. There was a significant interaction of genotype and tDCS group [Naming 80: F(1,61)=4.99, p=0.03; PNT: F(1,62)=5.14, p=0.027], where those without the Met allele receiving A-tDCS exhibited greater proportional change in correct naming over the course of the study. We failed to reject the primary futility null hypothesis, suggesting that a larger trial may be warranted to further evaluate the effects of A-tDCS on aphasia treatment. Carriers of the Met allele have been previously shown to display a reduced response to noninvasive brain stimulation protocols (Cheeran et al., 2008) and our results suggest that those not expressing the polymorphism show increased effect of A-tDCS on primary outcome, suggesting that typical BDNF is a mediator of tDCS effect.

Language Disorders

C39 Neuromodulatory effects of individualized tDCS on MEG dynamics in chronic post-stroke aphasia

Priyanka Shah-Basak[1], Gayatri Sivaratnam[1], Selina Teti[1], Alexander Francois-Nienaber[1], Tiffany Deschamps[1], Jed Meltzer[1]; [1]Rotman Research Institute, Baycrest Health Sciences, Toronto, ON Canada

Research on the modulatory effects of transcranial direct current stimulation (tDCS) on neural oscillatory activity is in its infancy. Despite a large body of evidence suggesting significant behavioural gains in post-stroke aphasia with tDCS treatments, the neuromodulatory oscillatory changes in response to tDCS are largely unknown. In the current, serial tDCS-magnetoencephalography (MEG) study, we investigated language task-induced changes in oscillatory activity in individuals with aphasia after a single-session of excitatory (anodal) tDCS to left-hemisphere perilesional cortex, or inhibitory (cathodal) tDCS to the right-hemisphere homolog area. Eleven chronic stroke survivors with aphasia (mean age: 58.8±12.8 years; 7 males; years since stroke: 8.0±5.2; 3 global, 4 nonfluent, 2 fluent and 2 anomic) underwent 20-minutes of 2mA anodal- or cathodal-tDCS, or sham-tDCS during three separate sessions. Stimulation was delivered using high-definition tDCS (HD-tDCS) in a 3x1 center-surround electrode configuration. The location of the central electrode was determined individually, based on patients' resting-state MEG abnormalities, which manifest as increased slow-wave activity in the perilesional areas. For baseline and post-tDCS language performance assessments and for training during stimulation, we used the graded repetition exercises for aphasia therapy (GREAT) battery. The difficulty level of GREAT (easy, hard) was adjusted to ensure that patients with varying levels of language impairment were equally engaged during the task. Inside the MEG, patients performed a delayed word-repetition task, prior to and after each tDCS session. This task involved reading a word and saying it after a delay. To

delineate differential effects of tDCS based on lexical variables, we included low- and high-frequency words consisting of either three or one syllable(s). The oscillatory responses during word encoding were localized at the whole-brain level and compared across tDCS conditions for the low-beta (8-30Hz) and low-gamma (25-50Hz) bands. TDCS sites were localized to either the middle/superior temporal or the superior/inferior parietal areas. GREAT accuracy increased in patients receiving the hard battery (or those with less severe impairment) after anodal-tDCS ($p=0.026$), and there was a trend after cathodal-tDCS ($p=0.15$), compared to sham. No such improvement was found in patients receiving the easy battery (or those with more severe impairment). For the MEG task, accuracy and reaction time were not affected by tDCS. Overall accuracy, however, was lower for longer length ($p=0.003$; 13.5%) and lower frequency ($p=0.005$; 6.6%) words. On average, low-beta oscillatory activity was localized to bilateral posterior, temporo-occipital areas, and low-gamma activity to bilateral anterior, inferior frontal areas. After anodal-tDCS, event-related desynchronization (ERD) power was decreased in the low-beta band in the right precentral gyrus and cingulate gyrus ($p<0.01$). Whereas, after cathodal-tDCS ERD was increased in the low-gamma band in the left inferior frontal and superior/middle temporal areas, and bilateral middle frontal gyri ($p<0.01$). Our findings indicate that the hemisphere contralateral to stimulation is most affected, and the direction of oscillatory changes points to induction of left-hemispheric involvement after both types of tDCS. This study is the first to demonstrate oscillatory changes as a function of excitatory and inhibitory tDCS in post-stroke aphasia.

C40 Syntactic and thematic mechanisms of subject-verb integration in aphasia and typical sentence comprehension

Jennifer Mack[1], Cynthia K. Thompson[2]; [1]UMass-Amherst, [2]Northwestern University

Introduction. In both neurotypical adults and adults with agrammatic aphasia, subject-verb integration is relatively easy in unergative sentences, in which the subject receives the thematic role of Agent (i.e., a volitional actor) and originates in a pre-verbal syntactic position. Greater neurocognitive resources are required for unaccusative sentences, in which the subject is a Theme (i.e., an undergoer) and originates in a post-verbal position [1]. For example, in neurotypical listeners, sentence subjects are reactivated more quickly in unergative than unaccusative sentences [2]. Two visual-world eye-tracking experiments tested competing accounts of this finding. Experiment 1 compared unergative to unaccusative structures (e.g., The child … jumped/collapsed …, where "…" indicates additional linguistic material), whereas Experiment 2 compared processing of "mixed" structures (i.e., with Theme arguments but pre-verbal traces) to unaccusative sentences (e.g., The table … creaked/collapsed …). The syntactic hypothesis [2,3] predicts earlier reactivation for sentences with pre-verbal vs. post-verbal traces in both experiments. The thematic hypothesis proposes that listeners make online thematic predictions (i.e., animate subject – Agent; [4]), and thus predicts earlier reactivation when thematic predictions are confirmed (unergative vs. unaccusative sentences in Experiment 1) but no difference when thematic structure is matched (mixed vs. unaccusative sentences in Experiment 2). For listeners with aphasia, the syntactic hypothesis [3,5] predicts greater processing delays for sentences with post-verbal vs. pre-verbal traces, whereas the thematic hypothesis [4,6] predicts no differences across conditions, due to impaired thematic prediction processes. Methods. The participants were neurotypical young (n=20) and older adults (n=15) and adults with stroke-induced agrammatic aphasia (n=8). Participants listened to sentences, viewed visual arrays containing an image of the sentence subject and three distractors, and answered occasional comprehension questions. Mixed-effects logistic regression models quantified the time course of reactivation of the sentence subject. Results. In the first 500 ms after verb onset, neurotypical adults showed faster reactivation in unergatives vs. unaccusatives in Experiment 1, but no differences across conditions in Experiment 2. In the same time window, listeners with aphasia showed no effects of condition in either experiment. Conclusion. The results supported the thematic hypothesis, suggesting that thematic predictions guide subject-verb integration and impaired predictive processes may contribute to sentence comprehension deficits in aphasia. The results also suggest that left inferior frontal regions, often damaged in agrammatism, support linguistic prediction (cf. [6,7]).

References. [1] Thompson, C. K., & Meltzer-Asscher, A. (2014). In A. Bachrach, I. Roy, & L. Stockall (Eds.), Structuring the argument: Multidisciplinary research on verb argument structure (pp. 141-168). Amsterdam: John Benjamins. [2] Koring, L., Mak, P., & Reuland, E. (2012). Cognition, 123(3), 361-379. [3] Burkhardt, P., Piñango, M. M., & Wong, K. (2003). Brain and Language, 86(1), 9-22. [4] Meyer, A. M., Mack, J. E., & Thompson, C. K. (2012). Journal of Neurolinguistics, 25(1), 31-43. [5] Love, T., Swinney, D., Walenski, M., & Zurif, E. (2008). Brain and Language, 107(3), 203-219. [6] Mack, J. E., Ji, W., & Thompson, C. K. (2013). Journal of Neurolinguistics, 26(6), 619-636. [7] Nozari, N., Mirman, D., & Thompson-Schill, S. L. (2016). Brain and Language, 157-158, 1-13.

C41 Diversity of modular networks determines aphasia severity.

Barbara Khalibinzwa Marebwa[1], Julius Fridriksson[2], Leonardo Bonilha[1]; [1]Medical University of South Carolina, [2]University of South Carolina

About 30-40% of dominant hemisphere stroke survivors sustain permanent and disabling language problems, and factors that drive incomplete recovery remain unclear. Cognitive function arises from topological interplay that can be captured from the connectome's community structure, and the topological integrity of residual white matter networks driving language recovery is yet to be

fully investigated. We therefore hypothesized that patients with a disorganized and less diverse topology would suffer worse aphasia. Using post-processing methods of diffusion tensor imaging optimized for lesioned brains, we reconstructed the individual structural whole-brain connectome from 83 right handed participants with a single left hemisphere ischemic or hemorrhagic stroke (age 60.1± 9.1 years, 28 females). All participants underwent language assessment using the Western Aphasia Battery that yields a global measure of aphasia severity on a scale of 0-100 (WAB-AQ, mean 68.2±28.7). We determined assortative network organization using Newman's modularity algorithm. We then calculated a consensus partition that gave the optimal organization of the community structure after 100 different optimizations. Using the maximum number of partitions obtained from each individual, we further fit the weighted stochastic block model (WSBM) to each connectome. The WSBM uncovers different motifs of assortative, dis-assortative, and core-periphery communities. Finally, we calculated the diversity index of each node, which is a measure of how much the node participated in the different community motifs. We found that left hemisphere modularity was significantly associated to the left hemisphere mean diversity score ($r = -0.3$, $p = 0.004$), meaning that less fragmented networks were more diverse and had more community motifs. We also found that higher left hemisphere modularity was associated more severe aphasia ($r = -0.4$, $p < 10\text{-}4$) meaning that fragmentation of left hemisphere networks led to less diversity, poor communication among modules, and more severe aphasia.

C42 Exploring neural organization for two different auditory-motor tasks in typical adults and adults who stutter.

Anastasia Sares[1,4], Mickael Deroche[1,4], Hiroki Ohashi[2], Douglas Shiller[3,4], Vincent Gracco[1,2,4]; [1]Integrated Program in Neuroscience and School of Communication Sciences and Disorders, McGill University, Montréal, QC, Canada, [2]Haskins Laboratories, New Haven, CT, USA, [3]School of Speech-Language Pathology & Audiology, Université de Montréal, Montréal, QC, Canada, [4]Centre for Research in Brain, Language, and Music, Montreal, QC, Canada

Introduction: Persistent stuttering is a neurodevelopmental disorder that starts as early as two years of age and continues through adulthood. The potential impact of the disorder on the development of neural networks is unknown, although recent resting state connectivity analyses are consistent with atypical functional organization (Chang et al., 2017). The current project is focused on examining the impact of the disorder on the neural organization of sensorimotor networks for speech and nonspeech. We examined the behavior and brain contributions of individuals who stutter (IWS) to two auditory-motor tasks, vowel production and paced tapping. We examined the task positive and task negative networks for each behavior and evaluated the independent components that comprise each. Methods: For the speech task, participants produced the vowel /a/ while hearing their own voice in real time through headphones. On some trials, the pitch of the feedback was shifted, eliciting a compensatory response. For the tapping task, participants listened to a metronome stimulus and kept time by squeezing a pressure pad between their fingers. The metronome stimulus contained sudden increases or decreases in tempo, and the participant had to adjust their production to the change. Both tasks were completed inside and outside of an MRI scanner. In addition to a univariate general linear modeling (GLM) approach to examine both task positive and task negative differences in the groups, we used independent component analysis (ICA) to extract information from the data not apparent from GLM results. Results: The behavioral performance for both tasks was comparable across the groups. Differences in performance were primarily related to increased timing variability in the stuttering group. Neural activation and deactivation and the composition of the independent positive and negative components differed in a number of ways. For the speech task, IWS had, on average, reduced cerebellar and supplementary motor area activation, and increased insular and temporal cortical activation on the right hemisphere. Areas of deactivation were differentially distributed and sometimes missing for IWS. For tapping, similar neural patterns were observed in auditory-motor integration areas. Differences in the independent components were observed reflecting an atypical neural organization for the IWS with different patterns of correlated-anti-correlated connectivity within components. Conclusion: While the sensorimotor behavior of IWS is only mildly impacted by the disorder, functional neural organization is substantially affected, likely reflecting compensatory development. These differences were observed in speech and nonspeech behavior, possibly due to a common impact on sensorimotor timing. The atypical neural organization, including differences in distribution and balance of task activation and deactivation, highlight an importance consequence of neurodevelopmental problems with substantial implications for treatment. Chang, S. E., Angstadt, M., Chow, H. M., Etchell, A. C., Garnett, E. O., Choo, A. L., ... & Sripada, C. (2017). Anomalous network architecture of the resting brain in children who stutter. Journal of fluency disorders.

C43 The role of white-matter tracts in language processing in patients with brain tumors

Svetlana Malyutina[1], Olga Dragoy[1], Elisaveta Gordeyeva[1], Andrey Zyryanov[1], Dmitry Kopachev[2], Ekaterina Stupina[1], Valeria Tolkacheva[3], Igor Pronin[2], Maria Ivanova[1]; [1]National Research University Higher School of Economics, [2]Burdenko National Scientific and Practical Center for Neurosurgery, [3]European Master in Clinical Linguistics

Contemporary hodotopic models emphasize the critical role of white-matter tracts, rather than just cortical areas, in language processing (Catani, Jones, & ffytche, 2005). Still, the specific roles of different tracts in particular

components of language processing remain to be delineated. The neurosurgical population provides a unique opportunity for studying this. Unlike stroke-related damage, brain tumors grow over time, allowing for functional re-organization of language processing. So, language deficits in the neurosurgical population demonstrate which functions of white-matter tracts could not be re-mapped onto a different neural substrate during tumor growth. This allows to establish unique contributions of different tracts to language processing. This study investigated correlations between the integrity of left-hemisphere white-matter tracts and language processing in brain tumor patients pre-operatively. Participants were 30 Russian-speaking individuals with brain tumors in the left frontal, insular, or temporal lobe (WHO grade II/III) recruited at the Burdenko National Scientific and Practical Center for Neurosurgery. Before neurosurgery, every patient underwent language testing and diffusion brain MRI. Language testing was performed with the Russian Aphasia Test (RAT; Ivanova et al., 2016), testing comprehension and production at the phonological, lexico-semantic, syntactic and discourse level. Diffusion-weighted MR imaging was performed on a 3T scanner (64 directions, 2.5 mm isovoxel, b=1500 s/mm2, two repetitions with opposite phase-encoding directions). After pre-processing in FSL and ExploreDTI, major left-hemisphere tracts were manually delineated in TrackVis in a deterministic tensor-based model: arcuate fasciculus (long, anterior and posterior segment), frontal aslant tract, inferior longitudinal, inferior fronto-occipital, and uncinate fasciculi. To establish tract-function relations, scores on language subtests were correlated with tract volume. Overall, the patients had minor language deficits: the mean RAT score (on a scale from 5, no deficits, to 0, severe deficits) was 4.82 (SD 0.19, range 4.20-5.00). Sentence comprehension scores were significantly positively correlated with the volume of the posterior segment of the arcuate fasciculus. Word, sentence and discourse production scores were significantly positively correlated with the volume of both long and posterior segment of the arcuate fasciculus. Unexpectedly, word and pseudoword repetition scores were negatively correlated with the volume of the frontal aslant tract (higher tract volume was associated with lower scores). No other significant correlations were observed. The findings are consistent with previous studies showing the role of the left arcuate fasciculus in syntactic processing (Wilson et al., 2011; Grossman et al., 2013) and language production at different levels (Bello et al., 2008; Duffau et al., 2002; Marchina et al., 2011). However, this is one of the few studies separately considering the segments of the arcuate fasciculus: here, syntactic processing was associated with the posterior segment, whereas language production was correlated with both long and posterior segment. In this sample, damage to inferior longitudinal, inferior fronto-occipital, or uncinate fasciculi was not associated with any language deficits. Further testing of patients with damage to these tracts is warranted. The results are relevant to hodotopic models of language processing and to clinical prognosis of language deficits and planning of awake neurosurgeries. The study was supported by RFFI (grant no. 16-06-00400).

C44 Assessing speech movements in people who stutter using real-time MRI of the vocal tract

Charlotte Wiltshire[1], Jennifer Chesters[1], Mark Chiew[1], Kate E Watkins[1]; [1]University of Oxford

Introduction: The speech motor systems of people who stutter (PWS) are less stable than those of fluent controls. Previous measures of lip aperture over repeated utterances of nonwords reported greater variability in PWS than controls (Smith et al., 2010); variability increased with the length and phonological complexity of the nonword and decreased over repetitions in PWS. Here, we examined these effects in PWS using a novel technique of real-time MRI of the vocal tract during speech. Method: Mid-sagittal images of the vocal tract from lips to larynx were acquired with in-plane spatial resolution of 2mm x 2mm using a radial FLASH sequence (TE/TR = 1.4/2.5ms) with golden angle sampling. Images were reconstructed at 33.3 frames per second. We scanned seven adult men with moderate to severe stuttering (mean age = 27.9 years; range = 19-40) and five age-matched fluent male controls (mean age = 27.6 years; range = 20-41). Participants repeated nonwords at their normal speaking rate during scanning. Stimuli were identical to those used by Smith et al (2010); four nonwords of increasing length and phonological complexity: “mab” (/mæb/), “mabshibe” (/mæb□aIb/), “mabfieshabe” (/mæbfaI□eIb/), and “mabshaytiedoib” (/mæb□eitaId□Ib/) and a fifth nonword, “mabteebeebee” (/mæbtibibi/), matched for length but with low phonological complexity. Nonwords were presented in a random order. The imaging data were analysed using a custom Matlab toolbox that uses air-tissue boundary segmentation to track precise movements within the vocal tract (Kim et al., 2014). In this preliminary analysis, lip aperture (the distance between the upper and lower lips in mm) was measured across the entire utterance of the one- and four-syllable nonwords. The size of the lip movement for each nonword was calculated by summing the measurements across all frames to capture variability in both space and time. Variability across repeated utterances was calculated using the coefficient of variation. The change in coefficient of variation from the first five repetitions to the last five repetitions was also calculated. Group comparisons were made used a Mann-Whitney U test. Results: PWS produced larger movements than controls for both the complex ($U(8) = 24$, $Z = 2.4$, $p = .016$) and simple ($U(9) = 27$, $Z = 2.2$, $p = .03$) four-syllable nonwords but showed no difference in the overall size of the speech movement for the one-syllable nonword. There was no difference between PWS and controls in the coefficients of variation for one- and four-syllable nonwords. The coefficient of variation also did not change significantly from the first five to the last five utterances of these nonwords in either

group and the size of this change did not differ between PWS and controls. Conclusion: Using real-time MRI of the vocal tract, we found that PWS produced larger speech movements than controls when speaking multi- but not mono-syllabic nonwords. This result is consistent with previous findings in PWS (Max, Caruso & Gracco, 2003). However, this preliminary analysis of a small sample revealed no differences between PWS and fluent controls in the variability of lip movements.

C45 Apraxia of speech in aphasia maps to lesions in the arcuate fasciculus

Sebastien Paquette[1], Karen Chenausky[1], Andrea Norton[1], Gottfried Schlaug[1]; [1]Music, Stroke Recovery, and Neuroimaging Laboratory, Beth Israel Deaconess Medical Center - Harvard Medical School

Introduction. The contribution of lesion location to signs of apraxia of speech (AOS) and aphasia in individuals who have suffered a stroke, and the contribution of AOS to their communication impairments, are challenging to determine because of the overlap of both lesion location and symptomatology between AOS and aphasia. We began investigating these questions by (1) estimating the prevalence of AOS in a large group of patients with aphasia and (2) performing voxel□based lesion–symptom mapping (VLSM) analyses to determine whether the spatial location of brain lesions can predict symptoms of AOS (Rorden et al., 2007). VLSM tests each voxel to statistically determine whether individuals with lesions in a particular location are more likely to experience the deficit of interest than those without injury at that location. Methods. The Apraxia of Speech Rating Scale (ASRS; Strand et al. 2014) was used to rate video of 39 individuals (out of a final sample of 60) with chronic-stage aphasia. Tasks used were: conversation, how-to and picture descriptions, word/sentence repetition, and diadochokinesis. The ASRS contains 16 items corresponding to characteristic features of AOS. Each item is rated on a scale from 0 (not present) to 4 (nearly always evident and marked in severity). The overall ASRS score is a sum of all 16 items, with scores > 8 indicating the presence of AOS. Participant performance on the Boston Naming Test (BNT; not used for ASRS ratings) was used for a second VLSM analysis to contrast maps with the AOS maps. In order to perform VLSM analyses, lesions masks were first drawn manually on T1-weighted images by an experienced investigator, blinded to the question of interest, and normalized using SPM8. The Non-Parametric Mapping (NPM) software included in MRIcron (z-scores; Brunner-Munzel test) with a false discovery rate correction set at $p \leq 0.01$ was used to determine significant relationships between left-hemisphere lesioned voxel clusters and ASRS scores. A critical threshold of 26% was applied (i.e., voxels were ignored unless they were involved in at least 10 cases). Results. 10% of videos were coded by two investigators to establish ASRS scoring reliability. Two-way random-effects ICCs for absolute agreement on single measures yielded a between-judge ICC of 89.7 on overall ASRS score, indicating excellent reliability on the identification of features of AOS. 35 of 39 participants were identified as having AOS. No participants had dysarthria. VLSM analysis revealed a distinct white-matter voxel cluster in the longitudinal portion of the left dorsal arcuate fasciculus that was significantly associated with overall ASRS score and was distinct from the large voxel clusters associated with performance on the BNT (% correct). Conclusions. Our findings associate the expression of apraxia of speech in aphasia to damage circumscribed to the arcuate fasciculus, distinct from the cluster of regions identified using the BNT and reinforce the hypothesis that lesions of the dorsal stream, connecting Wernicke's and Broca's areas, plays a critical role in the disordered mapping of acoustics to articulation.

C46 Does a discrete lesion to the posterior left Middle temporal gyrus produce a language deficit?

Sonia Brownsett[1,2], Kori Ramajoo[1,2], Katie McMahon[3], Hanna Gauvin[1,2], Greig de Zubicaray[1,2]; [1]Faculty of Health, School - Psychology and Counselling, QUT, [2]Institute of Health Biomedical Innovation, QUT, [3]Faculty of Health, School - Clinical Sciences

Introduction: The role of the posterior middle temporal gyrus (pMTG) in semantic and language skills remains elusive. Citing lesion evidence from stroke patients, Hickok (1) argues that this region has long been associated with auditory comprehension deficits, suggesting that it's role in auditory comprehension is at a lexical-semantic level (2,3) or 'mapping sound onto meaning' (1,2,4) or a 'conceptual access mechanism' (Hickok, 2009). According to Turken and Dronkers (5) "even a small lesion in a strategic place such as the MTG would have far more serious ramifications than a comparable lesion elsewhere in the network". Given the neurovascular architecture, stroke lesions involving the pMTG typically also include additional perisylvian regions, it is therefore a challenge to draw conclusions about the role of this region from stroke data alone. We present data from a single case study of a patient with a discrete tumour resection involving the pMTG. Methods: A 49-year-old right-handed male had a unilateral grade 4 tumour resected. A T1- and T2-flair weighted MRI image was acquired on a 3T Siemens TRIO scanner. The tumour resection was isolated to the posterior middle temporal gyrus. A battery of assessments investigating residual language, speech and semantic skills were completed to investigate the impact of removal of this posterior cortical tissue on language processing. The patient was not receiving adjunctive treatment but had recently begun taking levetiracetam following an isolated seizure. Results: The participant presented with normal non-verbal cognitive skills and recognition memory of faces. He performed within normal limits on a range of auditory repetition tasks (at word and nonword, digit and sentence levels). Manipulating frequency, imageability and word length did not impact on repetition abilities. Auditory comprehension was also within normal limits,

as was reading abilities. Investigating semantic skills specifically, he performed within normal limits on picture and word versions of the camel and cactus test and on most subtests of the Cambridge semantic battery including non-verbal auditory semantics, comprehension, naming, living versus non-living and word fluency. However, the patient presented with an isolated semantic deficit on a synonym judgement task, specifically for low frequency and low imageability items. Conclusion: We present data that demonstrates that damage to the posterior MTG does not produce a comprehension deficit per se. This unique single-case study suggests a relatively circumscribed role for the posterior MTG in abstract semantic retrieval in high-level written synonym judgement rather than either auditory comprehension or amodal semantics. The data presented here does not support notions of a small lesion to the MTG having serious ramifications for the language network (cf. 5) or that this region is associated with auditory comprehension deficits at a lexical-semantic level (cf. 1,2,3,4).

C47 Atypical neural responses associated with inaccurate speech production in children with speech sound disorders

Alycia Cummings[1], Ying Wu[2]; [1]Idaho State University - Meridian, [2]University of California San Diego

Introduction. It is presently unknown what underlying mechanisms might account for the problems that children with speech sound disorders (SSD) encounter during speech production. One possible explanation is that they have poorly specified phonological representations, which are the result of inaccurate speech sound perception. In this view, SSD treatment aimed at improving sound production might lead to changes in neurocognitive processing associated with sound perception as well, including enhanced sensitivity post-treatment to the phonological properties of treatment sounds. To explore this prediction, the present study analyzed modulations in electroencephalographic (EEG) power and event-related potentials (ERP) elicited by auditory presentation of syllables in children with SSD prior to, and after completion of, a speech treatment program. Syllables contained phonemes that the children could (/b d/) and could not (/□ l □ □ s k/) say, one of which was each child's treated phoneme. EEG and ERP responses to the ba syllable and treated sound syllables were compared pre- and post-treatment. It was expected that speech treatment would lead to changes in patterns of brain response associated with cognitive effort and acoustic feature encoding in conjunction with post-treatment speech production improvements. Methods. Participants. Twenty children with speech sound disorders (SSD) (7 male; 3.83-6.58 years). Stimuli and Procedure. Two oddball stimulus sets, each containing four consonant-vowel (CV) syllables: one standard (ba/treated sound) and three deviants (ba/ treated sound, da, one other CV) were presented. Sixty-six channels of continuous EEG were recorded at a sampling rate of 256 Hz. EEG Analyses. Source level contributions to channel EEG were decomposed using Adaptive Mixed Model Independent Component (AMICA) Analysis in EEGLAB. IC scalp topographies were clustered on the basis of dipole locations. Event-related spectral perturbations (ERSPs) were computed from activations of each IC in each cluster. ERSP theta band power (3-6 Hz) analyses focused on IC clusters localized approximately to right and left IFG. ERP P2 Amplitude Analyses. Nine electrodes were divided into three groups: (1) Left: F5, FC5, C5; (2) Central: Fz, FCz, Cz; and (3) Right: F6, FC6, C6. The P2 was measured from 100-200 ms. Results. ERSP Theta Band Power. Post-treatment, theta band oscillations to the treated sound decreased in ICs localized in and near the right IFG ($F(1,8) = 8.133$, $p = 0.021$, partial eta2 = .504). ERP P2 Amplitude. The P2 elicited by treated sounds decreased in amplitude from pre-to-post treatment while the P2 elicited by /b/ increased ($F(1,19) = 4.767$, $p = 0.042$, partial eta2 = .201). Discussion. In response to treated sounds prior to treatment, children with SSD exhibited greater theta responses in areas of cortex associated with the right IFG, suggesting that sounds the children could not say required more cognitive processing effort; theta activity decreased post-treatment. Decreased post-treatment P2 amplitudes indicated that more specified neuronal populations responded to acoustic features of treated sounds. Thus, one potential neural deficit in SSD could be impaired right hemisphere theta oscillatory networks, which could impact the integration of acoustic features that allow for accurate phoneme perception and phonological development (Goswami, 2011).

Language Development

C48 Reading efficiency is associated with fractional anisotropy, but not with myelin content, in the superior cerebellar peduncles.

Lisa Bruckert[1], Katherine E. Travis[1], Aviv A. Mezer[2], Michal Ben-Shachar[3], Heidi M. Feldman[1]; [1]Stanford University, [2]The Hebrew University of Jerusalem, [3]Bar Ilan University

Introduction: Microstructural properties of the cerebellar peduncles are positively and negatively associated with reading abilities in children and adolescents. In diffusion MRI (dMRI), white matter microstructure is typically indexed by fractional anisotropy (FA) - a measure of directionality of water diffusivity. FA can be influenced by multiple tissue properties, including myelin content, axonal diameter, and axonal density, making it difficult to interpret the direction of structure-function correlations and the tissue properties that underlie them. R1 from quantitative T1 (qT1) imaging is directly associated with myelin content (R1 = 1/T1). Integrating measures of FA and R1 allows us to examine the unique and overlapping contributions of these white matter metrics on individual variation in reading efficiency. If both measures correlate comparably with reading, the results would suggest that these associations are driven by myelin content. In contrast, associations of FA with

reading in the absence of correlations with R1 would suggest that these associations are driven by axonal tissue properties. Methods: 23 children were assessed at age 8y with standardized tests of reading accuracy and fluency, as measured by the Test of Word Reading Efficiency, 2nd edition (TOWRE-2, Torgesen, Wagner & Rashotte, 1999). Each child underwent dMRI and qT1 imaging at 3T. In dMRI, we applied a dual-spin echo diffusion-weighted sequence (30 directions, b=1000 s/mm2, 3 b=0 volumes). In qT1, we applied a spoiled gradient echo sequence, using a number of different flip angles and inversion times. We used Automated Fiber Quantification (Yeatman et al., 2012) to segment and extract the mean tract-FA (based on dMRI) and mean tract-R1 (based on qT1) of the superior (SCP), middle (MCP), and inferior cerebellar peduncles (ICP) in each child. Pearson correlations were calculated to examine the associations between word reading scores and tract-FA or tract-R1. Results: Tract-FA of the left SCP negatively correlates with word reading ($rP(21)=-.43$, $p=.040$). In the right SCP, we observe a correlation of similar strength that approaches significance ($rP(21)=-.37$, $p=.079$). While tract-FA is strongly correlated with tract-R1 in these peduncles (left SCP: $rP(21)=.63$, $p<.001$; right SCP: $rP(21)=.76$, $p<.001$), tract-R1 of the left and right SCP does not correlate with word reading ($p>0.2$). Moreover, within the right SCP, the correlation between tract-FA and word reading becomes significant when we control for tract-R1 ($rP(20)=-.46$, $p=.031$). Associations between white matter metrics of the other cerebellar peduncles and word reading are not significant. Discussion: Our findings replicate, in an independent sample of 8y old children, the negative association between FA of the left SCP and reading proficiency, previously recorded in older children and adolescents (Travis et al., 2015). The lack of association between reading and R1 suggest that correlations of FA and reading are driven by axonal properties. The combination of these techniques helps to explain negative associations of FA and reading in the SCP and implicates axonal diameter or number of crossing fibers as the critical tissue properties for reading efficiency. Determining which of these factors is relevant requires additional MRI technologies and analyses.

C49 Development of Spoken Language Comprehension in Children with Cochlear Implants: Data from a Passive Listening Task

David Corina[1], Sharon Coffey-Corina[1], Laurie Lawyer[2], Kristina Backer[1], Andrew Kessler[3], Lee Miller[1]; [1]Center for Mind and Brain, University of California, Davis, [2]University of Essex, United Kingdom, [3]University of Washington, Seattle WA

Introduction. Deaf children who have received a cochlear implant(s) early in life often show gains in the development of spoken language, however great variability in language outcomes exist (Tobey et al., 2012). Determination of the developmental progression of language processing in these children has important clinical implications. In this study we used EEG technique to examine neurophysiological correlates of lexical processing in young children with cochlear implants and normally hearing controls. Method. Using a novel EEG paradigm we examined responses elicited during the passive listening of auditory sentences while children attended to unrelated silent cartoons. Twenty-eight children with cochlear implants (ages 2-8) and thirty normally hearing control children (ages 2-8) participated. Subjects heard 12 minutes of continuous speech presented over a speaker at approximately 65 dB(HG), 70dB (CI) SPL. Sentences were modified items from the Harvard sentence corpus. All speech was pitch-flattened to 82 Hz, and multiplexed with chirps in alternating frequency bands. This manipulation permits assessment of auditory brain stem responses (not discussed) in addition to lexical properties of speech [1]. Data was collected at 19 electrode sites and 2 mastoids. ICA was used to remove eye artifact and CI-artifact (EEGLAB v.14). Separate analyses examined responses to open versus closed class words and nouns versus verbs. Measurements of waveforms were taken for mean and peak amplitudes, and peak latency at 75-150 (P1-N1 time window) and 330-530ms (N4 time window). ANOVA was used to evaluate component amplitude and latency. Results. For hearing children, a significant effect of word class was observed between 330-530 ms. with open class words eliciting an expected N4 like response. ($p < .001$). Grammatical class also modulated responses. For hearing children nouns exhibited a greater negativity than verbs from 330-530 ms. ($p < .003$). In contrast, for children with cochlear implants, we observe a prominent N1 for closed class words and a reduced N4 for open class words. In addition, we observed a reduced noun-verb differentiation, with a prolonged latency. Additional analyses examined these patterns as a function of chronological age and time-in-sound (e.g. duration of CI use). Conclusion. The data indicate that linguistic properties of speech are detectable under passive (i.e. ambient) listening conditions. While hearing children showed expected wave form morphologies, deaf children with CI's showed significantly reduced N4 amplitudes and delayed componentry. Time in sound measures suggest that ambient language processing in children is less effective in children with CI and may contribute to language delays.

C50 Resting state versus Task Based Exploration of Age-Related Changes of the Neurofunctional Connectome.

Perrine Ferré[1], Yassine Benhajali[1], Jason Steffener[2], Yaakov Stern[3], Yves Joanette[1], Pierre Bellec[1]; [1]Centre de recherche de l'Institut Universitaire de Gériatrie de Montréal (CRIUGM), UdeM, [2]Interdisciplinary School of Health Sciences, University of Ottawa, [3]Cognitive Neuroscience Division, Columbia University, USA

According to the World Health Organization, the proportion of individuals over age 60 is expected to double by 2050. Cognitive impairments can be extremely frequent in particular in older age, and has been recurrently shown to be the most feared health conditions associated with

aging. In this context, a better understanding of the mechanisms that can support cognitive health during aging is crucial. Most of the current knowledge about the aged-related changes in brain neurofunctional organization stems from studies using cognitive tasks for which performance has a tendency to decrease with aging (e.g.: working memory). Few of those studies have looked at language processing related to vocabulary and semantic knowledge, abilities that have been shown to be relatively preserved in aging. The way by which the aging brain can continue to be efficient such as it is the case for vocabulary and semantic knowledge is still poorly looked at. Over the last decade, an increasing interest has been devoted to describing age-related changes in the functional connectivity of the brain. However, in most cases, these studies have been conducted while participants were in a "resting state", namely without engaging in any particular cognitive task. Important changes in the pattern of functional connectivity has been described in such resting state conditions. It remains to be determined if age-related differences in functional connectivity are also present within the neurofunctional organization in specific cognitive contexts, and in particular when participants are engaged in tasks requiring verbal and semantic processing of words. In the present study, a brain connectome analysis was performed on 300 adults ranging from 18 to 80 years old. They were tested systematically for whole brain connectivity to search for consistent differences as a function of age, performance, education or cognitive reserve factors during an fMRI session of resting-state and while performing three lexical-semantic tasks (antonyms, synonyms, picture naming). Then, similarities in age effect on brain connectivity across all tasks was examined for language-related seed regions. Results confirm that performances for the lexical-semantic tasks are preserved. Brain imaging also shows the existence of qualitative discrepancies between task-evoked and resting state connectivity patterns. Mean functional connectivity shows a general tendency to decrease with age, whatever the cognitive context. However, during lexical-semantic tasks, enhanced connectivity in semantic and visual-attentional regions is revealed. No interactions were to be found between connectivity patterns and performance, education or cognitive reserve as a function of age, thus not bringing imaging support to some of the determinants of presumed compensation of cognitive aging. The results of the present study suggest that investigation of functional connectivity in aging cannot solely rely on resting-state imaging data, especially when interpretation of cognitive processes is at stake. Our results also challenge the current models of aging in their ability to account for age differences in the semantic-language domain.

C51 Refining diffusion MRI as a tool to link Anatomical Connectivity and Second-Language Learning Success

Kaija Sander[1,2], Elise B. Barbeau[1,2], Shari Baum[2,3], Michael Petrides[1,2,4], Denise Klein[1,2]; [1]Cognitive Neuroscience Unit, Montreal Neurological Institute, McGill University, Montreal, [2]Centre for Research on Brain, Language and Music (CRBLM), Montreal, [3]School of Communication Sciences and Disorders, McGill University, Montreal, [4]Department of Psychology, McGill University, Montreal

Learning a first language occurs easily and naturally at a young age. However, learning a second language (L2) at a later age is more difficult, and there is a large variability in L2 acquisition, with individuals learning with more or less difficulty depending on the age and environment of acquisition. Variability in L2 acquisition is also influenced by between-individual differences in language learning abilities, though little is known about the factors that lead to those differences. In previous research, we have focused on identifying individual neural biomarkers of language learning success[1]. Specifically, we focused on brain functional connectivity between specific brain regions and their relationship with different aspects of language learning using resting-state MRI. In this follow-up study, we use improved behavioural measurements and more refined measures of anatomical brain connectivity to investigate the relationship between anatomical connectivity and learning success in monolingual English speakers who took an intensive French course and were scanned before and after the training. Using anatomical T1, diffusion MRI and behavioural data, we report relationships between the behavioural measures and the brain-related measures. We focus on improved reconstruction of language tracts for identifying differences between individuals in anatomical brain connectivity. We have extracted measures from these tracts and relate them to our behavioural measures of language learning outcomes. Here we focus on the Arcuate Fasciculus, classically considered the main language tract as it connects Broca's (left IFG) to Wernicke's (left STG) areas, and report increased macrostructural properties of this tract after L2 learning that were associated with better L2 behavioural measures. This project has several outcomes that are relevant to our understanding of L2 acquisition. Linking intrinsic anatomical patterns and the ability to acquire an L2 informs us about neural biomarkers predicting L2 learning success or difficulty, and comparisons of pre and post training sheds light on issues related to plasticity in response to language learning and reveals how the brain changes with training. [1]Chai et al. 2016. J Neurosci 36(3)755-761

C52 Neural correlates of sematic ambiguity in second language learners

Kiyo Okamoto[1], Hyeonjeong Jeong[2,3], Haining Cui[3], Ryuta Kawashima[4], Motoaki Sugiura[2]; [1]Graduate School of Medicine, Tohoku University, Sendai, Japan, [2]Department of Human Brain Science, IDAC, Tohoku University, Sendai, Japan, [3]Graduate School of International Cultural Studies, Tohoku University, Sendai, Japan, [4]Department of Advanced Brain Science, IDAC, Tohoku University, Sendai, Japan

Learning ambiguous words that have more than one meaning (i.e., polysemy) is challenging for most second language (L2) learners. It is true that bilinguals including L2 learners face difficulty in processing ambiguity in each of their languages as well as between languages (Degani & Tokowicz, 2010). Previous neuroimaging studies on first language (L1) have reported that semantic-related areas (i.e., the left inferior frontal gyrus) were activated during the reading of ambiguous words (e.g., Bitan et al., 2017). However, little is known about how L2 learners process ambiguous L2 words in the brain. We hypothesized (a) that L2 learners may need resolution of semantic processing with a similar way to process their L1, and (b) that L2 learners may process L2 ambiguous words in cognitive control areas such as the anterior cingulate cortex and caudate nucleus (Abutalebi & Green, 2016). Furthermore, learner's L2 proficiency levels may influence cognitive mechanisms of resolving ambiguous process of L2 words. The current fMRI study attempted to investigate the brain mechanism involved in resolution of ambiguity across languages (L2: English - L1: Japanese) and the mediating role of L2 proficiency level on its brain mechanism by controlled within-language ambiguity (L1: Japanese). Participants were 18 healthy right-handed native speakers of Japanese who had learned English as L2 (mean age: 21.6, female 7). They performed cross-language (L2-L1, hereafter referred to as L2 task) and within-language (L1-L1, hereafter referred to as L1 task) semantic relatedness judgment tasks during MRI scanning. In both tasks, we presented either ambiguous words or unambiguous words with semantically related or unrelated words in a random order. For L2 (cross-language) task, we prepared 25 ambiguous and unambiguous English words for each task. The same numbers of Japanese ambiguous (i.e., homonyms) and unambiguous words were prepared for the L1 (within-language) task as a control. Four types of conditions in each task (L2 and L1) were created: related ambiguous words (RA), unrelated ambiguous words (UA), related unambiguous words (RN), and unrelated unambiguous words (UN). We focused on only RA and RN conditions in L2 and L1 for the data analysis. Participants' standardized language proficiency score of L2 (i.e., TOEIC) were used to examine the proficiency effect. The correlation analysis was conducted in the contrast L2 [RA-RN] and the proficiency scores in the whole brain analysis. Statistical analyses were performed with SPM12 using a random effects model (voxel-level $p<0.001$ uncorrected and then corrected to $p<0.05$ by cluster-level). Two major findings are noteworthy. First, the main effect of ambiguity in the L2 and L1 tasks [RA_L2+RA_L1]-[RN_L2+RN_L1] revealed that both language similarly induced activation in the inferior frontal gyri. However, there was no significant interaction effect [RA_L2-RN_L2]-[RA_L1-RN_L1]. Second, the higher L2 proficiency was related to greater activation in the left caudate nucleus (small volume correction, FWE $p<0.05$). This result suggests that advanced L2 learners may recruit more language control areas to process ambiguous L2 words than lower-level L2 learners.

Multilingualism

C53 Bilingualism interacts with age-related cortical thinning in children and adolescents

Christos Pliatsikas[1], Vincent DeLuca[1], Lotte Meteyard[1], Michael Ullman[2]; [1]School of Psychology and Clinical Language Sciences, University of Reading, UK, [2]Department of Neuroscience, Georgetown University, USA

Recent evidence suggests that learning and using a second language (L2) affects the structure of the adult cortex, even in individuals who started learning their L2 in adolescence. Specifically, various cortical regions related to language processing or executive control, such as the left superior, middle and inferior frontal gyri (SFG, MFG, IFG), the superior parietal lobule (SPL), the supramarginal gyrus (SMG), and several temporal regions, have been found to show increases in volume and/or thickness (Pliatsikas,in press) in L2 learners/users vs. monolinguals. However, the variability in the available evidence makes it unclear whether the observed differences are due to brain reorganisation because of late L2 learning and long-term L2 usage, or whether they also apply to very young speakers of two languages, and if so, how they interact with brain development. Studies looking at the brain structure of bilingual children remain scarce, but it has been shown that cortical thickness in some of these regions differs between bilingual children with balanced and unbalanced proficiency in their two languages (Archila-Suerte et al., 2018). It is a well-documented finding that cerebral cortex becomes thinner in developing children (Tamnes et al., 2010), with regions such as the IFG and MFG more affected than others (Fjell et al., 2009). Crucially, since the same regions have also been reported to be increased in size as a result of L2 learning/usage, it would be expected that bilingualism interacts with typical cortical thinning of these regions, possibly by delaying it. To test this hypothesis, we extracted cortical thickness data from children and adolescents reporting speaking one (n=1524) and two (n=394) languages from the PING database (http://pingstudy.ucsd.edu/). We used Generalised Additive Mixed Models to test the effect of Age and Bilingualism on cortical thickness, accounting for confounding variables such as sex, handedness, education, and household income. Our results revealed a significant main effect of Age for a large number of brain regions, showing development-related cortical thinning as per previous findings. Interestingly, significant Age*Bilingualism interactions were reported for bilateral SFG, SMG, IFG, SPL, the postcentral, precentral and paracentral gyri, and the precuneus (all $ps<0.001$). For all regions, monolinguals had steeper age slopes than bilinguals, demonstrating that slower cortical thinning for the latter group over the course of childhood and adolescence in

regions related to the acquisition and handling of two languages. These results will be discussed against models on bilingualism-induced brain restructuring and recent suggestions about the applicability of critical periods in L2 learning in the face of neuroimaging data (DeLuca et al.,in press) References Archila-Suerte et al. (2018). Developmental Science, e12654. https://doi.org/10.1111/desc.12654 DeLuca et al (in press). Brain adaptations and neurological indices of processing in adult Second Language Acquisition: Challenges for the Critical Period Hypothesis. In J. Schwieter (Ed.), The Handbook of the Neuroscience of Multilingualism. Wiley- Blackwell. Fjell et al. (2009). Cerebral Cortex, 19(9), 2001–2012. https://doi.org/10.1093/cercor/bhn232 Pliatsikas (in press). Multilingualism and brain plasticity. In J. Schwieter (Ed.), The Handbook of the Neuroscience of Multilingualism. Wiley- Blackwell. Tamnes et al. (2010). Cerebral Cortex, 20(3), 534–548. https://doi.org/10.1093/cercor/bhp118

C54 Bilingualism is a Spectrum: Effects of specific language experiences on brain function and executive control in bilinguals. *Vincent DeLuca[1], Christos Pliatsikas[1], Jason Rothman[1,2], Ellen Bialystok[3]; [1]University of Reading, UK, [2]UiT: The Arctic University of Norway, [3]University of York, Canada*

The effects of bilingualism on executive control are heavily debated, given the variable results found across studies (Valian, 2015). However, discrepancies between bi-/monolinguals likely correlate to how bilinguals are treated as a monolithic group (Bak, 2016; Surrain and Luk, 2017). Theories state that individual bilingual language experiences confer shifting language control demands and that the mind/brain adapts accordingly (Green and Abutalebi, 2013; Grundy et al., 2017). However, few studies have specifically examined effects of individual differences in bilingual language use on executive control processes and their neural correlates. We address this by examining a range of specific experience-based factors (EBFs) within the bilingual experience and their effects on brain function related to executive control processes. We assess the hypothesis that specific EBFs will confer distinct effects in regions specific to language/executive control processes. Typically developing bilinguals (n= 65, 49 female, Mage= 31.8yrs, SD 7.59) were scanned (MRI) while they completed a Flanker task which contained mixed blocks (congruent and incongruent trials), a congruent block, and a neutral block. Participants also completed an English proficiency test (Oxford QPT; Geranpayeh, 2003), and a detailed language use/background questionnaire (LSBQ; Anderson et al., 2017). LSBQ scores were used to predict both task performance and neural recruitment. Five predictors were included in the model: length of second language (L2) immersion, L2 Age of Acquisition (L2 AoA), a weighted composite factor score representing the extent of active engagement with both languages (Bilingualism composite score, BCS), and two factor scores detailing degree of L2 use in 1) social/community settings (L2_Social) and 2) home settings (L2_Home). Behavioral analyses showed significant differences in reaction times (RTs) between different trial/block types on the Flanker task (all ps<.0001). RT differences were not significantly predicted by the language demographics (all ps>0.05). However, the predictors showed activation in distinct and specific regions in terms of neural recruitment; activations differences related to the mixing cost (mixed compared to neutral blocks) were modulated in specific ways by each factor from the LSBQ. Longer L2 immersion predicted increased activation in several regions including the left inferior frontal gyrus (LIFG), left precentral gyrus, and right supramarginal gyrus (p<.05, corrected). This indicates recruitment of a more broadly distributed language/executive control network commensurate with a longer duration of intensive L2 exposure (Abutalebi and Green; 2016). The factor scores L2_Home and L2_Social were found to positively correlate with increased activation in several portions of the cerebellum (p<.05, corrected). This indicates a shift toward automated language/executive control processing commensurate with the degree of engagement with the L2 in the immersive environment. Other data are discussed in light of how the brain optimizes specifically to handle language/executive control demands incurred by differing bilingual language experiences. More broadly, this approach highlights the need to consider several specific language experiences in assessing the neurocognitive effects of bilingualism. In turn, by beginning to reveal/understand the dynamics of the bilingual experience and how this manifests in adaptations to cognitive functions, we will contribute to a better understanding of the variability reported in the literature.

C55 Bilingual switching experience improves executive control: A follow-up fMRI study *Cong Liu[1], Lu Jiao[2], Yuan Chen[1], Ruiming Wang[1]; [1]South China Normal University, [2]Beijing Normal University*

Some researches deemed that the bilingual advantage in executive control does exist, but others did not. With regard to this debated topic, previous studies mainly used cross-sectional method, which can only examine whether the bilingual cognitive control advantage is correlated with language switching or not, but cannot reveal the causal relationship between them. To address this problem, recent studies began to use longitudinal studies to investigate the effect of bilingual experience on cognitive control and its neural basis. However, the majority of existed longitudinal studies were conducted by short training under laboratory environment, which lack ecological validity. Therefore, it is worth further studying that how bilingual experience under natural situation in daily life shapes individuals' domain-general executive control network. In this study, we explored how bilingual experience under natural learning environment shapes executive control networks by a follow-up fMRI study. 25 college freshmen from South China Normal University were recruited to complete fMRI

scanning twice: the first time is when they just entered college (i.e., pre-test) and the second time is one-year later (i.e., post-test). During one-year academic learning, the college freshmen will have massed learning experience of foreign language, which make them own abundant bilingual switching experience. They were asked to complete color-shape switching task and modified Flanker task in both scanning. The color-shape switching task is used to measure cognitive switching, and the modified Flanker task is used to measure response suppression and interference inhibition. Behaviorally, the results of self-rating language proficiency and Oxford Placement Test indicated that the participants' language proficiency are significantly improved in the post-test as compared to the pre-test. More importantly, compared with the pre-test, the switching costs for cognitive switching ability was smaller in the post-test, but no behavioral difference for interference inhibition and response suppression. However, the fMRI results showed decreased activation in anterior cingulate cortex (ACC) and left inferior frontal gyrus (LIFG) for cognitive switching, and decreased activation in bilateral inferior frontal lobule and subcortical regions for interference inhibition in the post-test, relative to the pre-test. By contrast, there was no difference in brain activation for response suppression between the two tests. Overall, these findings suggested bilingual switching experience in natural environment could improve executive control, but this improvement was only limited in certain components of executive control. Our study provided new experimental evidence for bilingual advantage, and offered further insights into the neuroplasticity of human brain.

C56 Individual Differences in Executive Function and L2 Age of Acquisition Modulate Bilingual Homograph Processing

Pauline Palma[1], Veronica Whitford[2], Debra Titone[1]; [1]McGill University, [2]University of Texas at El Paso

Numerous psycholinguistic studies have examined lexically ambiguous words, such as homographs (e.g., chest = 'torso' or 'furniture' in English). The Re-Ordered Access Model (Duffy et al., 1988) proposes that sentential context influences meaning selection by re-ordering access of dominant and subordinate (infrequent) meanings. In particular, biasing contexts should delay access of subordinate meanings. However, it is unclear whether this model extends to bilinguals, for whom cross-language activation might also re-order access of dominant and subordinate meanings of within-language homographs (see Schwartz et al., 2008). Moreover, it is unclear whether individual differences in language background and executive function also play a role, given prior monolingual work demonstrating fronto-cortical regions involvement in ambiguity resolution (e.g., Mason & Just, 2007). Here, we conducted an eye-movement reading study that investigated whether individual differences in L2 age of acquisition (AoA) and executive function (assessed by a non-linguistic Simon task) modulate how French-English (n = 47) and English-French (n = 40) bilinguals process homographs embedded in different sentential contexts. The homographs were either uniquely-English (e.g., chest) or had a subordinate meaning that was also an English-French cognate (e.g. cabinet: dominant meaning = 'kitchen cabinet'; subordinate meaning = 'governmental body', which overlaps with French). The sentences either biased the dominant meaning, subordinate meaning, or did not bias either meaning (e.g., George glared at the [kitchen] cabinet, and decided to hire another worker to fix the broken shelf; George glared at the [republican] cabinet, and convinced them to overturn the illegal fiscal policy). Using linear mixed-effects models, we found that French-English bilinguals reading in their L2 (English) exhibited less slowing when processing cognate-homographs embedded in sentences that biased the subordinate meaning. In contrast, English-French bilinguals reading in their L1 (English) exhibited the same slowing, regardless of cognate status. Moreover, for French-English bilinguals, greater executive function facilitated the processing of uniquely-English homographs, but not of cognate-homographs. L2 AoA, however, did not play a role. For English-French bilinguals, individual differences in executive function did not play a role; however, earlier L2 AoA facilitated cognate-homograph processing. Taken together, we found evidence that the subordinate L1 meanings of within-language homographs are co-activated during L2 reading, and that both individual differences in language background and executive function modulate bilingual homograph processing.

C57 The Impact of Second Language Age of Acquisition and Language Usage Entropy on Reinforcement Learning among Bilingual Adults in a Non-Verbal Decision Making Task

Mehrgol Tiv[1], Jason Gullifer[1], A. Ross Otto[1], Debra Titone[1]; [1]McGill University

We investigated whether bilingual language experience modulates the interplay of two behaviorally and neurally dissociable cognitive systems that contribute to reinforcement learning in a non-verbal decision making task. One system draws on simple reward-driven associations ("model-free") to make choices, and the other leverages information about the environment's structure and the decision-maker's current context and goals ("model-based") to prospectively plan choices. Of relevance, neural networks related to bilingual language control (e.g., Green & Abutalebi, 2012) overlap with those involved in reward valuation, and could thus manifest as behavioral differences in a decision task that has dynamically shifting reward probabilities. We specifically examined individual differences in second language (L2) age of acquisition (AoA) and bilingual language entropy (entropy = 0 indicates compartmentalized use whereas entropy = 1 indicates an even integration of languages; Gullifer et al., in revision), which we hypothesized could modulate bilingual choice behavior (i.e. model-free or model-based) on a non-verbal decision making task. A total of 45 sequential, bilingual French-English adults performed

a two-step decision task (Daw et al., 2011; Otto et al., 2014) where both the transition type between stages and the probability of receiving a reward dynamically varied. We first compared model-free vs. model-based behavior using a factorial mixed-effects logistic regression on "stay" probability as a function of the prior trial's reward (reward vs. no reward) and transition type (common vs. rare). We then examined the interaction of L2 AoA and language entropy on choice behavior in conjunction with model-free and model-based predictors. Consistent with past work, we found a significant interaction between reward and transition type, indicating that bilingual choice behavior was both model-free and model-based to differing degrees. Crucially, L2 AoA and language entropy jointly modulated choice behavior. Bilinguals having more integrated L1/L2 capacities (earlier L2 AoA, greater language entropy), relied more on simple reinforcement to guide their decisions, whereas bilinguals having more compartmentalized L1/L2 capacities (later L2 AoA, lower language entropy) demonstrated greater sensitivity to model-based reward frequencies. These preliminary results suggest that bilingual adults successfully integrate contextual information with reward in a two-step decision task, but that bilinguals who acquired an L2 later in life and compartmentalize their language usage rely upon model-based learning to a greater degree. There are minimally two possible explanations for this experiential effect. First, it is possible that late compartmentalized bilinguals are more reliant upon context-based cues or recruit additional control capacities when communicating to suppress a highly entrenched L1 during L2 processing. In contrast, early integrated bilinguals may be substantially more practiced at managing language co-activation because L1 processing is less entrenched and L2 processing is more proficient. Second, it is possible that differences in bilingual language experience relate to other cognitive propensities that would impact task performance, such as tolerance of ambiguity or reward uncertainty, given that integrated bilinguals explore unrewarded choices more than compartmentalized bilinguals. In our ongoing work, we are pursuing these options, as well as examining how bilingual experience and reinforcement learning both relate to individual differences in cognitive control.

C58 Bilingualism modulates L1 word processing in the developing brain

Olga Kepinska[1], Myriam Oliver[1], Zhichao Xia[1,2], Rebecca Marks[3], Leo Zekelman[1], Roeland Hancock[1,4], Stephanie Haft[1], Priscilla Duong[1,5], Yuuko Uchikoshi Tonkovich[6], Ioulia Kovelman[3], Fumiko Hoeft[1,4,7]; [1]University of California, San Francisco, [2]Beijing Normal University, [3]University of Michigan, [4]University of Connecticut, [5]Palo Alto University, [6]University of California, Davis, [7]Haskins Laboratories

While there is increasing consensus that the core neural phenotype of language is more universal than once thought (Rueckl et al., 2015), it is still considered gold-standard that language development requires additional neural resources to be recruited. In bilinguals, evidence suggests that second language (L2) is processed using the first language's (L1) network (Tan et al., 2003). Recent findings also show an interaction between the L1 and L2, suggesting that L2 acquisition also influences L1 processing (Costa & Sebastián-Gallés, 2014). With the majority of studies on bilingualism and L2 acquisition concentrating on L2 representations and processing in the brain, here, we investigated whether experience with additional language(s) in childhood exerts influence on the processing of the L1. Typically developing kindergartners were recruited from public schools at the San Francisco Unified School District and participated in the study. During acquisition of functional MRI (fMRI) using a gradient-echo echo-planar pulse sequence, children performed an auditory L1 (English) word match task blocked alternating with periods of rest. In the task upon hearing two words, they indicated with a button press whether the words were the same or different. Based on task accuracy (>60%) and motion (<30% of time-points removed due to movement), fMRI data from 57 children (23 males, 5 left-handed, 1 ambidextrous) were subjected to further analyses. These kindergarteners were 5-6 years old (M=5.90, SD=0.36), and had varying levels of L2 experience, operationalized as the numbers of years of exposure to any language but L1, which ranged between 0 to 6.77 years (M=2.67, SD=2.45). We performed two whole-brain fMRI analyses of the data acquired during the L1 auditory task: (1) with years of exposure to L2 as a covariate of interest, and controlling for children's age, gender and handedness; and (2) with additional covariates representing children's socioeconomic status (SES), task performance and receptive English language skills, in order to test if the L2 exposure modulates L1 brain activity patterns above and beyond these variables of no-interest. The levels of brain activity during the task in L1 were modulated by L2 exposure: a cluster localized in the superior parietal lobule/precuneous showed higher levels of activation in children with longer L2 exposure, both when SES, task accuracy and L1 language skills were accounted for, and when they were not (Zmax=3.48, p=0.004, and Zmax=3.35, p=0.001, respectively, corrected for multiple comparisons using Gaussian Random Field theory, Z>2.0, cluster-wise p<0.005). Superior parietal lobule has been previously shown to be involved in (among others) reasoning, working memory, and attention processes (Wang et al., 2015). Our results suggest L2 exposure may impact L1 auditory word-related brain activation in a very young sample, and are in line with previous evidence showing that bilinguals recruit higher cognitive control regions when performing a language task (Bialystok, 2001). Our findings demonstrate the brain's extraordinary ability to change in response to environmental experiences and point to the conclusion that the length of language exposure is a crucial factor that can affect the brain representation of even their native language.

C59 Neural discrimination of non-native vowel contrasts by late Spanish-English bilinguals *Daniela Castillo[1,2], Eve Higby[3], Sarah Kresh[1], Nancy Vidal-Finnerty[4], Jason A Rosas[1], Valerie L Shafer[1]; [1]The Graduate Center of the City University of New York, [2]Queens College, [3]University of California, Riverside, [4]Iona College*

In this study, we used the mismatch negativity (MMN), an event-related potential (ERP), to address whether native Spanish speakers who learned American English after 14 years of age rely more on spectral or durational information to distinguish English vowels that are non-contrastive in Spanish. Spanish vowels are highly distinct in spectral information but do not differ from each other in duration (Bradlow, 1995). Spanish speakers who learn English late in life have particular difficulty with the American English /□/ (as in "hot"), /□/ (as in "hut"), and /æ/ (as in "hat") and typically assimilate these three vowels into a single category (Flege et al., 1997). Second language (L2) speech perception can improve with experience, but may be less automatic than perception in the first language (L1). Strange (2011) hypothesized that under difficult task circumstances or when attention is directed elsewhere, L2 learners fall back on their L1 perceptual routines. Even so, Burnham (1986) argues that durational cues are more robust than spectral cues. Thus, we asked whether Spanish L2 learners of English show good discrimination of American-English vowels that differ in duration. ERPs were recorded from 64 electrode sites using an Electrical Geodesic Net from 10 Spanish L2 learners of English and 12 American-English monolingual controls. Speech stimuli were presented in an oddball discrimination task; in one condition /□p□/ was the standard (80% of the time) and /□p□/ and /æp□/ were deviants (10% each), and in another condition /□p□/ was the standard and /□p□/ and /æp□/ were deviants. Three natural speech tokens of each stimulus were used that varied in non-target acoustic cues so that listeners would have to rely on phonological information to discriminate the stimuli. Approximately 150 deviants of each stimulus type were presented. Participants performed a visual oddball task to draw attention away from the auditory stimuli. The amplitude and latency of the MMN at fronto-central sites served as dependent measures. Participants were also tested on behavioral discrimination of the vowels via a button press whenever they heard a deviant stimulus, following the ERP study. Spanish L2 listeners were better at behaviorally discriminating /æp□/ and /□p□/ than /□p□/ and /□p□/ (85% and 68% accuracy, respectively). ERPs supported these results with a greater amplitude MMN to the /æp□/ versus /□p□/ than to the /□p□/ versus /□p□/ contrast, but only when /□p□/ was the standard and not when /□p□/ was the standard. Spanish listeners showed worse behavioral categorization than the American-English controls; in addition, their MMN was smaller in amplitude to /□p□/ versus /□p□/ than observed for the American English listeners. These findings indicate that Spanish listeners relied more on spectral than duration differences for American-English vowel discrimination. Our future direction will be to examine whether English exposure and use versus English proficiency level lead to improved discrimination of these vowels and increased reliance on spectral and/or durational information at the automatic level of processing indexed by the MMN.

C60 The Electrophysiological Effects of L2 Negation Processing *Gabrielle Manning[1], Laura Sabourin[1], Sara Farshchi[2]; [1]University of Ottawa, [2]Lund University*

The processing of negation in a speaker's first language (L1) has been found to occur in one of two ways: either following a two-step account or a pragmatic account. The two-step account states that speakers incur a processing cost when interpreting a negated sentence (Kaup et al., 2006; Kaup et al., 2007). The negation of a sentence is processed at a later stage of comprehension, following the interpretation of the affirmative form. Therefore, negation is said to be more difficult to process than the affirmative counterpart of a sentence. In contrast, through the use of Event Related Potential (ERP) research, Nieuwland and Kuperberg (2008) found that speaker's process negated sentences effortlessly, using their pragmatic and real-world knowledge, resulting in the pragmatic account of negation. When the beginning of a sentence provides predictive information for a negated element at the end of a sentence, negation does not cause difficulty in processing. This is evidenced by the lack of an N400 (semantic violation) for the negated element in pragmatically true sentences and the presence of an N400 in pragmatically untrue sentences. The lack of an N400 in true sentences indicates that negation is processed effortlessly when it is within a pragmatically acceptable context. These negation processes have not yet been investigated in second language (L2) speakers in regard to how speakers process negative elements in their L2. In the current study, we investigated the electrophysiological response to negation in L2 English speakers. Functional English monolingual data and French-English simultaneous data is currently being analyzed as control groups to further investigate this process. During the experiment, all participants read 64 English affirmative and negated sentences using the rapid serial visual presentation technique while their neural activity was measured. The conditions of the target adjective varied in both affirmative and negated sentences in relation to the adjective at the beginning of the sentence. These adjectives either matched (true: The jury found him innocent because the fire was recognized as not intentional in court) or mismatched (false: The jury found him guilty because the fire was recognized as not intentional in court). L2 speakers show a late negativity to the negated predicate in the true sentence context between 500-700ms. Preliminary analyses revealed significant effects of sentence type (affirmative vs. negated: p=.048), as well as an interaction between sentence type and laterality (p=.032). This negativity

may be an indication of a late N400 effect to negation, due to participants being L2 speakers and taking longer than native speakers to fully process the elements of the sentence. The current results indicate that L2 speakers appear to have a processing cost associated with negation, as an effect is present not only in pragmatically true sentences, but also at a later processing stage. As this study investigates how an element is processed in a speaker's L2, the results provide further insight on the underlying mechanisms in use for processing in non-native speakers.

Methods

C61 Worse than useless: traditional ERP baseline correction reduces power through self-contradiction

Phillip M. Alday[1]; [1]Max Planck Institute for Psycholinguistics

Baseline correction plays an important role in past and current methodological debates in ERP research (e.g. the Tanner v. Maess debate in Journal of Neuroscience Methods), serving as a potential alternative to strong high-pass filtering. However, the very assumptions that underlie traditional baseline also undermine it, making it statistically unnecessary and undesirable. In particular, the assumption that the electrophysiological activity of the baseline interval does not differ systematically between conditions implies by definition that the baseline interval is essentially a by-channel noisy reference. The noise from the baseline interval is then projected into the target interval, thereby reducing power. Moreover, as a reference, the baseline interval can bias topographies, especially if the no-systematic-difference assumption is violated. This reference nonetheless serves to address non-experimental recording factors (electrode drift, differences in environmental electrical noise), but there are better methods for controlling for theses environmental issues. Instead of assuming a fixed baseline correction, whether trial-by-trial or at the level of single-subject averages, we can instead include the baseline interval as a statistical predictor, similar to other GLM-based deconvolution approaches (e.g. removal of eye-artifacts, Dimigen et al. 2011; rERP, Smith & Kutas 2014). The baseline interval can then interact with, i.e. allow its influence to be weighted by topographical and experimental factors. This controls for topographical biases, addresses electrode drift in block designs, does not require the no-systematic-difference assumption, and allows the data to determine how much baseline correction is actually needed. Additionally, both full traditional baseline correction and no baseline correction are included as special cases. The lack of the no-systematic-difference assumption also allows for this method to be applied more naturalistic settings, which have recently begun to gain ground in M/EEG research (cf. Alday et al. 2017, Broderick et al. 2017, Brodbeck et al. 2018). In addition to this theoretical argument, we show the effectiveness of this method by reanalysis of previous ERP studies on language. We find that the empirically determined baseline correction is often much less than the traditional correction. Using semi-parametric simulations from mixed-effects models fit to these data, we further show that the trade-off in power between additional model complexity and the noisiness of the dependent variable is worth the improved fit to the data.

C62 Overcoming the challenges of electrophysiology recordings during multi-word speech production

Svetlana Pinet[1], Nazbanou Nozari[1], Robert T. Knight[2], Stephanie K. Riès[3]; [1]Johns Hopkins University, [2]University of California, Berkeley, [3]San Diego State University

Executive processes are required during language production to control accurate production and resolve potential conflicts. Sentences and word sequences in general are particularly conflicting situations, since several words must be processed and produced in a short period of time. In that context, studying sequential speech production can be challenging due to the potential mixture of processes. A response-related component that has been widely used to study conflict with EEG is the error-related negativity (ERN). Typically, its amplitude increases in higher conflict situations (e.g., for errors compared to correct trials). The aim of this study was to evaluate the feasibility of recording electrophysiological indices of monitoring such as the ERN in the context of a continuous sequence of words, and in particular, whether separate components could be isolated for each item in the sequence. We used a tongue-twister paradigm, consisting of 32 sequences of four words sharing the same vowel and with their onset consonants arranged in an ABBA pattern (e.g., "beige tame take bale"), adapted from Oppenheim & Dell (2008). Sequences were recited twice from memory at a regular pace (a word every 650 ms). EEG data were acquired from ten participants. EEG analyses focused on correct trials, around the onset of each word. We used ICA to correct for vertical ocular movements and BSS-CCA to correct for muscular artefacts associated with speech production. Trials presenting remaining artifacts were rejected by visual inspection (20.3±9.5% trials on average), leaving 185±21 correct trials per subject on average. Laplacian transform was used as a spatial filter to enhance the resolution of components. Comparisons were performed using non-parametric statistics. The electrophysiological data revealed a clear negative component over fronto-central electrodes, peaking 80ms after the onset of each word, similar to an ERN. Importantly, we were able to observe such distinct components for each word in the sequence. Mean amplitudes were not significantly different before and after the onset of each word ($z = -1.17$, $p = 0.24$ on FCz, between [-300:-200ms] and [+300:+400ms]), indicating a true return to baseline and a component well delineated in time. Left lateral electrodes capturing motor preparation presented a less straightforward pattern ($z = 1.89$, $p = 0.059$ on FC5), potentially suggesting more overlap between processes. An effect of repetition was evidenced over

fronto-central electrodes in the [50ms:150ms] time-window (z = 2.19, p = 0.028), with a higher ERN amplitude for the second compared to the first repetition. At the behavioral level, participants made significantly more errors on the second repetition, z = -2.7, p = 0.0039. Our results demonstrate the feasibility of isolating ERP components that index monitoring processes (ERN) at the level of single words within a multi-word speech sequence. The effect of repetition on behavioral (error rates) and electrophysiological indices (ERN amplitude) suggests that the second repetition of a sequence might be more demanding in terms of monitoring. This work paves the way to future studies of speech monitoring in contexts more complex than single word production, such as sentential production.

C63 Analysis of functional connectivity furthers understanding of spontaneous speech and auditory comprehension in chronic stroke. *Helga Thors[1], Brielle C. Stark[1], Grigori Yourganov[1], Alexandra Basilakos[1], Julius Fridriksson[1]; [1]University of South Carolina*

Lesion-behavior analyses in post-stroke aphasia have been core for identifying areas crucial for language processing. But, language likewise relies on areas functionally communicating as a network, and this too is interrupted post-stroke. Therefore, resting state fMRI (rsfMRI) may provide complementary and supplementary information about functional connections required for language processing. Here, we compare rsfMRI and lesion analyses in the prediction of language impairments in chronic aphasia due to stroke. METHODS: We retrospectively analyzed 92 participants with pre-morbid right-handedness and a stroke to the left hemisphere (29 F, mean age=60.47±9.36 yrs; time since stroke, M=38.85±46.53 mos; lesion volume, M=107.86±95.28cm3). Aphasia was identified using the Western Aphasia Battery-Revised (WAB-R; Kertesz, 2007). Eighteen participants had anomic aphasia; Broca's: n=32; conduction: n=9; global: n=7; Wernicke's: n=6; and 20 had no aphasia. The average aphasia severity for the whole group of participants, represented by the WAB Aphasia Quotient (AQ), was 65.15±28.64. We acquired structural (T1, T2) and rsfMRI scans, lesions were demarcated manually. We assessed brain damage and reduced functional connectivity associating with impairments on two subtests of the WAB: auditory word comprehension and spontaneous speech. To do this, we predicted normalized (z-scored) behavioral scores using multivariate support vector regression within a leave-one-participant-out framework from (a) binary lesion maps (considering only the voxels damaged in at least 10% of participants), and (b) resting-state functional connectomes. Functional connectomes were computed using the AICHA parcellation with 384 regions of interest (Joliot et al., 2015) and subsequent analyses were restricted to only cortical regions. For all analyses, we regressed out overall lesion volume; did not correct for multiple comparisons; and report the two-tailed value of prediction accuracy (the correlation between actual and predicted behavioral scores). We subsequently compared prediction accuracy using Fisher's r-to-z transform. RESULTS: Prior to z-scoring, average score for the group on spontaneous speech (max=20) was 12.5±6.16 and auditory word comprehension (max=60), 50.36±13.83. Spontaneous speech (r=0.39, p<.0001) and auditory word comprehension (r=0.34, p=.0005) impairments were significantly predicted by reduced functional connectivity. Impaired spontaneous speech was predicted by reduced ipsilesional connectivity between supramarginal and precentral gyrus and by interhemispheric connections between frontal, frontoparietal and temporoparietal connections. Impaired auditory word comprehension was predicted by reduced ipsi- and contralesional connectivity between temporoparietal cortex. Lesion damage in insula, posterior superior temporal gyrus and inferior frontal gyrus was significantly predictive of spontaneous speech impairment (r=0.34, p<.0001) and damage to temporal (anterior, posterior) and angular gyrus predicted auditory word comprehension impairment (r=0.44, p<.0001). Spontaneous speech impairment was significantly better predicted by reduced functional connectivity (z=4.46, p<.0001), but lesion damage was a better predictor of impaired auditory word comprehension (z=24.76, p<.0001). DISCUSSION: Spontaneous speech likely relies on ipsilesional and interhemispheric connectivity. In line with the dual stream model, impaired auditory word comprehension was predicted by decreased interhemispheric connectivity but in our study more accurately predicted by regional damage. These results suggest a role for left hemisphere temporoparietal cortex in language comprehension and suggests that spontaneous speech relies on dorsal stream ipsilesional connectivity but also on the recruitment of the bilateral dorsal stream areas.

C64 The impact of sample size on the reproducibility of voxel-based lesion-deficit mappings *Diego Lorca-Puls[1], Andrea Gajardo-Vidal[1], Jitrachote White[1], Mohamed Seghier[1,2], Alexander Leff[1], David Green[1], Jenny Crinion[1], Philipp Ludersdorfer[1], Thomas Hope[1], Howard Bowman[3,4], Cathy Price[1]; [1]University College London, [2]Emirates College for Advanced Education, [3]University of Kent, [4]University of Birmingham*

This study investigated how sample size affects the reproducibility of findings from univariate voxel-based lesion-deficit analyses (e.g., voxel-based lesion-symptom mapping and voxel-based morphometry). Our effect of interest was the strength of the mapping between brain damage and speech articulation difficulties, as measured in terms of the proportion of variance explained. First, we identified a region of interest by searching on a voxel-by-voxel basis for brain areas where greater lesion load was associated with poorer speech articulation using a large sample of 360 right-handed English-speaking stroke survivors. We then randomly drew thousands of bootstrap samples from this data set that included either 30, 60, 90, 120, 180, or 360 patients. For each resample, we recorded

effect size estimates and p values after conducting exactly the same lesion-deficit analysis within the previously identified region of interest and holding all procedures constant. The results show (i) how often small effect sizes in a heterogeneous population fail to be detected; (ii) how effect size and its statistical significance varies with sample size; (iii) how low-powered studies (due to small sample sizes) can greatly over-estimate as well as under-estimate effect sizes; and (iv) how large sample sizes (N ≥ 120) can yield highly significant p values even when effect sizes are so small that they become trivial in practical terms. Recognised solutions to the issues highlighted here include using: (a) larger sample sizes; (b) multivariate methods; (c) informed sampling strategies; and (d) independent replications.

C65 Post-stroke impairment of auditory comprehension is associated with changes in cerebral blood flow

Grigori Yourganov[1], Jaleel Jefferson[1], Julius Fridriksson[1], Brielle Stark[1], Christopher Rorden[1]; [1]University of South Carolina

INTRODUCTION Lesion-symptom mapping is the most common analysis of the relationship between post-stroke brain damage and behavioral impairments. However, this analysis is strongly dependent on the underlying vasculature: it can only detect the regions that are lesioned in a sufficient number of participants. Theoretically, a brain region which might be behaviorally important but spared by the stroke is not likely to be identified by lesion-symptom mapping. We tested this hypothesis by analyzing regional cerebral blood flow (CBF) data, performed on a set of participants with post-stroke aphasia. METHODS 141 people with middle cerebral artery (MCA) strokes and various degrees of post-stroke speech impairment were evaluated using Western Aphasia Battery. Their structural brain damage was assessed by T1- and T2-weighted imaging, and CBF was assessed with Arterial Spin Labeling technique. Binary lesion maps were manually demarcated on T2-weighted images. We used the NiiStat MATLAB toolbox to see how the participants' auditory comprehension scores were related to CBF maps, and, separately, to lesion maps. For this purpose, we used univariate analysis (VLSM for lesion maps, GLM for CBF maps) as well as multivariate analysis (Support Vector Regression for both CBF and lesion maps, with a leave-one-out framework for out-of-sample prediction). For lesion analysis, only the voxels damaged in at least 10 participants were considered; CBF analysis was performed on the whole brain. RESULTS Using multivariate analysis, auditory comprehension scores could be predicted from lesion and CBF maps with approximately the same accuracy (Pearson's correlation coefficient between actual and predicted scores: r = 0.6534 for CBF, and r = 0.6541 for lesion maps; p < 10^-18). For lesion analysis, this prediction was largely driven by damage to superior and middle temporal regions (stretching from temporo-parietal junction to temporal pole) and supramarginal gyrus. In CBF analysis, in addition to these regions, we found that impairment of auditory comprehension was associated with reduced CBF to cingulate gyrus, cuneus, and basal ganglia, as well as with increased CBF to several right-hemisphere regions (among others, ventromedial prefrontal cortex and cingulate and inferior frontal gyri). These findings were also supported by univariate analysis. DISCUSSION Compared with lesion maps (which are usually drawn on high-resolution T1- or T2-weighted images), the ASL-derived CBF maps have poor spatial resolution and signal-to-noise ratio. However, they are less dependent on the underlying vasculature, and can help us to identify the brain regions that might be involved in speech but are not commonly lesioned. We showed this by identifying a set of regions where reduced CBF is associated with impairment of auditory comprehension; these regions are perfused by anterior and posterior cerebral arteries and therefore cannot be identified by lesion analysis of our sample of MCA stroke survivors. In addition, CBF analysis revealed potential "luxury perfusion" in the right hemisphere, i.e. increased blood flow associated with behavioral impairment. We suggest that CBF maps can provide the information about the association between brain damage and behavioral impairment which is not available in lesion maps.

Computational Approaches

C66 Break the ice vs. boa constrictors: Do they have different neural bases?

Shohini Bhattasali[1], Murielle Fabre[1], John Hale[1]; [1]Cornell University

Introduction: Language comprehension is widely viewed as being subserved by a left-lateralized perisylvian network of frontal and temporal brain regions. Several compositional and memory-related processes occur incrementally to accomplish sentence comprehension. We address the neuroanatomical basis of these processes by focusing on the frequently co-occurring word sequences, known as Multiword Expressions (MWEs) in computational linguistics. MWEs are considered a single unit, rather than a structurally composed combination (Sag et al., 2002). Thus, MWEs are a perfect testing ground to understand how expressions like break the ice, boa constrictor, safe and sound, see to it, in spite of are processed in the brain. This study investigates whether different types of MWEs evoke different patterns of activation in the brain using fMRI. Specifically, we ask if the strong relationship between verbs and their arguments are encoded in different brain areas compared to non-verbal MWEs featuring no argumental structure. Method: Participants (n=51, 32 female) listened to The Little Prince's audiobook for 1hour 38min. Participants' comprehension was confirmed through multiple-choice questions (90% accuracy, SD = 3.7%). Functional scans were acquired using multi-echo planar imaging sequence (ME-EPI) (TR=2000ms; TE's=12.8, 27.5, 43ms; FA=77 degrees; FOV=240.0mm X 240.0mm; 2X image acceleration; 33 axial slices, voxel-size 3.75 x 3.75 x 3.8mm).

Preprocessing was done with AFNI16 and ME-ICAv3.2. MWEs were identified using a statistical tagger trained on Children's Book Test dataset. Presence/absence of verbal expression yielded two categories of MWEs (i.e. 56% verbal vs. 44% non-verbal). Additionally, we entered four regressors of non-interest into the GLM analysis (SPM12): word-offset, word frequency, pitch, intensity. To account for sentence-level compositional processes, we included a regressor formalizing syntactic structure building based on a bottom-up parsing algorithm. These regressors were not orthogonalized. Contrasts were inclusively masked with the main effect of all MWEs and FWE-corrected (T-score>5.32). Results: The main effect for presence of MWEs elicited activation mainly in bilateral Supramarginal Gyrus, right Angular Gyrus, right MFG, and right Precuneus Cortex (Fig1A). Whole-brain contrasts show that these two types of MWEs activate different brain regions with no overlap. Verbal MWEs appear right-lateralized compared to non-verbal ones in IPL and in IFG triangularis (Fig.1B). The opposite contrast yielded a mostly right-lateralized and wider pattern of activation, including bilateral Supramarginal Gyrus extending to STG and right SMA together with smaller activation clusters in Pars Opercularis and MTG (Fig.1C). Conclusion: The results indicate posterior Supramarginal and Parietal areas and SMA as involved in lexical-semantic memory (Binder et al., 2009) and show that these non-compositional MWEs mostly implicate a right-lateralized network. Our findings confirm that bilateral Supramarginal Gyrus is sensitive to co-occurence frequency of word combinations as reported previously for semantically meaningful and frequent word-pairs (Graves et al., 2010; Price et al. 2015). Additionally, the significant clusters for verbal and non-verbal MWEs illustrate spatially distinct patterns of activation and a dorso-ventral gradient is observed in Broca's area for verbal versus non-verbal MWEs. Finally, activation patterns for verbal-MWEs indicate that verb-argument selectional relations in frequent verbal collocations exclusively involve right hemisphere activity in Broca's area and IPL.

C67 DeepListener: A computational model of human speech recognition that works with real speech and develops distributed phonological codes

Heejo You[1], Hosung Nam[2], Paul Allopenna[1], Kevin Brown[1], James Magnuson[1]; [1]University of Connecticut, [2]Korea University

SUMMARY. Cognitive models of human speech recognition (HSR) can simulate complex over-time dynamics of lexical activation and competition but operate on idealized phonetic inputs rather than real speech. We report on DeepListener, a two-layer network with elements of deep networks, that processes real speech with high accuracy while demonstrating human-like activation and competition dynamics. We use a neural decoding approach to unpack distributed representations that the model learns. INTRODUCTION. McClelland and Elman (1986) introduced the tension between computational adequacy (model performance) and psychological (explanatory) adequacy (our ability to understand how and why a model works). Cognitive models of HSR prioritize psychological adequacy, while models used to perform ASR focus on computational adequacy. Leading models of HSR, whether connectionist or Bayesian, make the "temporary" simplifying assumption to use abstract phonetic codes or human diphone confusion probabilities as inputs rather than real speech, allowing models to remain simple. Leading ASR models use deep learning to engineer highly complex (many layers of many types), largely opaque systems that provide robust, high accuracy ASR deployable in the real world. Given the shared history of cognitive connectionist and deep learning models, we asked whether cognitive approaches could borrow aspects of deep learning to break free of simplified inputs without sacrificing psychological adequacy. METHODS. DeepListener receives 256-channel fast-Fourier transformed speech as input in 10ms windows. Inputs feed to a hidden layer of 256 long short-term memory units (LSTMs, often part of a deep learning pipeline for speech recognition). Target output patterns were random sparse vectors (10 elements "on" in a 300-element vector; a common simplifying assumption, given largely arbitrary form-meaning mapping). The network's task was to activate the correct output pattern for each word. Inputs were 1000 frequent words produced by each of 10 talkers, presented in random order in each training epoch. The model was trained with backpropogation through time (with recurrent hidden units). RESULTS. Lexical "activations" were calculated as cosine similarity of outputs to each word's defined pattern at each time step. A word was "recognized" when output-target cosine exceeded all other output-word cosines by 0.05. Mean peak output-target cosine was 0.91, while mean peak cosine similarity of the second-most similar word to the output was 0.75. After 20,000 epochs, accuracy was 95%. Predictors such as neighborhood and onset cohort density related to item-specific RTs similarly to how they relate to human RTs. Over-time competition dynamics (e.g., of onset and rhyme competitors) resembled that observed with humans. We borrowed a neural decoding approach from electrocorticography to identify spatiotemporal receptive fields of hidden units. Some units responded preferentially to specific phonemes or phonological classes (e.g., obstruents), while others had more complex response properties. These analyses allow us to begin to understand the inner workings of the model. CONCLUSIONS. Previous attempts to couple ASR and HSR approaches have led to interesting insights, but with low computational adequacy (e.g., very low accuracy rates). This is the first model with high potential psychological adequacy that can be been applied to real speech with high accuracy and human-like dynamics.

Poster Session D

Friday, August 17, 4:45 – 6:30 pm, Room 2000AB

Control, Selection, and Executive Processes

D1 How does functional connectivity between domain-general and language networks relate to sentence comprehension? A resting-state fMRI study in older adults

Megan C. Fitzhugh[1], Leslie C. Baxter[2], Corianne Rogalsky[1]; [1]Arizona State University, [2]Barrow Neurological Institute & St. Joseph's Hospital and Medical Center

As many as one-third of older adults without dementia experience difficulties understanding conversations in their everyday lives. While comprehending speech in quiet environments or with simple sentence structures remains relatively preserved in older adults, their ability to comprehend speech in noisy environments or with more complex sentence structures can be reduced, and not fully explained by hearing loss. Research in older adults suggests that as we age, the traditionally-defined left-lateralized frontotemporal language network may not be sufficient to process relatively complex or degraded speech, requiring additional domain-general resources to maintain a sufficient level of comprehension. Such resources include the cingulo-opercular and frontoparietal brain networks associated with selective attention and working memory, respectively. Yet the degree to which these networks can support language comprehension in challenging situations remains unclear. The present study examines how functional connectivity between domain-general brain networks and the language network are related to difficult sentence comprehension performance in older adults. Twenty adults aged 60 to 80 years completed the experimental protocol. Participants were all native English-speaking, right-handed, and without cognitive impairment as measured by the Mini-Mental Status Examination. Participants completed a sentence-picture matching task with six conditions: sentences varied by two types of sentence structure (canonical and noncanonical word order) and three types of masker (multispeaker babble, broadband noise, or none). The canonical sentences presented without a masker served as a control condition to which performance in the other conditions was compared. Accuracy and reaction times were recorded. A 10-minute resting-state fMRI scan, pure tone audiometry, and several cognitive and psycholinguistic measures were obtained. The CONN Toolbox using SPM12 functions (http://www.nitrc.org/projects/conn) was used to preprocess the resting-state fMRI data and compute functional connectivity measures between the networks of interest (frontoparietal, cingulo-opercular, and language networks). Multiple regression models were then used to determine the relationship between functional connectivity measures and sentence comprehension performance in each condition. Age, hearing status, and vocabulary and processing speed measures were included in the models as covariates. Accuracy in the sentence comprehension conditions was not significantly related to any of the functional connectivity measures. However, reaction time results reveal: (1) reaction time in multispeaker babble was significantly positively correlated with functional connectivity between the cingulo-opercular and language networks and (2) reaction time for noncanonical sentences was significantly positively correlated with the functional connectivity between the frontoparietal and language networks. These initial results suggest that increased effort in comprehending challenging sentences (defined as longer reaction times) in older adults is related to greater network connectivity between the language network and specific domain-general networks, and that the cingulo-opercular and frontotemporal networks contribute to difficult sentence comprehension in unique ways. Future studies are needed to determine if these increased functional connectivities between domain-general and language networks reflect compensatory mechanisms in older adults, and to further characterize the distinct contributions of the frontoparietal and cingulo-opercular networks to sentence comprehension.

D2 Neural correlates of nonverbal executive performance in chronic post-stroke aphasia

Rahel Schumacher[1], Matthew A. Lambon Ralph[1]; [1]Neuroscience and Aphasia Research Unit, University of Manchester, UK

There is increasing interest in the interrelation of language and other cognitive functions in stroke aphasia. However, data on attentional and executive (dys) functions in individuals with stroke aphasia are still scarce. Moreover, lesion information is rarely taken into account. Thus, an extensive selection of standardized nonverbal neuropsychological tests was administered to 38 individuals with chronic post-stroke aphasia in addition to language testing and magnetic resonance imaging. A principal component analysis yielded three components underlying the performance in the nonverbal tests of attention and executive function (shift-update, inhibit-generate, speed). Individual scores on each component were included in a voxel-based correlational morphology analysis. The first two components were associated with significant clusters. The shift-update component was associated with a subcortical cluster mainly comprising parts of the left thalamus, and with a more posterior left temporo-occipital cluster. The inhibit-generate component was associated with bilateral regions, including medial frontal areas. These findings fit well with other lines of research showing that these brain regions are involved in executive functioning and also seem to play a role in recovery from aphasia. In conclusion, our findings extend the multidimensionality of stroke aphasia and underline the importance of executive and attention functions. Furthermore, including data on these aspects of cognition

- together with their associated neural correlates - might significantly improve outcome prediction as well as influence therapeutic interventions.

D3 Identifying the Neural-Computational Correlates of Cognitive Control During Language Processing - Combined Activation Likelihood Estimation and Functional Imaging Evidence of Language Production

Nicolas Bourguignon[1], Vincent Gracco[2]; [1]Department of experimental psychology, Ghent University, Belgium, [2]Haskins Laboratories, New Haven

INTRODUCTION The relationship between language and cognitive control – i.e. the coordination of actions and thoughts in accordance with internal goals – is a highly debated issue in cognitive neuroscience. This debate has far-reaching implications insofar as both faculties are taken to reflect similar facets of human adaptive behavior such as creativity, generativity and intentionality. In this respect, recent functional imaging (fMRI) research has shown a marked functional anatomic subdivision between a fronto-temporo-parietal network involved in language processing (i.e. a language network) and a fronto-parietal and cingulo-opercular "multiple-demand" network for cognitive control tasks in the brain. While such findings are assumed to reflect an initial functional-anatomic separation between the two faculties, the possibility remains that both networks may interact in principled ways in certain language processing contexts. In the present study, we propose and test a dual-stream model of the cognitive control of language processing based on a computationally derived information-theoretic notion of control as the selection of responses amongst competing alternatives. Specifically, we propose that response selection takes place within a working memory stream (WMS) that monitors information held in verbal working memory and a lexico-semantic stream (LSS) involved in top-down retrieval of representations from long-term lexico-semantic memory. We further suggest that WMS and LSS closely follow the functional anatomic separation between the multiple demand network and the language network, respectively. Unlike a strict language vs. cognitive control dichotomy, this architecture predicts that the "language" network (i.e. LSS) should be involved in the controlled selection of language-relevant information when this information derives from lexico-semantic storage systems. METHODS We began with an activation likelihood estimation (ALE) analysis of 111 fMRI studies of working memory-monitoring (N=69) vs. lexico-semantic selection (N=42) to assess the proposed functional anatomic subdivision between WMS and LSS and to show that they closely follow the functional anatomy of the multiple-demand network and the language network, respectively. We then test the involvement of these networks' core regions of interest (ROI) in the controlled selection of lexico-semantic representations in an fMRI study of confrontation naming and verb generation, using normed stimulus-related entropy indices of competition as predictors of cognitive control demands. RESULTS AND DISCUSSION Results from the ALE analysis reveal a functional anatomic dissociation between WMS and LSS and confirm their areal overlap with the multiple-demand network and the language network respectively. Furthermore, our ROI analyses of the confrontation naming and verb generation data show a clear involvement of LSS in controlled selection of lexico-semantic representations in concert with the cingulo-opercular sub-component of the multiple-demand network. By contrast, the fronto-parietal sub-component of the multiple-demand network does not covary reliably with selection competition in either confrontation naming or verb generation. Not only do these results confirm an involvement of the "language" network (LSS) in controlled selection of lexico-semantic information, but they highlight the need to reevaluate the role of the multiple-demand network in basic operations of cognitive control. These results have interesting implications for future efforts at integrating basic assumptions of neurocognitive models of language and adaptive behavior.

D4 Effect of bilingualism and perceptual load on the subcomponents of attention in older adults: Evidence from the ANT task

Tanya Dash[1,2], Yves Joanette[1,2], Ana Inés Ansaldo[1,2]; [1]Centre de recherche de l'Institut Universitaire de Gériatrie de Montréal, Quebec, [2]École d'orthophonie et d'audiologie, Faculté de médecine, Université de Montréal, Quebec

Life-long experience of using two or more languages enhances the attentional control abilities (Bialystok, 2011; Costa et al., 2008). This bilingual experience may also foster cognitive reserve (CR) – protective shield for old age to delay cognitive decline. Age-related changes in the attentional control abilities are also influenced by the amount of perceptual load (PL) in the environment (Maylor & Lavie 1998). Attention is not a unitary function, but encompasses distinct components. Age, perceptual load as well as CR may affect the subcomponents of attention in a distinct manner. Thus, the goal of the study is to understand the influence of age, bilingualism and PL on the subcomponents of attention. Method: All the participants (30 French-English bilingual young (YA) and old adults (OA); 15 each) performed a behavioural version of the Attention Network Test (ANT) at three levels of PL. Age of acquisition, language use as well as language proficiency, were the measures of bilingualism. The Attention Network Test measures alerting, orienting and executive attention abilities (Fan et al., 2003). In the ANT, a target stimulus (a central arrow) is surrounded by flankers on each side. By comparing the two flanker condition – congruent (same direction for all arrows), and incongruent (flankers point in the opposite direction of the central arrow) – we measured the executive attention ability. There were also three types of warning cues before the target, to check for alerting and orienting abilities - no, center, double and spatial cues. The PL was manipulated by varying the set size of the arrows (3, 5, 7). Each trial begins with a fixation window of 400-1600 millisecond (jittered), followed by the cue window of

100 milliseconds. The stimuli appear either above or below the fixation (based on the cue type) for 1700 millisecond followed by the response window. Results and Discussion: A 2 (between; OA and YA)*3 (within; level of loads)*2 (within; condition) mixed ANOVA was performed for each of the subcomponents of attention separately. The result showed differences in performance with increasing level of load (3>5>7) for the OA in alerting, orienting and executive attention abilities. In contrast, YA showed effect of PL for executive attention only. Group differences were observed for alerting and executive attention abilities only (OA>YA; all p< 0.05), with more differences in high load condition. This suggests that the distraction from flankers generally increased with perceptual load as a function of age. Age-related differences were not present for all the subcomponents. Language proficiency measures were able to predict the ANT task performance. With the increasing age and perceptual load, L2 proficiency had positive correlation with executive attention and alerting abilities only. In conclusion, this study suggests that elderly bilinguals' performance is influenced by the perceptual load, in addition to the cognitive reserve built over time. Thus, highlighting the dynamic and complex nature of the interaction between different aspects of goal-directed behaviour. This work provides crucial information on how distinct attentional abilities can be observed in bilinguals as a function of age and L2 proficiency.

Speech Motor Control and Sensorimotor Integration

D5 Speech rate is associated with cerebellar white matter in persistent developmental stuttering

Sivan Jossinger[1], Vered Kronfeld-Duenias[1], Avital Zislis[1], Ofer Amir[2], Michal Ben-Shachar[1]; [1]Bar-Ilan University, [2]Tel-Aviv University

The ability to produce speech is a key component of human cognition. One of the basic characteristics of speech production is speech rate, affecting the intelligibility, fluency, and communication efficiency of the speaker. Altered speech rate has been documented in various speech disorders, including persistent developmental stuttering. Specifically, adults who stutter (AWS) exhibit slower speech rate compared to fluent speakers (de Andrade et al. 2003). Evidence from fMRI implicates the cerebellum in the paced production of speech, in clinical and non-clinical populations (Ackermann 2008; Riecker et al. 2005). However, the cerebellar white matter pathways that communicate signals relevant for determining speaking rate remain unexplored. Here, we aim to assess the contribution of the cerebellar peduncles to speech rate in AWS and controls. Diffusion imaging data and speech rates were evaluated in 42 participants (23 AWS, 19 controls). The imaging data were acquired on a 3T General Electric scanner using diffusion weighted single shot EPI sequence (2 repetitions; b=1000 s/mm^2; 19 diffusion directions; ~2x2x2mm^3 resolution). Deterministic tractography was used to identify the superior, middle and inferior cerebral peduncles (SCP, MCP, ICP) bilaterally. Fractional anisotropy (FA), axial- and radial- diffusivity profiles were calculated along each tract and the resulting profiles were compared between the groups using Wilcoxon's signed-rank test. Speech rate was measured over audio recordings of unstructured interviews, and quantified as the ratio between the total number of analyzed syllables and the time required for the participant to produce them (after excluding stuttered syllables from both measures). Spearman's correlations were calculated between speech rate and diffusion measures along the tracts. We did not find significant differences between AWS and controls in the diffusivity values of the cerebellar peduncles. However, in AWS we found a significant negative association between speech rate and FA within the left ICP (r=-.6235, p<.05; family-wise error corrected). Controls did not show this correlation, and the coefficients calculated in the two groups differed significantly (Fisher's Z=1.763, p<.05). Spearman's partial correlations confirmed that the negative correlation observed in the left ICP of AWS maintained its significance after controlling for age, semantic or phonological fluency (p<.005), but not when controlling for stuttering severity (p>.05). Post-hoc analysis revealed that the association between the left ICP and speech rate, observed in AWS, is driven by radial, not axial, diffusivity. Finally, no significant correlations were detected with speech rate in the SCP and MCP of either group. Our findings support the role of the left ICP in mediating speech rate among AWS, but not in controls. The ICP is a major cerebellar pathway that transmits sensory feedback signals from the olivary nucleus into the cerebellum (Sokolov et al. 2017). It has been previously suggested that AWS rely too heavily on sensory feedback (Civier et al. 2010; Max et al. 2004), which can potentially lead to a reduction in speech rate, due to the slow nature of biological feedback loops. Together, our findings suggest a tentative but plausible neural mechanism for speech-rate reduction observed in AWS.

D6 Ageing does not affect excitability of articulatory motor cortex during speech perception

Helen E Nuttall[1,2], Gwijde Maegherman[2], Patti Adank[2]; [1]Lancaster University, UK, [2]University College London, UK

It has become increasingly evident that motor areas for speech production activate during speech perception. Such motor activation has been proposed to assist perception of speech, particularly in challenging listening environments. Recent reports suggest that upregulation of activity in motor areas may compensate for impaired speech perception in older adults. However, it is not known how ageing affects the recruitment of articulatory motor cortex during speech perception, in optimal or sub-optimal listening conditions. The aim of the present study was to determine the effect of ageing on the excitability of articulatory motor cortex when listening to speech in quiet, and in varying levels of background noise. We hypothesised that if older adults demonstrate greater

recruitment of articulatory motor cortex, then excitability of articulatory motor cortex would be enhanced when listening to speech in challenging conditions, relative to excitability measured in younger adults (H1). If older and younger adults equally recruit articulatory motor cortex, then excitability of articulatory motor cortex would be equivalent (H2). We tested these hypotheses by applying single-pulse Transcranial Magnetic Stimulation (TMS) to the lip area of left M1 to elicit Motor Evoked Potentials (MEPs) to index excitability of articulatory motor cortex. The M1 hand area was also tested as a control site. TMS was applied while subjects listened to clear speech syllables, syllables presented in +10 dB signal-noise-ratio (SNR), 0 dB SNR, and -10 dB SNR. Subjects completed a syllable identification task throughout MEP recording to assess speech perception ability. Twenty younger adult subjects (aged 18-25), and twenty older adult subjects (aged 65-80) participated in this study. Results showed a significant effect of background noise level on the syllable identification task ($F(3,114) = 7.40$, $p < 0.001$), as well as an interaction between age group and task ($F(3,114) = 5.30$, $p = 0.002$). This was driven by a significant effect of noise on the older group's ability to perform the syllable task ($F(3,57) = 9.57$, $p < .001$), that was not present for the younger group ($F(3,57), = 0.36$, $p = 0.78$). Specifically, the older adults were significantly less accurate in the 0 dB SNR condition compared to the younger adults ($F(1,38) = 4.54$, $p = 0.04$). There was also a significant effect of background noise level on lip MEPs ($F(3,114) = 3.92$, $p = 0.01$). Planned contrasts confirmed that there was a significant reduction in MEP excitability when listening to speech in the 0 dB SNR condition compared to clear speech ($F(1,38) = 8.45$, $p = 0.006$). There was no interaction between age group and lip MEPs ($F(3,114) = 1.37$, $p = 0.255$). There was no effect of background noise on control hand MEPs ($F(3,108) = .89$, $p = .45$). These data indicate that speech-induced facilitation in articulatory motor cortex is suppressed when listening to speech in noise at 0 dB SNR, but this effect is not modulated by ageing (H2). These findings suggest that activity in articulatory motor cortex may be modulated by listening effort, and not background noise level, as previously thought.

D7 Sensorimotor adaptation in speech is sensitive to vowel targets of altered feedback

Hardik Kothare[1,2], Inez Raharjo[1,2], Kamalini Ranasinghe[2], Vikram Ramanarayanan[2,3], Benjamin Parrell[4], John Houde[2], Srikantan Nagarajan[1,2]; [1]UC Berkeley-UCSF Graduate Program in Bioengineering, [2]University of California, San Francisco, [3]Educational Testing Service R&D, [4]University of Wisconsin- Madison

Auditory feedback plays an important role in speech production. Any alteration in auditory feedback usually engenders a change in speech output. The speech motor control system also learns to anticipate and compensate for consistent feedback alterations. This counteractive response or sensorimotor adaptation persists temporarily even after feedback returns to normal. Sensorimotor adaptation in speech is a form of learning that helps the motor system maintain desired speech output in spite of changes in the properties of the vocal tract. An important type of sensorimotor adaptation in speech is that seen in response to formant-shifted auditory feedback. From one study, we know that the extent of such formant adaptation is heterogeneous across different target vowel productions (Mitsuya et al, 2015) but the formant shifts investigated were only upshifts or downshifts in the single formant F1. What if we shift multiple formants (F1 and F2) at once, shifting feedback in different directions in F1-F2 space? Does the accuracy and consistency of sensorimotor adaptation depend on the size and direction of the feedback alteration in F1-F2 space? To investigate these questions, we employed real-time auditory feedback alteration to shift the frequency values of the first and second formants (F1 and F2) of participants' speech. The experiment comprised six cases; the shift was different in each case (from /□/ to /ɪ/, /i/, /e/, /æ/, /□/ and /u/). In each case, participants produced 90 repetitions of the nonsense word 'bep' (vowel /□/). A case started with a non-altered block of 10 trials, followed by a block of 50 trials with a constant alteration and then by a non-altered washout block of 30 trials. Shifts were designed on a subject-by-subject basis using pre-collected baseline formant frequencies of vowels. We find that adaptive control of vowel formant frequency depends on the magnitude and direction of the applied shift in the two-dimensional F1-F2 vowel space. We also observe that all shifts, except the one from /□/ to /u/, elicit a response of a compensatory nature. A two-dimensional vector resolution analysis of the response vectors reveals that they have a component orthogonal to the axis of the shift and a component parallel to the shift axis. Statistical analyses reveal that the orthogonal component appears to be more resistant than the parallel component to changes in shift magnitude, suggesting that the orthogonal response may be more related to the detection of errors rather than nature of the errors. Additionally, the response seems to depend on whether the applied shift is upwards or downwards along the F2 axis in the F1-F2 plane. This suggests that the altered feedback's degree of vowel backness may play a role in determining the extent of formant adaptation. These results suggest that sensorimotor adaptation in speech is sensitive not only to the vowel sound to which altered feedback is applied but also on the spatial directionality and magnitude of applied shift in formant space.

D8 Neural mechanisms underlying the impact of speech sound naturalness during transformed auditory feedback

Sadao Hiroya[1], Takemi Mochida[1]; [1]NTT Communication Science Labs

Articulatory compensations in response to formant perturbation in vowels have shown that auditory feedback plays an important role in speech production. Although most conventional perturbation studies have used linear predictive coding (LPC) for estimating

formants, it is known that formant estimation accuracy would be degraded due to a glottal source-vocal tract interaction especially for low vowels and female speech. Misestimating of formants by LPC would result in degradation of sound naturalness of transformed speech. To improve sound quality, we have developed a real-time robust formant tracking system using phase equalization-based autoregressive exogenous (PEAR) model which utilizes the glottal source signals measured by electroglottography (EGG). Our previous results have shown that compensatory responses to formant perturbation using PEAR were significantly larger than LPC, possibly due to the improved speech sound naturalness by PEAR. In this study, to investigate the neural mechanisms underlying the impact of speech sound naturalness, we performed fMRI scans during transformed auditory feedback in which formant frequencies estimated by LPC or PEAR were perturbed. For this purpose, we developed a novel PEAR-based system which does not require EGG, so that it is applicable to fMRI scans. Speech stimuli consisted of eight /Ce/ syllables. Formants were transformed so that vowel /e/ shifted to sound like /a/. fMRI scanning was performed using a sparse sampling protocol. Formant perturbation by LPC or PEAR randomly occurred. Behavioral results showed that compensatory responses to PEAR was larger than those to LPC, consistent with previous studies. fMRI results showed that left and right anterior cingulate cortices (ACC) were more activated for PEAR than for LPC. This probably indicates that natural transformed sound by PEAR resulted in greater activation in the ACC and the larger compensatory responses. On the other hand, left-lateralized cerebellum was more activated for LPC than for PEAR. This implies that less natural transformed sound caused greater cerebellum activation. Relating to the above, recent studies showed that patients with cerebellar degeneration showed a larger compensatory response than control subjects. Thus, the involvement of the cerebellum during auditory feedback will be an issue to be addressed in the future. In conclusion, the impact of speech sound naturalness in transformed auditory feedback emerged in the ACC and the cerebellum.

D9 Stuttering-related differences in auditory-motor coherence in speech and tone discrimination. *Tim Saltuklaroglu[1], Ashley Harkrider[1], David Jenson[1], David Thornton[1]; [1]University of Tennessee Health Sciences Center*

Background: Sensorimotor processing across the dorsal stream is thought to be disrupted in people who stutter (PWS) due to compromised internal modeling mechanisms. However, the nature of the deficit remains unclear and investigation of sensorimotor dynamics in speech production is problematic due to the potentially contaminating effects of stuttering behaviors. Therefore, speech and tone discrimination tasks, also known to recruit sensorimotor regions for internal modeling, may be used to access these mechanisms. Independent component analysis of raw EEG data can identify mu rhythms with characteristic alpha (8-13 Hz) and beta (15-25 Hz) spectral peaks that emanate from anterior dorsal (pre/primary motor regions). In addition, tau rhythms with a characteristic alpha spectral peak emanate from posterior auditory (superior temporal gyrus) regions. Time-frequency analysis can be applied to these rhythms to examine changes in oscillatory power in a given region. Also, phase coherence measures establish oscillatory synchronization of the rhythms as an indicator of connectivity. Compared to non-stuttering participants, PWS are expected to produce time-frequency differences in mu and tau rhythms and different patterns of auditory-motor coherence. Methods Raw EEG recording were made from 27 PWS and matched non-stuttering adults in a control condition (passive listening to noise) and four discrimination conditions: 1) tones in a quiet background, 2) tones in a noisy background, 3) speech in a quiet background, and 4) speech in a noisy background. Independent component analysis identified mu and tau components. Time-frequency analysis via event-related spectral perturbations identified patterns of anterior and posterior dorsal stream activity in mu and tau rhythms respectively across the time course of events. Phase coherence measures between mu and tau rhythms were calculated using the EEGLAB newcrossf for subjects who contributed both mu and tau components. Statistical comparisons were performed with permutation statistics (2000 permutations). Results All participants achieved over 95% discrimination accuracy and only data from correct discriminations were used in the EEG analysis. In addition to time-frequency differences observed in mu rhythms (Saltuklaroglu, et al., 2017), PWS display increased peri-stimulus event-related dysynchronization by reduced post-stimulus alpha event-related synchronization in auditory components. In addition, PWS demonstrate elevated mu to auditory phase coherence in the alpha band, which is more robust in the presence of noise. Discussion Mu rhythm data indicate that PWS show increased sensorimotor activity when passively listening to noise and have reduced capacity for inhibiting noise when discriminating (Saltuklaroglu, et al., 2017). Tau rhythm data suggest that auditory stimuli are covertly replayed following discrimination, which produces a form of speech-induced suppression. This suppression is reduced in PWS. Coherence data indicate that PWS demonstrate abnormally elevated coherence between sensorimotor mu and auditory tau alpha rhythms. Together, these findings suggest aberrant sensorimotor function across the time course of perceptual events, providing temporally sensitive evidence that sensorimotor dysfunction associated with stuttering may subtly affect cognitive processes in addition to speech production.

D10 Delayed auditory feedback, vocal oscillations, and embedded rhythms *François-Xavier Brajot[1]; [1]Ohio University*

Introduction: Corrections in on-going speech production for changes in sensory feedback suggest that sensorimotor loops act as negative feedback systems. An important property of negative feedback systems is that they tend to oscillate when delay is introduced into the system. Delayed auditory feedback should therefore promote oscillations in speech. Methods: 20 young adults sustained a vowel and repeated syllables as auditory feedback was delayed from 0 to 600 ms. Vocal fundamental frequency, intensity and formant frequencies were extracted from the audio. Fourier Transforms were carried out on each of the measures and the largest spectral peak was retained to model the primary oscillation in the signal. Results: Delayed auditory feedback enhanced a low-frequency oscillation of fundamental frequency and intensity. The period of the oscillation increased to over 2 seconds and peak-to-peak amplitude by over 20 Hz as delay magnitude increased to 600 ms. Fluctuations were also observed in formant frequencies, but were not consistently periodic in nature. Linear mixed-effects modeling confirmed that delay was a significant predictor of the frequency of oscillation for fundamental frequency and intensity, but not formant frequencies. The effect was observed in syllable repetitions as well and correlated with a decrease in syllable-based spectral energy. Conclusion: The presence of spectral energy at low frequencies under normal conditions suggests that this delay-induced oscillation is an enhancement of an existing fluctuation in the voice. The differential effect between vocal (fundamental frequency, intensity) and articulatory measures (formant frequencies) suggests that the laryngeal system is particularly susceptible to the effect, which in turn alters the coupling between phonatory and articulatory systems during speech. Future directions include applying non-linear signal decomposition methods to determine whether this feedback-dependent fluctuation represents a basic physiological rhythm embedded in the speech signal important for articulatory-prosodic coordination of speech.

Phonology and Phonological Working Memory

D11 Electrophysiological Effects of Bilingualism and Aging on Working Memory

Cassandra Morrison[1,2], Farooq Kamal[1,2], Giovanna Busa[1,2], Vanessa Taler[1,2], Jason Steffener[1]; [1]University of Ottawa, [2]Bruyère Research Institute

Introduction: Being bilingual (fluent in two languages) appears to confer a benefit in certain aspects of cognitive functioning relative to being monolingual (fluent in only one language). Differences between monolinguals and bilinguals may be more evident in older than younger adults due to age-related cognitive decline. However, little research has examined differences in working memory between younger and older monolinguals and bilinguals. The current study utilizes electroencephalography (EEG) to examine working memory differences between younger and older bilinguals and monolinguals. Methods: To date, 78 participants have taken part in the study: 22 monolingual and 22 bilingual younger adults (aged 18-30); and 10 bilingual and 24 monolingual older adults (65+). The participants first underwent neuropsychological testing to characterize cognitive functioning and working memory capacity and processing. They then completed a Sternberg task while their EEG, reaction time, and accuracy were recorded. Results: Analysis of these preliminary data found no effects of bilingualism on accuracy or reaction time ($p > .05$ in all analyses). Overall, older adults responded more slowly than young adults at all three levels of task difficulty ($p < .001$), although accuracy did not differ between groups ($p = .15$). When examining frontal and central regions, both the P300 and N200 were influenced by age and language. Younger adults exhibited larger (more negative) N200 amplitudes relative to older adults ($p = .002$), but smaller P300 amplitudes compared to older adults ($p < .001$). Monolinguals exhibited a larger N200 than bilinguals ($p = .016$), but smaller P300 amplitudes compared to bilinguals ($p = .006$). Conclusions: These results indicate that ERPs are more sensitive than behavioral measures to cognitive differences related to age and bilingualism. The ERP findings suggest that bilinguals may require less effort to discriminate whether the test array matches the memory array (as shown by less negative N200s), and more resources available to allocate to task completion (larger P300s). Interpreting the age-related findings in the same way, it would also seem that older adults have more resources available relative to younger adults and require less effort to discriminate whether the test array matches the memory array. However, the increased amplitude in frontal regions in older relative to younger adults is consistent with the posterior to anterior shift (PASA) in aging. This increased activity in the frontal regions suggests that older adults depend more on frontal regions to complete the task.

D12 Nonword repetition recruits distinct and overlapping nodes of language and working memory networks

Terri L. Scott[1], Sara C. Dougherty[1], Ja Young Choi[1,2], Tyler K. Perrachione[1]; [1]Boston University, [2]Harvard University

Phonological working memory (PWM) is the process by which we temporarily maintain representations of speech sounds in short-term memory. This ability is believed to be important for language and reading acquisition, and is measured clinically using tests of nonword repetition. The operationalization of PWM is not always clearly dissociated from verbal working memory (VWM), which is theorized to be supported by a phonological loop independent from core language processing (Baddeley & Hitch 1974; Baddeley 1986, 2003). However, more recent studies propose that phonological working memory necessarily recruits core language regions otherwise specifically implicated in encoding phonological information (McGettigan et al. 2010; Barry et al. 2011; Perrachione et al. 2017; Scott et al. 2018). Using

functional magnetic resonance imaging (fMRI), this work explores how neural structures responsive to PWM-load are differentially sensitive to modulation by language and VWM. Twenty adult participants (12 female; age 19-32, M=24.1 years) underwent functional magnetic resonance imaging (fMRI) while completing three separate tasks designed to engage PWM (nonword repetition), VWM (digit span), or language processing (auditory language localizer; Scott et al. 2017). Brain regions modulated by working memory were localized by contrasting high (long nonwords/digit sequences) vs. low (short nonwords/ sequences) working memory loads. The language processing task required participants to listen to clips of intact speech, contrasted with unintelligible degraded speech. Nonword repetition activation was measured during a sparse-sampling block design fMRI (TR=2.25s, TA=0.75s, 3mm isotropic, 45 slices, 5 simultaneous slices). Digit span and the language localizer activation was measured during continuous-sampling fMRI (TR=0.75s, TA=0.75s, 3mm isotropic, 45 slices, 5 simultaneous slices). Group-constrained subject-specific (GSS; Fedorenko et al. 2010; Julian et al. 2012) analyses were employed to define and interrogate functional regions of interest (fROIs) in individual subjects. We previously identified five regions (bilateral STG, L-PT, L-PreCG, and right cerebellum) that are commonly sensitive to PWM load in our participants (Scott et al. 2018). Of these regions, only L-PreCG and L-PT both showed similar patterns of activity during language and VWM (L-PreCG: r=0.42 ± 0.08; L-PT: r=0.37 ± 0.09). fROIs were defined within these regions based upon each subject's top 10% of voxels in the critical contrast of high vs. low PWM load and then responses to the critical contrasts for language and digit span were measured. Responses to language were found to be significantly larger than VWM in both L-STG ($p << 0.01$) and R-STG ($p << 0.01$). By examining the convergences and divergences of task activation in language processing, VWM, and PWM, we show that, of the regions commonly activated during PWM, L-PreCG and L-PT evince highly similar patterns of activity during language and VWM, whereas significant differences between language and VWM were measured in bilateral STG. Taken together; these results suggest that PWM processing involves a combination of core language sensitive regions in STG with dual language/VWM convergent regions in the dorsal stream.

D13 Neural dynamics of repetition-based learning of language comprehension parallels perceptual learning

Ayelet Gertsovski[1], Olga Aizenberg[1], Merav Ahissar[1]; [1]Hebrew University of Jerusalem

Detection of task-relevant regularities facilitates learning and allows the acquisition of expertise in perceptual tasks. It provides reliable predictions regarding upcoming stimuli, and reduces the required ad-hoc computations. The neural dynamics associated with formation of reliable predictions was previously studied for simple tone discrimination. It was found to be accompanied by a shift from fronto-parietal activity, associated with higher working-memory demands, to posterior superior temporal activity, related to successful detection of regularity introduced by a repeated reference tone in consecutive trials (Daikhin & Ahissar, 2015). We now asked whether similar neural dynamics is evident in learning from task-relevant repetition in a high-level language comprehension task. We conducted two fMRI experiments with the same behavioral protocol, but with slightly different acquisition parameters. In study 1 (n=17, TR of 1 s and 42 acquired slices of 3 mm) our scanning did not fully cover the cerebellum. In study 2 we modified our scanning protocol (n=20, TR of 1.2 s in order to collect 51 slices) to fully cover the cerebellum. Participants heard a sentence with a novel semantic content, then saw an illustrative cartoon, and had to determine whether it matches the sentence. To reveal the areas activated during an effortful on-line task, we compared two syntactic structures known to differ in processing difficulty: object-extracted relative clauses (ORs, e.g. "Mr. Rectangle is the creature that Mr. Circle pushes") and subject-extracted relative clauses (SRs, e.g. "Mr. Circle is the creature that pushes Mr. Rectangle"). To reveal the areas sensitive to regularity (repeating either the doer or the doee of the action in consecutive SR sentences), we compared SR trials with and without repetition. As expected, behavioral results in both studies showed that participants performed worse in ORs compared with SRs, and benefited from trials with repetition. They also benefited more from repetition of the doer compared with repetition of the doee. The contrast between ORs and SRs revealed known language areas in the left hemisphere, and was specifically associated with a strong left frontal activity. The contrast between non-repeated and repeated SR sentences revealed activation of posterior superior temporal areas (and not frontal areas). The cerebellum was activated both in the OR versus SR contrast and in the doer versus doee repetition contrast. These results suggest that fast improvement in sentence comprehension is similar both behaviorally and in brain distribution to fast learning in simple auditory discriminations. It is facilitated by item-specific repetition and is associated with changes in activity in posterior stimuli-specific brain areas, presumably encoding the context and forming stimuli-specific predictions. This suggests that the functional division of labor between frontal and posterior language areas reflects the level of sentence-specific expertise rather than the domain of linguistic analysis. Our results further imply that the cerebellum is involved both in verbal working memory processes, as was previously shown (e.g. in Marvel & Desmond, 2010), and in fast learning from repetition.

D14 Phonotactic Rule-Learning Without Semantics: An EEG study

Enes Avcu[1], Ryan Rhodes[1]; [1]University of Delaware

Artificial grammar learning (AGL) studies have been widely used for testing the learnability of phonological agreement patterns. It has been clearly shown that learners

can extract adjacent and non-adjacent dependencies with relatively short training at the behavioral level. Less is known about how these patterns are encoded at the neurophysiological level. Domahs et al. (2009) and Moore-Cantwell et al. (forthcoming) reported a higher amplitude Late Positive Component (LPC) to novel words that violated a learned phonotactic constraint than novel words that satisfied it. The LPC has been reported in response to violations of many kinds of long-distance sequencing rules, both syntactic and phonotactic. However, previous AGL studies have conflated long-distance rules with semantic information. The aim of the current study is to observe an LPC to a phonotactic rule violation in the absence of semantic information, using a sibilant harmony rule which is an attested long-distance harmonic pattern. Our finding is that once syntactic and semantic components are excluded from training, the LPC is not elicited in response to novel words violating the phonotactic pattern. 15 monolingual English speakers participated in an AGL experiment in which ERPs were recorded. All training and test stimuli had three syllables of the form of CV.CV.CVC, with sibilants ([s, □]) as the first, third, and last consonant. All words were either "harmonic" (all sibilants identical) or "disharmonic" (mixed [s] and [□]). During training, participants listened to and repeated sibilant harmonic words. During testing, participants rated the likelihood that each word followed the rule they had learned. One-third of the test words were present during training, one-third of the words were novel and sibilant-harmonic, and the last one-third were novel and disharmonic. The total duration of both training and testing was about 75 minutes. Behavioral results show that there was a significant mean rating difference between novel-harmonic and disharmonic words ($t(14)=3.685$, $p=0.002$, $d=0.951$, $1-\beta=0.968$). The stimuli elicited a clear auditory evoked potential (AEP). However, we observed no LPC following the stimulus or response, and there was no significant difference in ERP response to harmonic and disharmonic words. These results indicate that the LPC is not purely a response to violations of non-local sequencing rules. We observed a difference in behavioral response to harmonic and disharmonic words, indicating that the rule was learned. However, we saw no difference in brain response between the two conditions. In fact, a late positive component was entirely absent from the data. Although the harmonic pattern was learnable in the absence of semantic information, violations of the rule in this paradigm did not elicit the expected LPC. This suggests that the LPC, an index of syntactic and phonotactic rule violations, is also dependent on semantic integration. References Domahs, Ulrike, W. Kehrein, J. Kraus, R. Wiese, and M. Schlesewsky. (2009). Event-related potentials reflecting the processing of phonological constraint violations. Language and Speech 52: 415–435. Moore-Cantwell, Claire, J. Pater, R. Staubs, B. Zobel and L. Sanders. (forthcoming). Event-related potential evidence of abstract phonological learning in the laboratory.

Perception: Speech Perception and Audiovisual Integration

D15 Impaired Incidental Phonetic Learning in People with Aphasia

Christopher Heffner[1], David Saltzman[1], Samantha Formica[1], Emily Myers[1]; [1]University of Connecticut

Learning does not end after a stroke. People with aphasia (PWA) must learn or relearn many attributes of language to recover from their stroke, and it is likely that this learning process recruits multiple systems (Menke et al., 2009), including systems responsible for declarative and procedural learning. Although previous studies have found that PWA are slower to learn non-linguistic categories (Vallila-Rohter & Kiran, 2013, 2015), phonetic categories have not yet been investigated. In the present study, we investigate the acquisition of non-native phonetic categories in PWA, focusing on the influence of feedback on phonetic learning in PWA. Although nearly every proposal related to learning in PWA suggests that their procedural memory should be relatively spared, it is unclear if feedback encourages (Vallila-Rohter & Kiran, 2013b) or inhibits (Gabay, Dick, Zevin, & Holt, 2015) effective use of procedural learning. All PWA sustained left hemisphere damage, with variable lesion sites and behavioral consequences. Participants completed two tasks. In each task, they learned one of two phonetic continua—German fricatives and Arabic geminates—with assignment of continuum to task counterbalanced across participants. In the Incidental Task (based on Gabay et al., 2015), participants were told their job is to fight zombies by pressing a button corresponding to the location of a zombie on a screen. Although the participants were not told this before the experiment, the location of the zombie could be predicted based on the speech sounds they hear before the zombie appears. The pairings of zombies to sounds were scrambled during one block, with the degree of RT slowing serving as a measure of learning. In the Explicit Task, participants were explicitly told that they were going to learn to pair speech sounds with colored squares. After hearing a sound, they pressed a button corresponding to one of three colored squares. They were then given feedback on their responses: a checkmark for a correct response, and an X for an incorrect response. The index of learning for this experiment is the number of trials correct across the whole experiment. On the Incidental Task, there was little evidence that participants slowed down during the random block, suggesting that PWA could not exploit regularities in the input to learn during the Incidental Task. Yet on the Explicit Task, a majority of PWA showed evidence of learning, although none at the same rate as typical controls. The participants who successfully learned the contrast in the explicit condition tended to have spared frontal language areas, potentially indicating the importance of these areas for successful category learning; they also almost uniformly had lesions in temporal regions encompassing portions of Heschl's gyrus, which

may indicate that those regions are less important. The patterns for the non-learning participants were much more heterogeneous. This suggests that (1) PWA are impaired relative to controls on the acquisition of novel phonetic categories and (2) feedback may help promote successful exploitation of remaining learning systems on the part of PWA (Vallila-Rohter & Kiran, 2013).

D16 Lexical tone classification in frontal and posterior regions using fNIRS *Benjamin Zinszer[1], Todd Hay[1], Alex Athey[1], Bharath Chandrasekaran[1]; [1]The University of Texas at Austin*

Introduction: Tonal languages encode linguistic information through changes in pitch height and direction across phonological segments. In Mandarin Chinese, the same monosyllables form minimal pairs when contrasted between four distinct tones. Previous research has demonstrated that these tones are decodable from neurophysiological measures, namely EEG (Llanos, Xie, & Chandrasekaran, 2017) and fMRI (Feng et al., 2017), using various machine learning algorithms. Feng and colleagues used a support vector machine to successfully decode responses to intonated syllables measured with fMRI in superior temporal gyrus and inferior parietal lobule. In this study, we apply functional near-infrared spectroscopy (fNIRS) to decode neural responses to Mandarin lexical tones. Like fMRI, fNIRS measures cortical hemodynamics across several seconds after stimulus onset, but fNIRS is portable, silent, and resilient to head motion. Method: Seven native speakers of Mandarin Chinese (2M/5F) heard 100ms duration /i/-vowels intonated with tones 1 (high-flat), 2 (rising), and 4 (falling), interleaved with 140-150ms silences via insert earphones. Participants watched a silent, subtitled nature film throughout the experiment and were instructed to ignore the sounds. Tone stimuli were organized into Static blocks that repeated the same /i/+tone stimulus. Participants heard each Static block (and three additional variable-tone blocks), randomly ordered, in each run for seven to nine total runs with self-paced breaks. One participant withdrew after three runs. We measured changes in blood oxygenation (HbO) using a NIRx NIRScout system with 12 sources and 14 detectors distributed bilaterally over superior temporal, inferior parietal, and frontal regions. The fNIRS data were bandpass filtered between 0.005 and 0.7 Hz and converted to oxygenated hemoglobin (HbO) using Homer2 (Huppert et al., 2009). HbO measurements were normalized to zero mean and unit standard deviation. We trained perceptron models with two hidden layers of varying sizes (2 to 128 nodes) to discriminate the HbO measurements for the Static blocks (Tone 1, Tone 2, Tone 4) for each scan within a participant (80% training, 10% validation, and 10% testing). Inferring the basis dimensionality of the data from these single-subject models, we trained one model to generalize across all participants and estimated channel importance using integrated gradients (Sundararajan, Taly, & Yan, 2017). Results: Scan-classification accuracy was greater than 95% in every subject for hidden layers with 16 nodes. In the combined classification using this hidden layer size, accuracy for the group data was 79%. Channels above 90th percentile importance were located in bilateral posterior temporo-parietal and left frontal areas. Conclusion: Our findings suggest that fNIRS captures information about tone-specific processing activity, as previously demonstrated in EEG and fMRI. Consistent with an fMRI classifier (Feng et al., 2017), bilateral temporo-parietal regions provided important tone-specific information. Previous univariate fNIRS research using Mandarin tones also found effects of categorical perception in the superior and middle temporal gyri (Zinszer et al., 2015). Importantly, the present study also highlights left frontal regions, which have a debated role in auditory and phonetic processing. This work sets the stage for lexical tone research with MRI-incompatible populations, such as children and cochlear implant users.

D17 Perceptual processing of pre-boundary lengthening during phrase segmentation in English: Preliminary ERP evidence. *Annie Gilbert[1,2], Jasmine Lee[3], Max Wolpert[2,4], Shari Baum[1,2]; [1]School of Communication Sciences and Disorders, McGill University, Canada., [2]Centre for Research on Brain, Language and Music, Canada., [3]Honours in Cognitive Science, McGill University, Canada., [4]Integrated Program in Neuroscience, McGill University, Canada.*

The study of phrase processing has greatly benefited from the identification of a specific Event-Related Potential (ERP) component associated with the perception of phrase boundaries, namely the Closure Positive Shift (CPS). Most of the work on the CPS has looked at higher-level phrase processing where the phrasing informs the syntactic-semantic parsing of the sentence (see for example the difference between "When the man was parking the truck # ..." and "When the man was parking # the truck …"). Interestingly, a few studies have also found CPSs (or CPS-like positivities, hereafter included in CPS) associated with the acoustic processing of the prosodic markers of phrase boundaries, even if such boundaries did not have a significant impact on the interpretation of the stimuli (in nonsense stimuli, for example). Among these studies, Gilbert et al. (2015) demonstrated that phrase-final lengthening (without F0 modulation) is sufficient to trigger a CPS-like positivity in both simple French sentences and nonsense series of syllables. They interpreted their results as reflecting a domain-general perceptual process related to phrase segmentation and independent of the content of the utterance. It should be noted that there are topographical differences between the classic CPS and the 'perceptual' CPS, which might indicate that they index slightly different processes. Moreover, French has a very simple prosodic system with no lexically-coded prosody; thus, it is unclear if a similar perceptual CPS would emerge in languages from different prosodic typologies. To answer this question, we designed an ERP experiment to determine if phrase-final lengthening would

trigger a perceptual CPS in simple English utterances, as was shown in French. Stimuli consisted of fifty sentence pairs allowing for the comparison of the same target word in phrase-final (e.g.: Last year's flu / caused…) and non-phrase-final position (e.g.: Last year's flu scare / caused…). Stimuli were recorded by a native speaker of English with no salient phrase-final F0 rise and phrase-final words being on average 1.4 times longer than their non-phrase-final counterpart. Sentences were presented in pseudo-random order among fillers to ten monolingual English speakers so far. Their ERPs were time-locked to the target-word offset in both conditions and averaged from -500ms before to 1000 ms after the time-locking point. Average ERP amplitudes at electrode Cz were compared across conditions in 15 consecutive 100ms time-windows. Wilcoxon Signed Rank tests revealed no significant amplitude differences between conditions prior and up to 100ms after the time-locking point, but yielded significant differences across conditions from 100ms to 700ms after the time-locking point, with the phrase-final condition triggering a positive deflection in the ERP compared to the non-phrase final condition. Visual inspection of voltage maps revealed that the distribution of the present CPS is similar to the one found for French by Gilbert et al., with both CPSs being maximal over a left fronto-central region. These preliminary results demonstrate that phrase-final lengthening triggers a perceptual CPS in English, which supports the domain-general interpretation of phrase-final lengthening acting as a lower-level phrase segmentation cue.

D18 Speaker-normalized vowel representations in human auditory cortex *Matthias Sjerps[1,2], Neal Fox[3], Keith Johnson[4], Edward Chang[3]; [1]Donders Institute for Brain Cognition and Behavior, [2]Max Planck Institute Nijmegen, [3]University of California San Francisco, [4]UC Berkeley*

Speech perception is a computationally challenging task, in part because the acoustic dimensions critical for distinguishing among speech sounds are the same as those that distinguish among different speakers. For example, while a given speaker's /u/ will always tend to have a lower first formant (F1) than his or her /o/, a tall speaker (with a long vocal tract) will tend to have lower F1 formants for all vowels than a short speaker (with a short vocal tract). Consequently, a tall man's /o/ and a short man's /u/ might be acoustically identical. Behavioral research has demonstrated that listeners overcome such ambiguity by relying on context: a sound that is ambiguous between the vowels /u/ and /o/ is perceived as /o/ after a sentence spoken by a tall man (low F1), but as /u/ after a sentence spoken by a short man (high F1). However, the neurophysiological mechanisms underlying this speaker-dependent "normalization" effect remain unclear. To investigate the neural origins of normalization, neural activity was recorded directly from parabelt auditory cortex via subdurally-implanted high-density electrocorticography (ECoG) grids while five human participants listened to and identified vowels from a synthesized speech continuum ranging from /u/ to /o/ (an F1 continuum). Critically, these sounds were preceded by a context sentence that had been digitally manipulated to have either a high or low F1 range. Behavioral data replicated past normalization results: more vowels were identified as /o/ after a low F1 speaker than after a high F1 speaker. This demonstrates that listeners' perceptual category boundary shifted to more closely reflect the F1 of the context speaker. Analysis of the ECoG recordings revealed direct evidence that context-dependent (i.e., normalized) vowel representations emerged rapidly within parabelt auditory cortex. Specifically, we found that distinct cortical sites responded preferentially to vowels from either the /u/ or /o/ end of the continuum. Importantly, however, these same neural populations also responded differentially to the same acoustic token depending on whether it was preceded by a low or high F1 speaker. Analysis of the time course of normalization demonstrated that these normalized vowel representations were preceded by a brief window (~80ms) during which acoustically veridical (context-independent) encoding of target sound acoustics dominated, suggesting that normalization first emerges in cortical processing. Finally, we found that normalized representations may partly emerge as a result of local sensitivity to the contrast between frequency distributions in currently incoming information and that in preceding speech. These results highlight the key role auditory cortex plays in the integration of incoming sounds with their preceding acoustic context, leading to the emergence of talker-normalized encoding of speech sounds which is critical to resolving the lack of invariance in speech perception.

D19 Multimodal effects on comprehension in left hemisphere stroke *Laurel Buxbaum[1], Harrison Stoll[1], Anna Krason[2], Alessandro Monte[2], Gabriella Vigliocco[2]; [1]Moss Rehabilitation Research Institute, [2]University College London*

Face-to-face communication is multimodal in nature, comprising speech as well as co-speech gestures, and speech and gesture share large portions of a left-lateralized neuroanatomic network. Yet studies of language or gesture are typically performed in isolation. Furthermore, most research informing the rehabilitation of language disorders has not taken into account the multimodal information accompanying speech, and studies of limb apraxia (in which gesture comprehension deficits play a prominent role), have rarely considered the influence of language. Consequently, there is limited understanding of the factors that modulate the effects of gestural input on speech comprehension (or the effects of speech on gesture comprehension), the clinical characteristics of the individuals who may benefit from multimodal information (or, potentially, be adversely affected), or which brain regions play critical roles in multimodal gain or disruption. To explore the lesion, cognitive, and psycholinguistic characteristics of patients who benefit

from (or are disrupted by) congruent or incongruent speech and gesture, we investigated aphasic and apraxic patients' comprehension of audiovisual speech, gesture and speech/gesture combinations. Twenty-nine left hemisphere stroke patients and 15 matched controls performed a picture-video matching task in which they were cued in each block to attend to the speech or gesture present in the video. Videos showed an actor speaking, gesturing, or both, and the unattended modality (when present) was congruent or incongruent with the attended modality. Separately, we assessed lexical-semantic control with a semantic triplets task, and gesture recognition with a gesture-word matching task. Finally, we obtained research-quality MRI scans and performed Support Vector Regression-Lesion Symptom Mapping (SVR-LSM) to assess the brain regions that, when lesioned, were associated with abnormally large gains or disruptions ($p < .05$, corrected for multiple comparisons). Behavioral data indicated that patients showed both gains from congruent cross-modal information and disruptions from incongruent information that were significantly greater than those seen in controls. Furthermore, patients for whom lexical-semantic control was impaired were particularly sensitive to the congruence of gesture information when attending to speech. Conversely, patients for whom gesture comprehension was impaired were particularly sensitive to the congruence of speech information when attending to gestures. SVR-LSM analyses demonstrated a mirrored pattern of gain from congruent cross-modal information when patients attended to speech or gestures. In the speech task, patients with inferior frontal gyrus (IFG) lesions were particularly likely to benefit from congruent gesture, whereas patients with posterior (temporo-parietal junction, TPJ) lesions were less so. In the gesture task, patients with TPJ lesions were particularly likely to benefit from congruent speech, whereas patients with IFG lesions were less so. Thus, multimodal information has a strong impact on the comprehension of patients with left hemisphere stroke. Of relevance to aphasia rehabilitation, there were indications that patients with impaired lexical-semantic access and/or patients with IFG lesions may be particularly amenable to the benefit of co-speech gestures. Additional studies in our labs will explore whether the benefit reflects reliance on the intact gestural channel, or rather, an integration of speech and gesture input to a common conceptual representation.

Perception: Auditory

D20 Measuring the N400 during naturalistic conversation: An EEG hyperscanning study

Caitriona Douglas[1], Antoine Tremblay[1], Aaron Newman[1]; [1]Dalhousie University

While much work has investigated brain activity in different language production and perception contexts, practical constraints have meant little is known about brain activity during natural conversation. Yet, conversation is the most fundamental mode of language use — it is how we first learn language, and represents a significant proportion of most people's daily language use. A recent technical advance is 'hyperscanning', in which neuroimaging data is acquired from two or more individuals simultaneously. However, most of this work has looked over relatively long time scales, and there is little or no evidence that it is possible to obtain event-related potentials (ERPs) time-locked to individual words during a natural conversation. As an initial exploration of the feasibility of conducting world-level ERP research using hyperscanning, the aim of our experiment was to determine if we could obtain ERPs time-locked to the onset of individual words produced during a conversation between two people. Specifically, we investigated whether we could replicate the modulation of the N400 ERP component by lexical frequency. The N400 is commonly associated with lexical access, and prior studies have consistently reported larger N400s in response to low than high frequency words (e.g., Rugg, 1990, doi:10.3758/BF03197126, Van Petten & Kutas, 1990, doi:10.3758/BF03197127). We created a set of six scripted dialogues that included a number of low and high frequency nouns balanced for word length, number of syllables and morphemes, and orthographic and phonological neighbourhood size and frequency. Subjects (native English speakers) were run in pairs, with each individual reading one part of the dialogue (without being able to see the lines of their interlocutor). The target words for the N400 analysis were not distinguished in any way from other words in the scripts, and participants were instructed to read the scripts silently beforehand, and then read them as naturally as possible to their interlocutor during the experiment. EEG was recorded from both participants simultaneously using a 64 channel amplifier (32 channels/subject, including EEG, EOG, and facial EMG) with a ground splitter that ensured appropriate referencing for each individual; as well participants' speech was simultaneously recorded in a separate channel to the EEG data file, ensuring accurate time-locking. Following data collection, the onset of each target word was identified in the audio file and used to create event markers for ERP analysis. EEG data were processed separately for each individual, including manual artifact removal and ICA artifact correction. ERPs were time-locked to the onset target words that each individual heard (not to words they produced themselves). The results demonstrated a clear negativity from approximately 250-550 ms that was largest over midline central-parietal electrodes, consistent with past characterizations of the N400. Moreover, this negativity was larger for low than high frequency words, as predicted. These results provide compelling initial evidence that it is possible to obtain ERPs to individual words in a conversational context using hyperscanning, opening the door to an exciting range of future possibilities for neurolinguistic research.

D21 Hierarchical Processing of Degraded Speech: A Functional Near-Infrared Spectroscopy Study

Bradley E. White[1,2,3], Clifton Langdon[1,2,3]; [1]Language and Educational Neuroscience Laboratory, [2]PhD in Educational Neuroscience Program, [3]Gallaudet University

INTRODUCTION: Behavioral and neuroimaging research suggests that processing degraded acoustic information creates a cascading effect on the mechanisms underlying speech comprehension, suggesting that our cognitive resources are limited and causing a trade-off between effort and comprehension (Peelle, 2018). Here, using a plausibility judgment task and functional near-infrared spectroscopy (fNIRS), we aim to dissociate motivated listening and its modulation of language processing in response to increased demands on executive functioning. Hypotheses. We hypothesize that the processing of degraded speech is hierarchical in that hemodynamic activity in the prefrontal cortex is dependent on the amount of speech information preserved in the signal. Under this hypothesis, we predict the least amount of activation of prefrontal cortical areas for clear speech, with increases for distorted speech with a hearing aid simulation, and the greatest amount of activation for a cochlear implant simulation using 8-channel noise vocoded speech. Alternatively, we hypothesize that the processing of degraded speech is categorical in that hemodynamic activity in the prefrontal cortex may exhibit differences in clear versus degraded speech, but no significant linear relationships exists between hemodynamic activity and preserved speech features in the signal. METHODOLOGY: Participants. Monolingual, English-speaking adult participants (N=4; ages 24 to 37) with clinically-defined typical hearing, characterized by audiometric three-frequency pure-tone averages (i.e., 500 Hz, 1 kHz, and 2 kHz) ≤25 dB hearing level, and no reported history of hearing loss. Procedures. Participants complete a battery of language and cognitive assessments. The fNIRS task presents participants with 288 sentences for a plausibility judgment task. The sentences vary linguistically (i.e., simple subject-relative and complex object-relative clause structures) and acoustically (i.e., clear speech, moderately distorted hearing aid simulation, and severely distorted 8 channel noise-vocoded speech). RESULTS: Group-level fNIRS results show a positive, linear relationship between neural recruitment and increasing acoustic distortion for complex object-relative clauses (OS) compared to simple subject-relative clauses (SO). Specifically, the condition of greatest distortion (8 channel noise-vocoded speech) shows the greatest amount of modulation by linguistic complexity (OS>SO) with greater involvement of left temporal and frontal regions. The lesser-distorted condition (hearing aid simulation) reveals right temporofrontal sites modulated by OS>SO contrast. In the clear, undistorted condition, OS>SO contrast does not reveal significant modulation of neural activation. These results indicate support for the hypothesis that cognitive load to maintain traces in verbal working memory varies as a function of the speech information in the signal. CONCLUSION: Differentiating between these two hypotheses advances our understanding of how auditory degradations modulate language and associated processes (e.g., attention, short-term verbal working memory), and specifically the relationship of this modulation to the amount of speech features preserved in the signal. This work has potential to impact further research on auditory and spoken language processing in hearing aid and cochlear implant users.

D22 An EEG study on the influence of dialectal competence on neural processing of front vowels in German

Sarah Franchini; [1]

German dialects sometimes differ from standard language in pronunciation. Swabian is such a dialect which is commonly spoken in the south-west of Germany. It shows a lowering of the high front vowel [□] to [e] preceding a nasal and raising the low front vowel [□] to [e] in closed syllables. Standard German, on the other hand does not have [e] in its phoneme inventory and uses it in unstressed syllables of loanwords only. Several studies of languages like American English, French or Swedish have shown that speakers of dialects with a merged vowel representation are less able to discriminate height contrasts in perception compared to speakers without merged vowels, hence, suggesting differences in vowel representation. This study investigates whether familiarity with the Swabian dialect affects the phonemic perception of front vowels by German native speakers. Event related potentials (ERPs) were measured in response to minimally differing German nouns (“Finger” [Standard German ‘finger’], “Fenger” [dialect variant ‘finger’ or ‘catcher’], “Fänger” [Standard German ‘catcher’]), containing the vowels [□], [e] and [□]. Two groups of subjects (n=26) with differing levels of dialect knowledge were recruited. Thirteen native speakers of German (6 females, 7 males; mean age=27,4) with perfect self-rated knowledge of their regional dialect were tested in the field with a mobile EEG system. Thirteen native speakers of Standard German (7 females, 6 males; mean age=25,2), grown up without any dialect, represented the comparison group which was tested in the laboratory. The stimuli were recorded from a dialect speaker. Each participant had to listen to three blocks of a multi-deviant passive oddball paradigm. Three alternating conditions of randomized stimuli were presented binaurally using OpenSesame via loudspeakers, while the participants were watching a silent film. The EEG was recorded using a 32-channel LiveAmp amplifier. Electrophysiological results show an overall mismatch negativity (MMN) in a typical time window from 150 to 300 ms post vowel onset between the overall standard and deviant condition (p=0.0007299). Dialect as well as standard speakers show the largest MMN amplitude for “Fänger” (vowel [□]) irrespective of the direction of acoustic deviation. Both groups show reduced MMN amplitudes for “Fenger” (vowel [e]). However, for “Finger”, standard speakers show a larger MMN than

dialect speakers. This finding supports the hypothesis that dialect speakers differ in their representation of the vowel [□] in the context of a nasal consonant due to the attested lowering of high vowels in Swabian. In sum, we here show that dialect familiarity can shape the perception of acoustically similar vowels. This finding is particularly important because it shows different neurophysiological responses to the same acoustic stimuli in much the same way as has previously been shown between different languages.

Writing and Spelling

D23 Examining plasticity of the reading network: insights from deaf readers of Chinese

Junfei Liu[1,2,3,4], Tae Twomey[1,2], Mengke Wu[3,4], Yiming Yang[3,4], Mairead MacSweeney[1,2]; [1]Institute of Cognitive Neuroscience, University College London, [2]Deafness, Cognition and Language Research Centre, University College London, [3]Jiangsu Key Laboratory of Language and Cognitive Neuroscience, Jiangsu Normal University, [4]School of Linguistic Sciences and Arts, Jiangsu Normal University

The meaning of written words can be accessed directly from orthography or indirectly via phonology. These two routes work together during reading but the weights between them can be modulated by many factors such as the experimental task and the type of script used to represent spoken language. Spoken Chinese is represented using a logographic script. Unlike alphabetic scripts, Chinese orthography generally maps more closely to meaning than to sound. The only published fMRI study of deaf readers of Chinese showed greater activation in right inferior frontal gyrus (IFG), middle frontal gyrus (MFG), supramarginal gyrus (SMG) and angular gyrus (AG) during both rhyming and semantic tasks in deaf than hearing participants (Li et al., 2014). However, deaf and hearing people typically differ in their reading ability. Therefore, it is possible that the difference observed between deaf and hearing readers of Chinese are influenced by the difference in reading levels of the two groups. Using fMRI, we examined the brain network supporting reading Chinese characters in deaf and hearing participants who were matched on reading level. Fifteen deaf and 15 hearing adults were asked to make rhyming and semantic judgements on two simultaneously presented Chinese Characters. A visual similarity judgment task was used as the control task. For both the reaction time (RT) and accuracy data, the main effect of task was significant. However, the main effect of group and the interaction were not significant. The RTs were significantly longer and the accuracies were significantly lower for the rhyming task than the semantic task. RTs were included as a covariate in the whole brain analyses. The fMRI results showed that the rhyming task generated more activation than the semantic task in bilateral precentral gyrus and SMG, left superior parietal lobule, insula and SFG ($p < .05$, FWE corrected). For the semantic task relative to the rhyming task, significant activation was found in bilateral AG ($p < .05$, FWE corrected). The main effect of group as well as the interaction was not significant at $p < .05$ FWE corrected nor even at $p < .001$ uncorrected. It should be noted however, that, in line with previous literature, there was greater activation in deaf than hearing participants in superior temporal cortices bilaterally when fixation was used as a baseline. The present study shows that deaf and hearing readers of Chinese, who are matched on reading ability, recruit a similar reading network despite the very different auditory experience. This may be the result of the characteristics of the Chinese orthography and/or the visual and semantic approach used to teach Chinese children how to read. The findings suggest that the effect of deafness on the reading network may not be universal.

D24 Relationship between functional connectivity and spelling behaviour in individuals with dyslexia

Kulpreet Cheema[1], Dr. William Hodgetts[1,2], Dr. Jacqueline Cummine[1]; [1]Faculty of Rehabilitation Medicine, University of Alberta, Canada, [2]The Institute for Reconstructive Sciences in Medicine, Canada

Background. Writing skills are imperative to successful academic and social functioning in today's literate society. These skills are even more challenging for individuals with dyslexia who face lifelong impairments with reading and spelling. Although spelling acquisition is one of the most emphasized goals in schools, literature exploring the underlying neural mechanisms associated with spelling is surprisingly limited. Further, while spelling has been reported to activate a large network of brain areas, the connectivity among the brain regions in this distributed network remains unclear. This study looked into the functional connectivity patterns as they relate to spelling behaviour in adults with and without dyslexia. An understanding of the dynamic nature of the distributed neural systems associated with skilled and impaired spelling is critical for the development and advancement of theoretical models of written communication. Methods. 19 skilled individuals and 15 individuals with dyslexia completed the spelling-based fMRI task called letter probe task (LPT) in MRI. During LPT, the participant first hears the word, then sees a letter on the screen and then is asked to indicate if the letter they just saw was in the spelling of the word that they just heard. Participants completed three conditions of LPT: 1) retrieval of the whole word spelling representations is required (exception words e.g. 'c' in yacht), 2) retrieval of the whole word spelling representation is optional (regular words e.g. 'r' in charm), and 3) retrieval of the whole word spelling representation is impossible thus they must generate the spelling (nonwords e.g. 'b' in bint). Analyses. Overall functional connectivity between left hemispheric brain regions involved in orthographic processing (fusiform gyrus, inferior temporal gyrus), speech input (inferior frontal gyrus), articulatory processing (supplementary motor area, putamen, cerebellum, precentral gyrus) and phonological

processing (superior marginal gyrus, caudate and superior temporal gyrus) was calculated and correlated with the in-scanner accuracy and reaction time performances. Results. Overall, individuals with dyslexia had under-connective functional networks for regular and nonword spelling conditions and over connective networks for exception word condition. Assessing the connectivity-behaviour relationships revealed similarities and differences for both groups. Across the three spelling conditions, supplementary motor area connectivity emerged as being positively related to spelling accuracy for both skilled and impaired groups. Additionally, the functional network of inferior frontal gyrus consistently came up as being positively related to accuracy performance in skilled individuals while precentral gyrus connectivity emerged as being positively linked to accuracy in impaired readers. Conclusion. We provide evidence for aberrant connectivity patterns responsible for impaired spelling performance in dyslexia, and illustrate the importance of inferior frontal gyrus for skilled spelling behaviour. These results contribute to the advancement of neuroanatomical models for spelling, in addition to increasing the current state of knowledge regarding the underlying neurobiology of spelling performance.

Grammar: Morphology

D25 Contributions of left frontal and temporal cortex to sentence comprehension: Evidence from simultaneous TMS-EEG.

Thomas Gunter[1], Leon Kroczek[1], Anna Rysop[1], Angela Friederici[1], Gesa Hartwigsen[1]; [1]Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany

Sentence comprehension requires the rapid analysis of semantic and syntactic information. These processes are supported by a left hemispheric dominant fronto-temporal network, including left posterior inferior frontal gyrus (pIFG) and posterior superior temporal gyrus/sulcus (pSTG/STS). Previous electroencephalography (EEG) studies have associated semantic expectancy within a sentence with a modulation of the N400 and syntactic gender violations with increases in the LAN and P600. Here, we combined focal perturbations of neural activity by means of short bursts of transcranial magnetic stimulation (TMS) with simultaneous EEG recordings to probe the functional relevance of pIFG and pSTG/STS for sentence comprehension. We applied 10 Hz TMS bursts of three pulses at verb onset during auditory presentation of short sentences (i.e. pronoun-verb-article-noun). Semantic expectancy and syntactic gender was manipulated at the sentence final noun. TMS had a short-lasting impact restricted to the mid-sentence verb and affected verb processing differently for the two stimulation sites. Specifically, TMS over pIFG elicited a frontal positivity in the first 200 ms and a more parietal negativity at 400-600 ms post verb onset. TMS over pSTG/STS was limited to a parietal negativity at 100-700 ms post verb onset. This suggests that during verb processing in sentential context, frontal brain areas play an earlier role than temporal areas in predicting the upcoming noun pointing to a possible top-down control of pIFG on pSTG/STS. The short-living perturbation effect further suggests a high degree of flexible compensation for focal perturbation in the language system because the sentence final noun processing was unaffected.

D26 A neurophysiological investigation of translation and morphological priming in biscriptal bilinguals

Myung-Kwan Park[1], Wonil Chung[1], Say Young Kim[2]; [1]Dongguk University, [2]Hanyang University

The Revised Hierarchical Model (Kroll & Stewart, 1994) assumes asymmetric lexical links between first language (L1) and second language (L2) in unbalanced bilinguals, supported by stronger priming effects from L1 primes to L2 targets than from L2 primes to L1 targets (e.g., Jiang & Forster, 2001). Recent ERP studies also supported these asymmetric links in N250 and N400 components (e.g., Schoonbaert et al., 2011). However, other studies provided mixed results regarding the N400 effect for translation priming (e.g., Christoffels et al., 2013; Midgley et al., 2009). In order to answer the question of how two languages in bilingual readers are connected to each other, the present study examines if the pattern of cross-language translation priming is consistent with the asymmetric links between L1 and L2, and if it occurs via morphological decomposition, using ERPs and a masked priming lexical decision paradigm with unbalanced Korean-English bilinguals. We hypothesize that the N400 effect will be significant or larger when the participants are presented with Korean L1 primes and English L2 targets. In addition, this cross-language activation will be maintained by morphological priming when the targets are compound words and the primes are their constituents. In Experiment 1, Korean-English late bilinguals performed a masked priming lexical decision task where targets were Korean (L1) compound word (e.g., □□, ²mok-seon,² neckline), and primes were one of three English (L2) words; 1) translated whole word (neckline), 2) translated morphemic constituent (line), or 3) an unrelated word (work). Experiment 2 was the same as Experiment 1, except that the targets were in English (L2) and the primes were in Korean (L1). As for the behavioral results, both the translation priming effect and the morphological priming effect were significant only for Korean L1 primes and English L2 targets, but not for English L2 primes and Korean L1 target. In ERP results, the translation priming effect was found only for Korean L1 primes and English L2 targets on the reduced N150, P250, and N400. The morphological priming effect was found both for Korean L1 primes and English L2 targets, and for English L2 primes and Korean L1 target on the N400. Taken together, the results suggest that both cross-language translation priming and morphological priming occurs even between different scripts (between noncognate words), and the effects are stronger when L1 primed L2 as compared to when L2 primed L1. In addition, different time-course

between translation priming and morphological priming suggests that cross-language morphological decomposition occurs after translation in bilingual readers.

D27 Can morphological structure compensate for missing phonological information during reading? Evidence from skilled and un-skilled readers

Tali Bitan[1,2], Yael Weiss[3], Tammar Truzman[4], Laurice Haddad[4], Bechor Barouch[1], Tami Katzir[5]; [1]Psychology Department, IIPDM, University of Haifa, Israel, [2]Department of Speech Pathology, University of Toronto, Canada, [3]Psychology Department University of Texas at Austin, US, [4]Department of Communication Sciences and Disorders, University of Haifa, Israel, [5]Department of Learning Disabilities, The E.J. Safra Brain Research center, University of Haifa, Israel

Brain plasticity implies that the reading system could be tailored to demands of specific languages and orthographies. Theoretical models suggest that readers can rely on the word's morphological structure when reading a phonologically opaque orthography, and that morphological segmentation develops in late stages of reading acquisition. We tested these hypotheses in Hebrew, a morphologically rich language with two levels of orthographic transparency, and in individuals with varying levels of reading skill. In Hebrew, most words are composed of a consonant root interleaved with a vowel template. It has two versions of script: the common un-pointed script is opaque, with partial representation of vowels; and the transparent, pointed script, which is mainly used in first and second grade children, fully represents all vowels. In a series of behavioral and fMRI experiments we tested adult typical and dyslexic readers as well as 2nd and 5th grade children. Participants read aloud 96 noun words in 2 levels of morphological complexity: 48 mono-morphemic words and 48 bi-morphemic words composed of a root and template. Words were presented with or without points. For children in both age groups, bi-morphemic words were identified more accurately than mono-morphemic words. In contrast to the predictions, this was only true for the transparent, script, while the reverse (higher accuracy for mono-morphemic words) was found for the un-pointed script, especially in 2nd grade. Namely, the morphological structure facilitated word recognition, but when phonological information was scarce the shared root increased competition and resulted in interference. Finally, correlations with a standardized measure of morphological awareness were found only for 2nd grade children, and only in bi-morphemic words. For adults, only dyslexic readers benefitted from the morphological structure showing faster responses to bi-morphemic compared to mono-morphemic words. Dyslexic reader also read unpointed words faster than pointed words, presumably because pointed words were less familiar, and they could not benefit from the high phonological transparency. Neuroimaging results in adults show that 1) in regions associated with orthographic processing (i.e. Occipito-temporal ctx.) only dyslexic readers showed overactivation for bi-morphemic compared to mono-morphemic words, when the words were presented with diacritics. Thus, when reading the less familiar pointed script dyslexic readers rely on the words' morphological structure to access their orthographic representation. 2) Both typical and dyslexic adult readers showed increased activation for mono-morphemic compared to bi-morphemic words in left inferior & middle frontal gyri associated with phonological and morphological decomposition, across pointed and unpointed words. These results suggest that adult Hebrew readers engage in morphological decomposition of the root and template during the lexical-phonological access. Altogether these results suggest that readers of a morphologically rich language develop morphological segmentation skills already at an early age. Thus, unskilled readers, such as young children and adult dyslexic readers can rely on morphological segmentation during word recognition, to compensate for their immature orthographic lexicon or for impaired phonological abilities. However, we didn't find an increase in morphological segmentation in the non-transparent script, suggesting that morphological and phonological segmentation enhance each other in the process of word recognition.

Grammar: Syntax

D28 Expectation modulations based on verb bias and grammatical structure probability shape sentence processing: An ERP study

Kirsten Weber[1,2], Lena Henke[1], Cristiano Micheli[2]; [1]Max Planck Institute for Psycholinguistics, Nijmegen, the Netherlands, [2]Donders Institute for Brain,Cognition and Behaviour, Nijmegen, the Netherlands

Language processing is dynamic and is shaped and modulated by all kinds of factors. Here we investigated how prior knowledge and the current linguistic environment influence the processing of sentence structures. In this project we looked at how two types of information, 1) the statistics of the input (the proportion of two ditransitive sentence structures across different blocks) and 2) verbs biasing towards one of these structures or the other. We wanted to see how and when these different type of information influence sentence processing and whether they have similar or distinct electrophysiological markers. We acquired electroencephalography recordings while 32 Dutch native speakers were reading sentences word by word. The Dutch sentences either had a prepositional object (PO) or double-object (DO) structure. They contained verbs with either a DO or PO bias. The verb bias values were taken from a corpus analysis (Colleman, 2009) and were confirmed by a post test that participants filled in one week after the experiment. In this test participants had to generate ditransitive sentences for the different verbs resulting in their production preferences, and thus biases, per verb. In one block 75% of the sentences had a DO sentence structure and 25% a PO sentence structure, with the opposite pattern in the other block.

We thus had three factors in this study, Global Structure Frequency, Verb Bias and Sentence Structure. We looked at ERP effects on the post-verbal noun, where our two expectation manipulations should influence the processing of sentence structure. Reported results are either from a linear mixed effect model of single-trial N400 data of central-posterior electrodes or cluster-based permutation tests over all electrodes using the fieldtrip toolbox (http://www.fieldtriptoolbox.org). Expectation violations based on verb bias (unexpected verb-structure combination) resulted in a larger N400 on the post-verbal noun. This was especially the case when the verb biased towards a DO structure but a PO structure was presented. Also a later frontal positive component showed a larger effect if the verb-structure combination was more surprising. Global Structure Frequency, and thus the current linguistic environment, had a marginally significant effect on a later positive component. In sum, different types of information that could be used for predictive language processing of grammatical structures can have different ERP effects. Local information from the verb modulates the earlier N400 component as well as a later positivity. The statistics of the current linguistic environment on the other hand has a weaker effect later on during processing. These distinct effects shaping sentence processing are in line with findings from a previous fMRI study with a similar design. Verb-based surprisal effects were found within the canonical language network, while the anterior cingulate kept track of the current linguistic environment.

D29 EEG Evidence for Different Syntactic Expectations in Parsing Chinese Subject and Object-relative Clauses

Jiayi Lu[1], Matthew Walenski[1], Cynthia K. Thompson[1]; [1]Northwestern University

In English and other languages with head-initial relative clauses, where an extracted noun phrase precedes the relative clause, object-relative clauses incur higher processing costs than subject-relative clauses. In Chinese, relative clauses precede the extracted noun; thus Chinese subject-relative clauses begin with a verb, similar to pro-drop sentences like imperatives, whereas object-relative clauses begin with a noun phrase, similar to SVO sentences. Mixed results for the relative difficulty of these structures are found; some studies find increased processing costs for subject-relatives and others increased costs for object-relatives. We used event-related potentials (ERPs) to investigate whether expectations for competing structures (e.g., pro-drop for subject-relatives, SVO for object-relatives) may contribute to increased processing costs at different points for subject- and object-relative clauses in Chinese. We recorded EEG from twenty native Chinese speaking college-age participants. We examined four sentence types (n=38 each; 76 ungrammatical relative clause sentences were included but not discussed here): Subject-relative clauses (Xiaoming shuo: [[zhui mao de] daheigou dique zhang-zhe chang wei ba]; "Xiaoming says: The black dog that is chasing the cat indeed has a long tail"), Pro-drop imperatives (Xiaoming shuo: [zhui mao qu ba]; "Xiaoming says: Let's go chase the cat"), Object-relative clauses (Xiaoming shuo: [[mao zhui de] daheigou dique zhang-zhe chang wei ba]; "Xiaoming says: The black dog that the cat is chasing indeed has a long tail") and Simple SVO sentences (Xiaoming shuo: [mao zhui-zhe daheigou]; "Xiaoming says: The cat is chasing the black dog"). Sentences were visually presented word-by-word with an 800ms ISI; participants made an end-of-sentence acceptability judgment after each sentence. ERPs were time-locked to the onset of the first word of the relative clause (bolded), with a 100ms baseline and 2400ms epoch. At the initial word (zhui vs. mao), subject-relative clauses (1) evinced a larger P600 component (600-800ms) than object-relative clauses (2). At the relativizer position (de), there were no significant differences between subject- and object-relative clauses, though both had anterior negative (LAN) components (300-500ms) relative to the aspect marker (zhe) in the SVO sentences (4). Finally, a P600 component (600-800ms) was observed at the imperative marker (qu) in the imperative sentences (2) compared to the relativizer (de) in the subject-relative sentences (1). The P600 results indicate that the initial nouns in subject-relative clauses are more difficult to process, and likely less expected than initial verbs in object-relative clauses. However, compared to another verb-initial structure (imperatives), subject-relative clauses are the more expected structure. Thus an initial verb may trigger an expectation for a subject-relative clause structure. In addition, the similar LAN components at the relative clause marker suggest similar structure-building costs for subject- and object-relative clauses, despite the initial difference in structural expectations.

D30 Beta-band ERP activity during cyclic wh-movement in French as a physiological index of non-nativeness

Laurent Dekydtspotter[1], Kate A. Miller[2], Mike Iverson[1], Yanyu Xiong[1], Swanson Kyle[1], Gilbert Charlene[1]; [1]Indiana University Bloomington, [2]Indiana University Purdue University Indianapolis

Non-native processing may involve procedural delay (Boxell & Felser, 2017). We examined EEG activity in native (NSs; n=24) and advanced L1-English non-native (NNSs; n=22) speakers of French as information accompanying displaced wh-expressions (1a-d) passes through bridge dit que 'said that'. ERPs confirmed delayed distinctions in NNSs. Time-frequency analysis revealed signatures of non-nativeness in beta-band ERP activity. Information passing between clauses in wh-dependencies (1a-d) exemplifies the specificity of recursion in language. N-complements (à propos de lui; 1b,d) are re-represented in recursion, but not NP-modifiers (le concernant; 1a,c) (Chomsky, 2005; Lebeaux, 1988). When matching antecedents are available, re-represented pronouns can be syntactically bound (1b) or discursively coreferential (1a). Without matching antecedents (1c,d), these processes are thwarted. (1.) a. Quelle décision le concernant est-ce que Paul a dit que

Lydie avait rejetée sans hésitation? b. Quelle décision à propos de lui est-ce que Paul a dit que Lydie avait rejetée sans hésitation? c. Quelle décision le concernant est-ce que Lydie a dit que Paul avait rejetée sans hésitation? d. Quelle décision à propos de lui est-ce que Lydie a dit que Paul avait rejetée sans hésitation? 'Which decision regarding/about him did Paul/Lydie say that Lydie/Paul had rejected without hesitation?' Participants completed a RSVP task (300ms/word, 250ms/ISI) with 25 quadruples crossing Structure (N-complement/NP-modifier) and Antecedent Gender (Match/Mismatch) (1a-d). EEG was recorded via a 64-electrode EGI system with 50 kΩ maximal impedance, a Net Amps 300 amplifier, and 1000Hz sampling rate. Data were preprocessed with a .05-100.5Hz band-pass filter and cleaned of artefacts via epoch/channel rejections and Independent Component Analysis. 87% of NS and 86% of NNS trials were retained. Average amplitudes, with 50ms-baseline into critical words dit 'said' and que 'that' (Phillips et al., 2005), were compared over four regions (Fiebach et al., 2002). Mixed-effect models for 250-550ms after critical words' onsets revealed modifier-complement differences at dit in NSs (p=.02) but at que in NNSs (p=.027). Topographical differences accompanied delayed effects. Power analyses between 4-40Hz revealed a main group effect at 18-21Hz 250-400ms into dit in two clusters, with greater power for NNSs than NSs (p=.005). Main-effect modifier-complement differences arose during dit at 34-40Hz with greater modifier-complement differences in mismatch than match (p=.003) and during que at 4-5Hz with increased modifier-complement power-differences in match than mismatch (p=.035). Group-conditions interactions arose over anterior clusters for 30ms during dit at 36-40Hz (p=.038) and 50ms during que at 21-24Hz (p=.013). Analysis of average power over relevant clusters revealed the interaction at 36-40Hz resulted from greater modifier-complement power difference in match for NSs (p=.001) and in mismatch for NNSs (p=.002). The interaction at 21-24Hz resulted from a modifier-complement difference in mismatch in NNSs (p=.0005) not found in NSs (p=.077). Power-differences in gamma- and theta-band rhythms at the bridge reflected reference-related grammatical procedures linked to displaced wh-expressions. Power-differences in beta-band rhythms distinguished NNSs from NSs. This beta-band activity plausibly reflects second-language brain processing focused on maintaining weakly activated representations (Dekydtspotter & Miller, 2013; Miller, 2014, 2015), which could reduce the overall speed of processing.

D31 Left dorsal white-matter microstructure and oscillatory coupling jointly predict language comprehension

Benedict Vassileiou[1], Caroline Beese[1], Angela D. Friederici[1], Lars Meyer[1]; [1]Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany

Language comprehension emerges from electrophysiological information transfer between neuroanatomically connected brain areas. We thus hypothesized that language comprehension can be jointly predicted from the integrity of white-matter connections and the electrophysiological coupling between their termination regions. We recorded the scalp electroencephalogram of 20 participants who performed a language-encoding task; in addition, we acquired diffusion-weighted magnetic resonance images. Electrophysiological coupling was quantified in source space employing the debiased weighted phase-lag index (dwPLI). Following our prior work, we calculated dwPLI in the alpha band between frontal and posterior nodes of the left perisylvian language network. The anatomical integrity of the underlying dorsal and ventral white-matter structures was quantified by calculating their fractional anisotropy (FA). We then fitted statistical models to predict comprehension accuracy from dwPLI, dorsal FA, ventral FA, and their interactions. Our results showed that comprehension accuracy was near-perfectly fitted by an interaction between dwPLI and the FA of the left dorsal white matter: High axonal integrity, in concert with high functional desynchronization, predicted high accuracy. In the framework of alpha-band oscillations as a cortical mechanism of inhibition/disinhibition, our findings suggest that a disinhibitory functional desynchronization of the left dorsal perisylvian language network, supported by its microstructural profile, helps language comprehension. Our result is novel evidence that language comprehension is the outcome of complex relationships between rigid neuroanatomical connections and dynamic electrophysiological crosstalk.

D32 An ERP study of Q-particle licensing and question-answer congruence in Korean

Daeho Chung[1], Kiyong Choi[2], Wonil Chung[3], Say Young Kim[1], Bum-Sik Park[3], Myung-Kwan Park[3]; [1]Hanyang University, [2]Kwangwoon University, [3]Dongguk University

This ERP study examines the licensing relation between a clause-final question particle (Q-particle) and the preceding wh-phrase (WP) and the congruence between a yes/no or wh-question and its answer in Korean Kyengsang dialect, which employs different Q-particles depending on the types (-na for yes/no-question; -no for wh-question). The experimental materials consisted of 240 sets of 8 items, with a 2x2x2 factorial design: (i) the clause-final Q-particle factor (-na/-no), (ii) the Q-particle-licensing factor ((im) proper licensing between an embedded WP and the Q-particle), and (iii) the question-answer (in)congruence factor (a(n) (in)correct answer to a yes/no or wh-question). The structure of the materials is as follows; A: ni-nun yenghuy-ka mwusun chayk-ul ilk-ess-tako (or -nunci) alko iss-no (or -na)? 'Do you know whether Yenghi read some book?/Which book do you know that Yenghi read?' B: soselchayk-ul (or ung, alko iss-e) 'A novel (or Yes, I do)'. Twelve Korean speakers (male: 8) participated in the ERP experiment. The ANOVA results based on the descriptive data of the offline acceptability task showed that there are significant main effects of such factors as clause-final

Q-particle ($F(1,11)=20.90$, $p<0.001$), Q-particle-licensing ($F(1,11)=8.92$, $p<0.05$), and question-answer congruence ($F(1,11)=9.65$, $p<0.01$). ERPs were measured at the matrix verbs with Q-particles (alko iss-na/-no) and the answers (soselchayk-ul/ung, (alko iss-e) 'A novel/Yes, I do'). In pairwise comparison between the matrix verbs with the Q-particles, there was a significant anterior negativity effect between a Q-particle-licensing violation (the embedded and matrix verbal complex: ilk-ess-nunci alko iss-na) and its control (ilk-ess-tako alko iss-na), but no such effect between a wh-island violation (ilk-ess-nunci alko iss-no) and its control (ilk-ess-tako alko iss-no). In pairwise comparison between a Q-particle-licensing violation and its control, there was a RAN effect at 350-500 ms at the anomalous fragment answer to the yes/no-question (e.g, sosel-ul 'A novel') relative to the felicitous counterpart to the wh-question, and an anterior P600 effect at the anomalous yes/no answer to the wh-question (e.g., ung 'yes') relative to its counterpart to the wh-question. In pairwise comparison between a wh-island violation and its control, there was a left sustained negativity effect at the anomalous fragment answer to the yes/no-question (e.g., sosel-ul 'A novel') relative to the felicitous counterpart to the wh-question, and a sustained positivity effect at the anomalous yes/no answer to the wh-question (e.g., ung 'yes') relative to its counterpart to the wh-question. The results indicate that the wh-island violation is not in full force since the embedded WP is not required to be associated with the embedded Q-particle. However, the Q-particle-licensing requirement comes into effects, in that the embedded WP tends to be associated with the matrix wh-licensing Q-particle across the embedded non-Q complementizer. Regarding the question-answer (in)congruence, the incongruent fragment answers elicited a negativity, whereas the incongruent polarity answer particles evoked a positivity. One outstanding thing to note is that when the embedded verb complex contains a Q-particle, the positivity or negativity of ERP responses is sustained. This suggests that the conditions with this kind of structural configuration call for more cognitive demands in meeting the question-answer congruence.

Meaning: Lexical Semantics

D33 Language production across the lifespan: Insights from inferential naming

Raphael Fargier[1], Marina Laganaro[1]; [1]FPSE, University of Geneva, Switzerland

Language production abilities display specific dynamics across the lifespan. The vocabulary grows continuously (Salthouse, 2004) but lexical retrieval and word production latencies measured with referential tasks are slower in children and elderly relative to young adults. Previous electroencephalographic (EEG) studies contrasting these populations (Laganaro et al. 2015,Valente et al. 2015) using referential tasks reported converging evidence for modulations of pre-lexical processes rather than word-form encoding, which is compatible with recent behavioral findings on changes in semantic processes with age (Boudiaf et al., 2018). Inferential naming is another paradigm to elicit the production of words, in which word retrieval likely requires deeper semantic processes (Fargier & Laganaro, 2017). Here, we asked whether production latencies in inferential naming tasks follow the same dynamics as in referential naming. If pre-lexical speech planning processes undergo changes across the lifespan, then production latencies in inferential naming should also vary across different age groups, and functional and/or temporal neural differences may occur early in the course of word production. We recorded high-density EEG while participants overtly produced words in response to short oral definitions. Four groups of participants took part in the study including children (10-12 years), adolescents (16-18 years), young adults (20-30 years) and older adults (60-80 years), and analyses of waveform amplitudes and microstates were used to explore neural dynamics of inferential naming. Behavioral results revealed a significant main effect of age groups with slower production latencies in children (M=1060 ms) relative to all other groups (adolescents (M=921 ms; p=0.031), young adults (M=860 ms; p=0.003) and elderly (M=863 ms; p=0.003)). Large differences in waveform amplitudes were observed on multiple time-periods, notably before 300 ms. Microstates analyses revealed both qualitative (different topographic configurations) and quantitative (temporal shifts) differences between groups. As the time-window around 300 ms has been previously ascribed to lexical selection in inferential naming (Fargier & Laganaro, 2017), our results suggest age-related changes of pre-lexical processes. Interestingly, adolescents displayed similar microstates as in children and young adults, suggesting an intermediate pattern. Our results confirm that pre-lexical processes undergo changes across the lifespan. In inferential naming, such changes are probably mediated by semantic integration processes, which efficiency is assumed to peak after adolescence. This work therefore calls for a lifespan perspective on cognitive and language changes and further argues for considering adolescence as a critical stage of development. References Boudiaf, N, et al. (2018) Behavioral evidence for a differential modulation of semantic processing and lexical production by aging: a full linear mixed-effects modeling approach, Aging, Neuropsychology, and Cognition, 25:1, 1-22, Fargier R and Laganaro M. 2017. Spatio-temporal Dynamics of Referential and Inferential Naming: Different Brain and Cognitive Operations to Lexical Selection. Brain Topogr. 30:182–197. Laganaro et al. 2015. Functional and time-course changes in single word production from childhood to adulthood. NeuroImage. 111: 204–214. Salthouse, T.A. (2014). Quantity and structure of word knowledge across adulthood. Intelligence, 46, 122-130. Valente A, Laganaro M. 2015. Ageing effects on word production processes: an ERP topographic analysis, Lang. Cogn. Neurosci., 30 (10), pp. 1259-1272.

D34 A lesion study of semantic hubs: the anterior temporal lobe and temporo-parietal junction *Nicholas Riccardi[1], Chris Rorden[1], Julius Fridriksson[1], Rutvik Desai[1]; [1]University of South Carolina*

Introduction: Both the anterior temporal lobe (ATL) and temporo-parietal junction (TPJ) have been implicated as cross-modal hubs that are vital for conceptual processing. While some evidence indicates that damage to the left ATL is sufficient for cross-modal semantic impairment, other evidence suggests the left ATL is involved in lexical access and not conceptual representation per se. In a group of left hemisphere damaged stroke patients, we examined how damage to the ATL and TPJ affects performance on three tasks with varying lexical and semantic demands: lexical decision (LD), word-based semantic similarity judgment (SSJ), and picture-based Pyramids and Palm Trees (PPT). We hypothesized that damage to the ATL should impair accuracy on tasks with a high lexical demand (LD, SSJ), demonstrating its role in lexical access. Damage to the TPJ should impair tasks with high semantic demand (SSJ, PPT), demonstrating its role as a cross-modal hub. Methods: Lesion data of 63 left unilateral stroke patients were considered. The LD task required patients to make a binary choice as to whether the presented word (80 nouns, 80 verbs, 160 pronounceable nonwords) was real or not. For SSJ, 80 noun and 80 verb triplets were presented, and the patients had to determine which of the bottom two words most closely matched the meaning to the word on the top. PPT is similar to SSJ but uses 54 picture triplets instead of words. Region-based lesion-symptom mapping (RLSM), which determines the relationship between percent of voxels damaged within a region and a behavioral score, was then used in two masks made from the Johns Hopkins University atlas. The ATL mask consisted of the middle and superior temporal poles (MTGpole, STGpole), inferior temporal gyrus (ITG), and fusiform gyrus (FG). The TPJ mask consisted of the angular and supramarginal gyri (AG, SMG) and the posterior superior, middle, and inferior temporal gyri (pSTG, pMTG, pITG). RLSM was conducted in a pairwise manner for each task such that patient's accuracies in the other tasks were used as a nuisance covariate (e.g. LD regressing out SSJ, etc.). In this way, each patient also served as their own control for lesion volume. Significance and correction for multiple comparisons was accomplished via permutation testing (5000 permutations). Results: In the ATL mask, damage to the MTGpole significantly predicted LD accuracy when regressing out PPT ($p = .009$). No other pairwise comparison was significant. For the TPJ mask, damage to the SMG, AG, pSTG, and pMTG predicted SSJ accuracy when regressing out LD (all $p < .01$). Damage to the AG predicted PPT performance when regressing out SSJ ($p < .01$). Conclusions: Damage to the left ATL causes lexical impairments, even after accounting for lesion size and performance on a picture-based semantic task, highlighting its role in lexical access. TPJ damage was associated with impairment to semantic tasks regardless of input modality and when regressing out lexical performance, substantiating its role in cross-modal conceptual processing. This suggests a stronger role of ATL in lexical processing, and TPJ as a semantic hub.

D35 Multi-voxel pattern analysis reveals conceptual flexibility and invariance in language *Markus Ostarek[1], Jeroen van Paridon[1], Peter Hagoort[1,2], Falk Huettig[1,2]; [1]Max Planck Institute for Psycholinguistics, Nijmegen, [2]Donders Institute for Brain, Cognition, and Behavior, Radboud University, Nijmegen*

Conceptual processing is characterized by a striking degree of flexibility on the one hand (Barsalou, 1993), and a remarkable capacity for abstraction on the other (Fodor, 1975). Previous behavioral and electrophysiological work established that during language comprehension contextual demands strongly influence the informational content that is activated and the processing systems that are recruited. Recent functional magnetic resonance imaging (fMRI) studies have begun to explore the neuro-cognitive mechanisms underlying conceptual flexibility in language processing. They showed that task relevance of motor or visual features of words leads to higher activation in brain regions involved in movement planning and visual perception (Hoenig, Sim, Bochev, Herrnberger, & Kiefer, 2008; van Dam, van Dijk, Bekkering, & Rueschemeyer, 2012), and to increased functional connectivity between auditory cortex and these areas (Van Dam, Van Dongen, Bekkering, & Rueschemeyer, 2012). Using multi-voxel pattern analysis in fMRI, we investigated how task demands (performing an animacy vs. size judgement task) shape word-specific patterns elicited by nouns, focusing particularly on size and animacy information. Representational similarity analysis revealed that in the left anterior temporal lobe and in primary sensory and association areas size and animacy information was more strongly present when it was task-relevant. Surprisingly, we found no evidence for task invariant processing of size or animacy anywhere in the brain. To further probe flexibility vs. invariance, split half analyses compared how similar word-specific patterns were within and across tasks. The results suggest that patterns in occipital areas are strongly affected by task demands. In contrast, we obtained evidence for task invariant processing in the intraparietal sulcus and surrounding cortex (including the angular gyrus). This region was neither found to be sensitive to animacy or size information, nor to phonological information, suggestive of patterns with a non-systematic mapping to semantic and phonological word features. These results point to a possible neural architecture for conceptual flexibility and invariance in language: Whereas a distributed network encompassing the anterior temporal lobe and sensory areas seems to flexibly adapt to task demands to provide contextually relevant information, the intraparietal sulcus and surrounding cortex may contribute to stable context-invariant processing of words.

D36 Fine subdivisions of the left anterior temporal lobe in semantic processing of social words *Xiaosha Wang[1], Bijun Wang[1], Yanchao Bi[1]; [1]Beijing Normal University*

Recent neuroimaging studies consistently reported selective involvement of the anterior temporal lobes (ATLs) in conceptual processing of social words, i.e. words describing social behaviors of animate (social) entities. One potential factor that has been systematically confounded in this finding is emotional valence, given that social words tend to be associated with emotional feelings. It is thus unclear whether the ATLs are sensitive to sociality, emotional valence, or both. We investigated these effects in the ATLs using a 2 (social/nonsocial) × 2 (valenced/neutral) factorial design in an fMRI study, with words such as "honor" (S+V+), "duty" (S+V-), "miracle" (S-V+), "content" (S-V-). Two distinct subregions within the left ATL were identified to be sensitive to either sociality or valence without interaction between these two factors. Semantic judgment of social words evoked stronger activation than nonsocial words in the left anterior superior temporal sulcus (aSTS), regardless of whether social words are valenced or neutral (S+V+ & S+V- > S-V+ & S-V-); valenced words evoked stronger activation than neutral words in the left temporal pole (S+V+ & S-V+ > S+V- & S-V-); these two factors showed little interaction in the ATL at the group level. These social or valence-sensitive clusters were distinct from the left anterior superior temporal gyrus cluster that exhibited a general "abstractness" effect (all four abstract conditions > concrete object words), since the abstractness cluster showed little social and valence effects. These subregions exhibited distinct whole-brain functional connectivity patterns during the resting state, with the social aSTS synchronized with key regions in social cognition, the valence cluster with the left amygdala and the abstractness cluster with the perisylvian language regions. These results indicate that the way in which the left ATL supports semantic processing is highly fine grained, including at least dissociable neural substrates that support dimensions of social interaction, valence, and abstractness.

D37 An integrated neural decoder of experiential and linguistic meaning *Andrew Anderson[1], Jeffrey Binder[2], Leonardo Fernandino[2], Colin Humphries[2], Lisa Conant[2], Douwe Kiela[3], Rajeev Raizada[1], Feng Lin[1], Edmund Lalor[1,4]; [1]University of Rochester, [2]Medical College of Wisconsin, [3]Facebook, [4]Trinity College Dublin*

How the human brain codes the meaning of words is thought to draw on a combination of linguistic knowledge and non-linguistic experience interacting with the word. Despite extensive research into decoding meaning from brain activation there is minimal direct neural evidence that both linguistic and experiential aspects of meaning are present in neural activity elicited during natural reading. In part this is because neural decoding has been reliant on matching brain activation to models of word meaning that are either linguistic or experiential in nature. We rectify this. In the challenging task of decoding 14 participants functional Magnetic Resonance Imaging (fMRI) activation elicited in sentence reading, we integrate a state-of-the-art distributional semantic model induced from word co-occurrences in natural text with a behaviorally rated model of peoples' sensory, motor, social, emotional, and cognitive experiences with words. By demonstrating the integrated approach systematically boosts decoding accuracy over using either model in isolation, we reveal the first evidence that both experiential and linguistic elements of meaning are detectable in brain activation elicited in natural reading. We provide confirmatory evidence for the hitherto untested assertion that the text-based model will offer a decoding advantage for sentences containing linguistically oriented "abstract" words. By introducing a new method to decode individual's brain activation using other peoples' brain activation, we derive an estimate for the upper bound on individual-level decoding accuracy achievable. By comparing the model-based results to this upper bound we identify sentences for which model performance can be improved upon. These sentences are most associated with abstract concepts, benefit and upper-limb actions which suggests that these semantic domains may be important areas on which to focus future model development. Finally, by decoding all 14 participants fMRI data in parallel using both models, and then integrating all 14 decoding decisions to generate a group-level estimate we achieve high accuracy results surpassing any at individual-level. This high performance level hints that information extracted across multiple peoples' fMRI data could itself be sufficiently detailed to enhance semantic model representations for artificial intelligence purposes.

D38 Emojis and Prediction in Sentence Contexts *Ben Weissman[1], Darren Tanner[1]; [1]University of Illinois at Urbana-Champaign*

Emojis are ideograms that are becoming ubiquitous in modern digital communication; however, there is little work on how mixed word/emoji utterances are processed. Some work has investigated face emojis (e.g., Miller et al. 2016, 2017; Tigwell & Flatla, 2017; Weisman & Tanner, 2018), but little work has investigated non-face emojis, which can serve different communicative purposes (Riordan, 2017a,b). Here we report findings from two ERP experiments meant to investigate how semantic content from emojis is predicted and integrated during sentence comprehension, and whether brain responses elicited by emojis are qualitatively similar to those elicited by words. Prior work on language has implicated three relevant ERP components: the N400, the late frontal positivity (LFP), and the P600. Unexpected words in constraining sentence contexts are widely known to elicit larger N400 amplitudes, which in some cases can be directly tied to prediction of word forms and their associated semantic features (Federmeier & Kutas, 1999; Kutas & Hillyard, 1984). Plausible but unpredicted words have been shown to elicit enhanced LFPs following enhanced N400 effects,

whereas implausible unpredicted words show larger N400 amplitudes, followed by posterior P600 effects (Brothers et al., 2015; DeLong et al., 2014; Federmeier et al., 2007). Previous ERP work has investigated how the brain processes sentences with line drawing completions (Federmeier & Kutas, 2002; Ganis et al., 1996), showing that larger N400s are elicited by unexpected drawings, similar to N400s elicited by words. However, in the intervening years the rise of emojis in common digital discourse has both given rise to a set of familiar ideograms that were not previously available (i.e., emojis) and made picture sentence completions more common for populations who frequently communicate digitally using emojis. The present research therefore investigates emoji-related semantic processing in young adults who frequently use emojis. Stimuli were strongly constraining ending in an expected or plausible but unexpected completion, and weakly constraining sentences ending in a plausible or implausible completion. Completions were either emojis (Experiment 1) or their word counterparts (Experiment 2). iOS emojis were normed for high name agreement, which matched their word counterparts. Experiment 1 (N = 20) results showed larger amplitude N400s when the emoji was either unexpected or implausible for high and low constraint sentences, respectively, though the implausibility effect showed an anterior focus (similar to prior reports of N300 effects; Federmeier & Kutas, 2002; McPherson & Holcomb, 1999). The expectancy N400 effect in high-constraint sentences showed a very early onset (~150ms). Unexpected emojis showed an LFP, and implausible words P600 effects, relative to their expected/plausible emoji counterparts, respectively. Experiment 2 is currently underway and will allowed detailed comparison between these emoji-related ERPs and those elicited by words in the same contexts. Our results suggest that comprehenders rapidly access semantics from emojis and that these symbols are easily incorporated into a multimodal utterance. Moreover, our findings indicate qualitative similarity between prediction violations involving contextually relevant emojis and words, indicated by the LFP in high-constraint sentences – a finding, which is to our knowledge novel.

D39 The neural basis of phonological and semantic neighborhood density

Michele T. Diaz[1], Hossein Karimi[1], Anna Eppes[1], Victoria Gertel[1], Sara Winter[1]; [1]The Pennsylvania State University

There is considerable evidence that aging has a substantial negative effect on language production. One of older adults' most frequent, frustrating, and embarrassing cognitive problems is word retrieval difficulty. Consistent with these reports, older adults endure more tip-of-the-tongue states than younger adults, and during TOT states older adults report less phonological information and fewer alternative words compared to younger adults, consistent with a phonologically based deficit as the underlying causal mechanism of these retrieval deficits. Moreover, other indices of language production also demonstrate poorer performance for older compared to younger adults: aging is associated with decreased speed and accuracy in naming objects, increased errors in spoken and written production, and more pauses and fillers in speech, which indicate age-related increased retrieval difficulty. In contrast to language production, other aspects of language are largely preserved with age. Healthy older adults generally have larger and more diverse vocabularies and demonstrate comparable performance to younger adults in making word associations and semantic judgments. Age differences in phonological processes, contrasted with the relative sparing of semantic processes, suggest a fundamental difference in the cognitive organization of these two abilities. While word retrieval failures reflect a common aspect of aging that affects the vast majority of older individuals, the neural bases of language production in healthy aging has received little attention. Results from our lab have shown significant age-related decline and weaker brain-behavior links underlying phonological aspects of language production. However, the specific aspects of phonological processing that contribute to these retrieval difficulties remains unknown. In the present study, we investigated the influence of lexical factors (phonological and semantic neighborhood density) on the neural basis of word retrieval, with a picture naming task. Prior work has demonstrated that words with larger phonological neighborhoods are produced faster, and the opposite trend has been observed for words with large semantic neighborhoods, particularly for words with salient competitors. However, the neural bases of these effects remain unknown. Preliminary results from an fMRI experiment (N=9), show that naming pictures elicited activation in typical language regions including left inferior frontal gyrus, posterior inferior temporal gyrus, bilateral precentral gyri, and left dorsal medial prefrontal cortex, as well as posterior visual processing regions. Decreases in phonological neighborhood density were associated with increases in activation in bilateral posterior middle temporal gyri, which have been implicated in lexical and phonological selection. In contrast, increases in semantic neighborhood density were associated with increases in activation in bilateral inferior frontal gyrus, and right frontal pole – regions that have previously been associated with semantic selection (LIFG) and general cognitive control (right frontal). These preliminary results suggest that increasing phonological selection demands engage core language regions, and that increasing semantic selection demands engage both language-specific and domain general control regions.

D40 The neural organization of speech production: A lesion-based study of error patterns in connected speech

Brielle Stark[1], Alexandra Basilakos[1], Gregory Hickok[2], Chris Rorden[3], Leonardo Bonilha[4], Julius Fridriksson[1]; [1]University of South Carolina Department of Communication Sciences and Disorders, [2]University of California Irvine

Department of Cognitive Science, [3]University of South Carolina Department of Psychology, [4]Medical University of South Carolina Department of Neurology

Much of what we know about the neural architecture of language production is grounded in studies of single word retrieval. However, when we speak in everyday life, we select two or three words per second from an active vocabulary spanning an estimated 40,000 words (Levelt, 1989) and our word selection is vulnerable to "competition" from multiple sources. While numerous studies have explored single word retrieval, there is a need to evaluate more naturalistic language like the kind of connected speech we produce every day. Indeed, prior behavioral work (Mayer & Murray, 2003; Herbert et al, 2008; Nicholas et al, 1989) suggests that the distribution of paraphasias (word errors) in naming and connected speech differ, likely because connected speech requires dynamic changes in the linguistic system. In the current study, we evaluated the distribution of paraphasias and associated brain damage during a connected speech task and a naming task. 140 participants with left hemisphere stroke and pre-morbid right-handedness were retrospectively included (age: M=60.1±9.75 years; time since stroke: M=49.64±42.92 months). We divided participants into three groups: a group with the connected speech assessment (CS group: N=61, 40 males); a group with the Philadelphia Naming Test (Roach et al, 1996) (PNT group: N=113, 66 males); and a group with both the connected speech assessment and PNT (CSN group: N=34). Connected speech samples were acquired from three picture descriptions (~2 min duration each) and were coded using CHAT/CLAN (MacWhinney, 2000). Presence of aphasia was identified using the Western Aphasia Battery-Revised (Kertesz, 2007). Paraphasias from the PNT and connected speech samples were defined as verbal (semantically related or unrelated), phonemic or neologistic. To evaluate brain damage associated with each paraphasia type, we employed voxelwise lesion-symptom mapping (VLSM; voxelwise $p<0.05$ and cluster $p<0.01$; multiple comparison correction of 5000 permutations) for paraphasias in the CS and the PNT groups. To evaluate behavior, we compared the distribution of paraphasias between tasks in the CSN group. While paraphasias in connected speech and naming shared underlying neural substrates, analysis of their distribution suggested that lexical-semantic load was likely reduced during connected speech. We demonstrated that verbal (real word) paraphasias and phonological paraphasias during both connected speech and naming loaded onto the ventral and dorsal stream of language, respectively. Furthermore, our results supported prior evidence localizing semantically related paraphasias to more anterior left hemisphere temporal cortex and unrelated paraphasias to more posterior temporal and temporoparietal cortex, suggesting a gradient of specificity as one translates visual recognition from temporo-occipital cortex to posterior and subsequently anterior temporal cortex. Only VLSM analyses performed in the CS group, and not the PNT group, found significant brain damage associated with phonological paraphasias, suggesting that connected speech may be a particularly salient task on which to further evaluate lexical-phonological processing in the brain. The results presented here demonstrate a common neural substrate for paraphasias as well as characterize the dynamic processes of the language system occurring during connected speech, confirming the need for continued evaluation of the neural substrates of connected speech processes.

D41 Visual stream semantic priming of reading aloud and lexical decision

Josh Neudorf[1], Chelsea Ekstrand[2], Shaylyn Kress[3], Alexandra Neufeldt[4], Ron Borowsky[5]; [1]University of Saskatchewan, [2]University of Saskatchewan, [3]University of Saskatchewan, [4]University of Saskatchewan, [5]University of Saskatchewan

INTRODUCTION Converging evidence supports a distributed-plus-hub view of semantic processing, in which there are distributed modular semantic sub-systems for processing action, shape, and colour connected to an amodal semantic hub supporting integration of semantic representations (e.g., Patterson et al., 2007). Furthermore, object semantic processing of colour and shape, and lexical reading/decision, are processed mainly along the ventral stream, while action semantic processing, and phonetic decoding, occur mainly along the dorsal stream (e.g., Goodale & Milner, 1992; Borowsky et al., 2007). Priming was used to examine the sharing of the action semantic sub-system with the dorsal-sublexical reading stream, and the visual semantic sub-system with the ventral-lexical reading stream. METHODS In four experiments, participants read prime words that required imagining either the object or action referent in order to semantically prime one of the visual processing streams. In Experiment 1, they then named a lexical word target or sublexical pseudohomophone (PH) target. In Experiment 2, targets were degraded by decreasing the contrast to examine processing at the encoding level (Neudorf et al., 2018 under review). Experiments 3 and 4 were lexical decision tasks (LDTs) using the same primes and target words with either legal nonword (NW; Experiment 3) or PH (Experiment 4) foils. RESULTS In a Linear Mixed Model analysis of reaction time, object priming consistently produced faster reaction times for word targets in reading aloud and the LDT than action priming, reflecting the degree of shared-stream processing between imagined object primes and word targets. The priming effects were similar in size within each type of target, reflecting the degree of amodal priming, with the exception of PH foil LDT (Experiment 4), where action priming was eliminated. In the presence of PH foils, the LDT priming effect size was attenuated relative to the NW foil condition, which was expected given that NW foils allow semantics and phonology to assist with the task, wheras the PH foil condition does not. Additionally, the size of priming was similar between intact and degraded stimulus quality conditions, thus

ruling out encoding as a locus for effects. CONCLUSION The results are consistent with an account of shared-stream processing for word reading and object semantic priming. These findings also support the existence of an amodal semantic hub integrating information from semantic modalities. The prediction that priming would be attenuated with PH foil types compared to NW foil types in LDT was confirmed, supporting the idea that simple prime-target associations in orthography can not completely account for these effects. Priming of naming was not affected by stimulus quality, indicating that priming did not feed back to the level of encoding. This research extends the distributed-plus-hub model (Patterson et al., 2007) to include shared-stream processing advantages for the ventral visual stream, and provides a novel paradigm that we are exploring in functional Magnetic Resonance Imaging. ACKNOWLEDGMENTS/ FUNDING SOURCES: NSERC USRA 2017 and NSERC CGSM 2017/2018 to JN, NSERC CGSD to CE, NSERC Discovery Grant to RB

Meaning: Combinatorial Semantics

D42 Neural evidence for prediction of animacy features by verbs during language comprehension: Evidence from MEG and EEG Representational Similarity Analysis

Lin Wang[1,2], Ole Jensen[3], Gina Kuperberg[1,2]; [1]Department of Psychiatry and the Athinoula A. Martinos Center for Biomedical Imaging, Massachusetts General Hospital, Harvard Medical School, Charlestown, MA, USA, [2]Department of Psychology, Tufts University, Medford, MA, USA, [3]Centre for Human Brain Health, University of Birmingham, Birmingham, UK

INTRODUCTION: Previous studies have shown that people generate probabilistic predictions at multiple levels of linguistic representation during language comprehension [1]. Here, we used MEG and EEG in combination with Representational Similarity Analysis (RSA) to seek neural evidence for the prediction of upcoming animacy features based on a verb's selection restrictions. METHODS: MEG and EEG signals were simultaneously recorded from 32 participants, who read three-sentence scenarios. The final sentence was presented word-by-word (450ms; interstimulus interval: 100ms) and included a verb that either selected for animate features (e.g. "cautioned the…") or inanimate features (e.g. "emptied the…") of its upcoming noun-phrase argument. ANALYSIS AND RESULTS: For each scenario, at all time points between the onset of the verb and the noun, we extracted a spatial pattern of neural activity across all MEG sensors. We correlated this pattern across all possible pairs of animate-predicting and inanimate-predicting verbs, and then averaged the pairwise correlation R-values to yield two time series of R values. Between 450-600ms after verb onset, the pattern of spatial activity was more similar to animate-predicting than inanimate-predicting verbs. A spatial RSA carried out across all EEG channels revealed a similar result: greater spatial similarity to animate-predicting than inanimate-predicting verbs between 550ms and 600ms after verb onset. CONCLUSIONS: These findings suggest that animate-selecting verbs produce a pattern of neural activity that is more consistent than inanimate-selecting verbs. We suggest that this corresponds to the distinct pattern of neural activity previously associated with animate objects [2], which has been successfully decoded from the MEG signal [3]. If so, our findings provide evidence that comprehenders can use the animacy restrictions of verbs to pre-activate the animate features of nouns before their bottom-up input becomes available. Finally, the converging findings across MEG and EEG suggest that spatial RSA can be carried out using both techniques. References [1] Kuperberg, G. R., & Jaeger, T. F. (2016). Language, cognition and neuroscience, 31(1), 32-59. [2] Grill-Spector, K., & Weiner, K. S. (2014). Nature Reviews Neuroscience, 15(8), 536. [3] Cichy, R. M., Pantazis, D., & Oliva, A. (2014). Nature Neuroscience, 17(3), 455.

D43 Single trial analysis of EEG elicited by expected and implausible words in sentences

Seana Coulson[1], Megan Bardolph[1], Cyma Van Petten[2]; [1]UC San Diego, [2]Binghamton University

To gauge the sensitivity of the scalp recorded brain response to lexical retrieval versus integration, the present study utilized a regression-based approach to predict the amplitude of single trial EEG to words in sentences during time windows associated with the N400 and LPC. Unlike previous studies focused on highly constraining sentences, here we explore the full range of constraint. To help dissociate retrieval from integration, we utilized plausibility ratings (integration), and two corpus-derived measures of semantic similarity, contextual LSA and best completion LSA (retrieval). LSA (latent semantic analysis) represents the similarity between the sentence-final word and either the words in the sentence frame (contextual LSA), or, the sentence final word and the expected ending (Best Completion LSA). EEG was recorded as healthy adults read sentence frames such as "Gary doesn't think a husband should cheat on his", that ended either with the best completion (BC), such as "wife," or an implausible ending (Implausible), such as "cement". Participants' task was to answer comprehension questions following 25% of the sentences. Sentences ranged in constraint from 2-100%, and were divided into categories via a median split. Conventional ERP analyses involved mean amplitude measurements of ERPs 300-500ms post-onset over central-parietal electrodes (N400), and 600-900ms at six frontal and central-parietal electrodes (LPC). Relative to BC, Implausible endings elicited more negative N400 [Ending x Electrode, $p<0.001$], and more positive LPC [Ending x Anteriority, $p<0.01$]. Independent of the Ending effect, critical words elicited more positive LPC in low than high constraint sentences. Single trial N400 data in each condition were analyzed via linear mixed effects models with random intercepts for subjects (n=26) and for items (n=280). The initial model included factors of cloze

probability, constraint, plausibility, contextual LSA, and (for Implausible endings) Best Completion LSA. Model comparison suggested the BC condition was predicted by cloze probability (F = 5.95), contextual LSA (F = 3.18), and their interaction (F = 7.60). Among high constraint sentences, N400 amplitude was an inverse function of cloze probability, with the most predictable endings eliciting the most positive (least negative) N400; among low constraint sentences (cloze < 0.5), contextual LSA improved the model as words more similar to their sentence contexts elicited less negative N400. Thus corpus-derived measures of a word's contextual fit can capture variance among low constraint sentences that goes undetected by the cloze task, and indicate N400 amplitude is sensitive to contextual fit. N400 to Implausible completions was related to Best Completion LSA (the similarity of the final word to the best completion ending). As Best Completion LSA increases, the N400 elicited by Implausible endings was less negative. Results are argued to support a context-sensitive retrieval process underlying the N400. For the LPC in the BC condition, the only significant predictor was cloze probability. The more predictable a word was, the more positive the LPC. For the LPC in the Implausible condition, the only significant predictor was plausibility (F=4.51). The more implausible the ending, the larger the LPC. Results are consistent with the suggestion that LPC indexes lexical integration.

Meaning: Discourse and Pragmatics

D44 Negation, prediction and truth-value judgments: evidence from ERPs

Maria Spychalska[1], Viviana Haase[2], Jarmo Kontinen[2], Markus Werning[2]; [1]University of Cologne, [2]Ruhr University Bochum

Prediction has been shown beneficial in various cognitive domains and argued to play a key role in linguistic comprehension [1,2]. Predicting sentence continuation as it unfolds seems straightforward in the case of affirmative sentences, but it is less clear how negation modulates prediction. First, it is generally more difficult to predict something that is absent. Second, the time-course of integrating negation into the semantic representation of a sentence is still not well-understood. In our experiments we investigated how negation affects predictive processing. To this aim we compared the modulation of the N400 component in true and false, affirmative and negative sentences, such as "Julia has chosen/not chosen the plum". The N400 was time-locked to the presentation of content nouns (e.g. "plum"), whose cloze probability in a sentence was a function of the presented context scenario, i.e. of whether the scenario provided alternative referents that could be mentioned in the sentence. The scenarios contained three cards depicting three different objects, one or two of which were then selected (framed green) or rejected (framed red) by a virtual player. After the cards were marked, an affirmative or negative sentence (in German) was presented phrase-by-phrase: "X hat (nicht) den/die/das Y ausgewählt" ("X has (not) chosen Y"). In the first round of the experiments, all stimuli sentences provided a true description of the scenario (fillers of the opposite truth-value were added), while in the second round, all stimuli sentences gave a false description of the scenario. In the unique conditions, there was only one object that could complete a true (respectively false) sentence, i.e. one selected object in the affirmative condition or one rejected in the negative condition. In the multiple conditions, there were two alternative objects that could complete a true (respectively false) sentence. It is well-established that the N400 is inversely correlated with the cloze probability of the triggering word. Our model assumes that the processor has to split the probability weights between the number of alternative objects available in the scenarios, leading to lower probability weights for objects that are presented with alternatives, and furthermore that the expected probability is higher for those objects that make the sentence true (truth-makers) rather than false (false-makers). In line with these assumptions, we observed larger N400 ERPs for words of lower probability weights (multiple conditions) than for words of higher probability weights (unique conditions), both for affirmative and negative sentences. This effect indicates that the processing of the unique referent is facilitated relative to the case where multiple referents are available in the scenario. Additionally, we observed a sustained positivity effect for the negative compared to affirmative conditions, which indicates possible reanalysis mechanisms related to the processing of negation. The effects were similar for true and false sentences: for true sentence the presence of multiple truth-makers increases the N400 amplitude, for false sentences it is the presence of multiple false-makers that increases the N400 amplitude.

[1] Kuperberg and Jaeger. Language, Cognition, and Neuroscience, 2015. [2] Van Petten and Luka. International Journal of Psychophysiology, 2012.

D45 The neural basis of shared discourse: fMRI evidence on the relation between speakers' and listeners' brain activity when processing language in different states of ambiguity

Karin Heidlmayr[1,2], Kirsten Weber[1,2], Atsuko Takashima[1,2], Peter Hagoort[1,2]; [1]Max Planck Institute for Psycholinguistics, Wundtlaan 1, 6525XD Nijmegen, The Netherlands, [2]Donders Institute for Brain, Cognition and Behaviour, Radboud University, 6500 HB Nijmegen, The Netherlands

In natural language use, information is exchanged between speakers and listeners seldom in the form of isolated words or sentences, but usually in the frame of larger discourse contexts, such as narratives or expository texts. To create and understand meaning in a discourse, links between successive utterances within the text, but also with world-knowledge beyond the discourse have to be made. The goal of the present study was to identify the neural bases of meaning construction between speakers and listeners when processing naturalistic texts. The

successful exchange of conceptual information between speakers and listeners requires a balance between new information (uncertainty, entropy) and previously known information (redundancy). However, in suboptimal conditions, uncertainty can be exceedingly high, e.g. if within-text information is ambiguous and background information insufficient, leading to the listener's lack of understanding of the utterance. Thus, in the present fMRI pseudo-hyperscanning study, we aimed at investigating how the amount of given contextual information influences the understanding of ambiguous discourse. Critically, to assess the neural activity related to the sharing of meaning between interlocutors, i.e. the conceptual pact, the relationship of the neural activation associated with meaning creation between the speakers and listeners was assessed. An fMRI experiment using a variant of the ambiguous text paradigm (Dooling & Lachman, 1971; Bransford & Johnson, 1972) was designed, i.e. conceptually ambiguous expository texts were presented with preceding contextual information that in some cases did and in others did not facilitate the extraction of a coherent meaning. Ten speakers produced ambiguous texts preceded by a highly informative title in the scanner and 18 listeners subsequently listened to these texts, preceded by either a highly informative, intermediately informative (highly/intermediately informative title conditions) or no title at all (non-informative condition). Shared conceptual processing was expected to be reflected by neural coupling that varied with comprehension-relevant contextual information, while linguistic and sensory information was equal across conditions. BOLD activation analyses as well as inter-subject correlation (ISC) analyses (Hasson et al., 2004) between the speakers' and the listeners' BOLD time courses were carried out. Besides a strong involvement of the left-lateralized language network (Hagoort, 2017) in all three conditions, preliminary BOLD data revealed activation of the left dorso-medial prefrontal cortex in the highly informative title condition, indicating its role in establishing text coherence. Moreover, ISC analyses showed an alignment between speakers' and listeners' BOLD time courses in medial frontal and parietal regions when ambiguous texts were preceded by a highly or intermediately informative title. In the absence of a title, no such alignment was found. These regions overlap with parts of the default-mode network (Fox & Raichle, 2007) and have previously been suggested to play a role in integrating information over larger time scales when processing discourse (Ferstl et al., 2008; Simony et al., 2016). The present data indicate that the construction of coherent meaning and the representation of situation models in discourse rely on the involvement of medial parietal and frontal regions, which show alignment in the BOLD activation across interlocutors who share discourse information.

D46 Anatomical connectivity and conversational impairments in patients who suffered from a moderate to severe traumatic brain injury

Karine Marcotte[1,2], Simona Maria Brambati[2,3], Erlan Sanchez-Gonzalez[1,2], Caroline Arbour[1,2], Christophe Bedetti[3], Nadia Gosselin[1,3]; [1]Centre de recherche du CIUSSS du Nord-de-l'île-de-Montréal (Hôpital du Sacré-Cœur de Montréal) Montréal, Quebec, Canada., [2]Université de Montréal, [3]Centre de recherche de l'Institut Universitaire de Gériatrie de Montréal, Montréal, Québec, Canada.

Background Patients who suffered from a moderate to severe traumatic brain injury (TBI) often present significant long-term cognitive impairments in multiple domains including communication skills. Given the diffuse nature of the pathology, attributing communication deficits to a specific area in the brain can be difficult. Initial structural imaging is considered a good clinical tool for detecting focal lesions, that are mostly localized in the ventral and polar frontal regions and in the anterior temporal lobes. However, diffuse axonal injury may not be apparent on conventional imaging techniques and thereby, may limit its prognostic value. Despite the functional significance of the communication impairments following traumatic brain injury (TBI), language related fiber bundles have not been investigated with regards to communication skills. The aim of this study was to determine the role of the major white matter fiber bundles reconstructed using anatomically-constrained probabilistic high angular resolution diffusion imaging (HARDI)-based tractography in patients presenting chronic communication impairments following TBI. Methods In the present study, 15 moderate to severe TBI patients were compared to 15 healthy controls. Diffusion magnetic resonance imaging (dMRI) was conducted on a 3T Siemens Trio scanner using the following parameters: eight-channel coil, 65 noncollinear directions with a b=1000 and one unweighted image (TR=9500 ms, TE=93 ms, 120 X 120 matrix, 240 mm FOV, 2 mm slice thickness). Diffusion tensor estimation and corresponding fractional anisotropy (FA) map generation were done using MRtrix3. Fiber orientation distribution function was computed using the spherical deconvolution of the single fiber response. Then, we used a whole brain tractography algorithm that was randomly seeded in a FA mask. Based on the FreeSurfer parcellation, the Tract-Querier, a novel open-source tool, was used to extract fiber bundles known for their role in language (left arcuate fasciculus, inferior longitudinal fasciculus, uncinate fasciculus) as well as the genu and splenium of the corpus callosum, known to be particularly vulnerable to TBI. Fractional anisotropy (FA), radial diffusivity (RD), number of fiber orientation (NuFO) and volume were extracted from each tract. Conversational skills were evaluated using the Protocole Montreal Evaluation de la Communication. Results Chronic TBI patients present with persistent conversational impairments. TBI patients showed lower FA and NuFO than the control group in the language-related

fiber bundles and both subparts of the corpus callosum as well as higher RD in the language-related bundles. Most importantly we found a negative correlations between conversational scores and RD in the left arcuate fasciculus whereas significant correlations were found between the Glascow score in the emergency room and FA in the left inferior longitudinal fasciculus. Conclusion These results provide evidence that conversational impairments in TBI patients are associated with structural lesions to the left arcuate fasciculus, which suggest that the measures extracted from this bundle could predict long-term conversational outcome in TBI patients. Further research regarding the longitudinal evolution between acute, subacute and chronic changes in white matter structural changes and recovery of communication skills could help defining a more specific prognostic of communication impairments for moderate to severe TBI patients.

D47 Prior experience modulates electrophysiological responses to novel metaphorical language.

Rafal Jonczyk[1,2], Gül E. Kremer[3], Zahed Siddique[4], Janet G. Van Hell[1]; [1]Pennsylvania State University, USA, [2]Adam Mickiewicz University, Poland, [3]Iowa State University, USA, [4]University of Oklahoma, USA

Novel metaphorical language use signifies the incredible human ability to produce meaningful linguistic expressions that have never been heard before, coloring communication. This, however, may come at a price of increased comprehension costs in readers or listeners who need to integrate information from semantically distant concepts. Indeed, electrophysiological research has demonstrated that novel metaphor comprehension may be more effortful than literal language but less effortful than nonsense language (Goldstein et al., 2012; Rataj et al., 2017; Rutter et al., 2012). Little is known, however, if this processing effort may be modulated by prior experience and knowledge about the world. To this end, we collected electrophysiological responses to literal, nonsense, and novel metaphorical sentences that were referring either to engineering knowledge (e.g., The wind tickled the turbine) or to general knowledge (e.g., The earthquake inhaled the city), testing engineering (n=20) and non-engineering (n=24) students. Sentences differed in verb only and were classified in prior norming studies (n = 65) as highly unusual and highly appropriate (novel metaphors), low unusual and highly appropriate (literal sentences), and highly unusual and low appropriate (nonsense sentences). In the EEG/ERP experiment, participants read sentences and then judged the sentences' unusualness and appropriateness. Ongoing EEG was time-locked to the verb and to the final word to assess the early and late stages of sentence comprehension. The results reveal an increased N400 to novel metaphors and nonsense sentences relative to literal sentences at the early sentence processing stage (verb position) for both participant groups. At the later, sentence-final stage, the N400 amplitude is most pronounced for nonsense sentences, followed by novel metaphors and then literal sentences. This N400 modulation follows the pattern reported in the literature (e.g., Rataj et al., 2017; Rutter et al., 2012), and here it is also not sensitive to prior knowledge modulation as indexed by comparable N400 in both participant groups. Notably, however, prior knowledge seems to effectively modulate novel metaphor processing at the meaning re-analysis stage, indexed by the Late Positive Complex (LPC) component of ERPs. Specifically, novel metaphors embedded in engineering context lead to decreased LPC amplitudes compared to non-engineering novel metaphors in engineering students only, suggesting less effortful re-evaluation of novel engineering metaphors in engineering students. This modulation is reversed for non-engineering students, with engineering metaphors evoking increased LPC amplitudes compared to literal sentences, suggesting more effortful re-analysis of novel engineering metaphors in non-engineering students. These results provide novel evidence demonstrating that prior experience modulates electrophysiological responses to novel metaphorical language. References: Goldstein, A., Arzouan, Y., and Faust, M. (2012). Killing a novel metaphor and reviving a dead one: ERP correlates of metaphor conventionalization. Brain Lang. 123, 137–142. Rataj, K., Przekoracka-Krawczyk, A., and Lubbe, R.H.J. van der (2017). On understanding creative language: the late positive complex and novel metaphor comprehension. Brain Res. Rutter, B., Kröger, S., Hill, H., Windmann, S., Hermann, C., and Abraham, A. (2012). Can clouds dance? Part 2: an ERP investigation of passive conceptual expansion. Brain Cogn. 80, 301–310.

Language Therapy

D48 Sensorimotor Strategies for the Improvement of Naming Abilities in Aphasia: Neural and Behavioral Correlates of POEM – Personalized Observation, Execution, and Mental Imagery Therapy in two participants with verb anomia

Edith Durand[1,2], Pierre Berroir[1,3], Ana Inés Ansaldo[1,2,3]; [1]Centre de Recherche de l'Institut Universitaire de Gériatrie de Montréal CRIUGM, Canada, [2]Ecole d'orthophonie et d'audiologie, Faculté de médecine, Université de Montréal, Canada, [3]Université de Montréal et Ecole polytechnique, Institut de génie biomédical, Canada

Anomia is the most frequent and pervasive symptom for people with aphasia (PWA) and can affect all grammatical categories. Research has long focused on noun retrieval, while therapies targeting verb anomia remain scarce. This is somewhat surprising, considering the central role of verbs in sentence and speech production. Single word retrieval therapy for verbs is effective across different approaches, namely therapies based on sensorimotor strategies. However, this kind of therapy has been rarely explored. This study reports on the efficacy of Personalized Observation, Execution, and Mental Imagery (POEM) therapy, a new approach designed to integrate sensorimotor and language-based strategies to treat verb

anomia, a frequent aphasia sign. Two participants with chronic aphasia and verb anomia were followed up in a pre-/post-therapy fMRI study. Tests of language and cognitive functions were completed. A personalized set of stimuli was built based on the naming performance on baseline and controlled for linguistic variables. POEM was administered in a massed stimulation schedule: three one hour-sessions per week over five weeks. Both participants benefited from POEM, with improvements observed with both trained and untrained items. Concurrently with the behavioral improvement, changes in the neural substrates sustaining verb naming were observed for both participants, with distinctive activation patterns, reflecting a reduction in the number of recruited areas supporting recovered naming, and the recruitment of brain areas, part of language and mirror neuron systems. In sum, the evidence suggests that structured anomia treatment integrating sensorimotor strategies can improve word retrieval of treated and untreated verbs. In particular, POEM' is the first to show generalization of therapy effects to untreated verbs in two cases, which suggests that POEM favors the implementation of sensorimotor-based word-retrieval strategy that can be generalized to untrained items. This sensorimotor strategy resulting from POEM is also witnessed by the post-intervention activation pattern observed in the two participants, who showed for P1 significant activation of premotor cortex being part of the sensorimotor circuit, and for P2 significant activation of cerebellum and middle temporal gyri, known to participate namely in semantic processing and verb generation. The activation patterns are consistent with the sensorimotor nature of POEM and therefore is likely to have been therapy-induced. Finally, the fact that a reduction in the number of brain areas supporting correct naming was observed following therapy suggests that POEM leads to more efficient use of brain resources. To conclude, behavioral and functional neuroimaging data provide preliminary evidence on the effects of POEM to treat verb anomia, and highlight the added value of combined language and sensorimotor strategies in contributing to consolidate a word-retrieval strategy that can be better generalized to untrained words. Future studies with a larger sample of participants are required to further explore this avenue.

Language Disorders

D49 Dissociable thalamo-cortical network disruption explains language, motor and sensory deficits after stroke

Anika Stockert[1], Sophia Hormig[1], Max Wawrzyniak[1], Mandy Pirlich[1], Stefan Schob[1], Dorothee Saur[1]; [1]University Clinic of Leipzig, Germany

Background: Besides motor and sensory symptoms thalamic stroke can cause deficits in several cognitive domains including aphasia that resembles cortical stroke. Based on structural (pre-) frontal and parietal connectivity motor and sensory functions have been linked to the ventral lateral/anterior (VL/VA) and the ventral-posterior lateral/medial (VPL/VPM) thalamic nucleii respectively (Behrens et al. 2003, Lambert et al. 2017). Similarly, thalamic nuclei that connect to the left frontal, parietal and temporal cortex, namely VL/VA nucleus, pulvinar (PUL), medial geniculate (MG) and lateral posterior (LP) nucleus have been associated with language (Barbas et al. 2013, Hackett et al. 1998). Aim: To date, no systematic analysis has been conducted to explore the functional specificity of particular thalamic nuclei in causing clinical stroke symptoms. Alternativly to a non-overlapping, dissociable lesion-symptom association with thalamic nuclei, overlapping thalamic regions may play a multifunctional role in processing motor, sensory as well as language information. Therefore lesion-functional network associations with cortical motor, sensory or language networks could give a more comprehensive view on how thalamic stroke causes different stroke symptoms. Method: In 74 patients with thalamic stroke we combined a voxel-based lesion-symptom mapping (VLSM) and lesion-network symptom mapping (LNSM) approach (Boes et al. 2015, Wawrzyniak et al. 2018). Information on the presence of motor, sensory or language symptoms was taken from the patients' records. Firstly, non-parametric voxel-wise analysis was performed to examine the relationship between lesion location and motor, sensory or language symptoms. Secondly, lesion-dependent network connectivity (LNC) was identified based on normative functional connectome data (NKI Rockland Sample) to study the association between thalamo-cortical networks affected by a thalamic lesion and these symptoms. Results: The analyses revealed that (i) lesion affecting the right VL led to left motor symptoms, (ii) lesions in the right VPL/VPM resulted in left sensory symptoms and (iii) overlapping lesion in the left VPL/VPM were concomitantly linked with right motor and sensory symptoms, while (iv) lesion in left VL and PUL were significantly associated with aphasic symptoms. LNSM revealed that language symptoms were associated with higher normative LNC to left superior temporal and fusiform gyrus. In contrast right sensory symptoms were linked to lesions that showed higher LNC to left parietal cortex and right motor symptoms were associated with higher prefrontal LNC. Conclusions: These findings suggest specificity of thalamic nuclei and associated functional thalamo-(sub-)cortical networks for language as compared to sensory and motor networks.

D50 Effects of active and sham tDCS on lexical decision in three persons with chronic aphasia

Rachael M. Harrington[1], Simone R. Roberts[1,2], Lisa C. Krishnamurthy[1,2,3], Venkatagiri Krishnamurthy[2,3], Amy D. Rodriguez[3], Keith M. McGregor[2,3], Marcus Meinzer[4], Bruce Crosson[1,2,3]; [1]Georgia State University, Atlanta, GA, USA, [2]Emory University, Atlanta, GA, USA, [3]Atlanta VAMC, Decatur, GA, USA, [4]University of Queensland, Herston, QLD, AU

Introduction: Noninvasive brain stimulation can be used to improve language recovery after stroke. It is unclear how tDCS montage should be selected based on task demands and individual patient profiles. Here we present performance differences on a lexical-decision task during sham and active tDCS in three patients with unique lesion profiles. Methods: 3 native-English speaking adults with chronic aphasia were enrolled in the study. MPRAGE were collected from each patient (Siemens Prisma 3T (TR=2530 ms, TE=2.96 ms, 1 mm slice thickness)). In the scanner, patients performed an auditory lexical decision task in which they indicated via button press whether the stimulus was a real word or nonword. Real words were balanced for number of syllables, frequency, category, and number of phonemes, and nonwords were created from this set. In two separate sessions, patients performed the lexical decision task under sham or active tDCS (NeuroConn, DC-Stimulator MC4 4-channel) with the cathode over F8 and the anode over F7. Accuracy and reaction time data were collected in E-Prime. The MPRAGE images were twice warp-transformed into MNI152 space using LINDA and proprietary algorithms. Lesion size was determined in mricron and lesions were overlaid on the Harvard-Oxford cortical and subcortical structural atlases and the 1 mm JHU white-matter tractography atlas to determine lesion location. Results: QED03, a 66-year-old male with mild nonfluent aphasia had a total lesion volume of 39.38 cc and large areas of the lesion occupied pars opercularis (pOp) (31.1%), pars triangularis (pTr) (15.1%), Heschl's gyrus (12.4%) and anterior superior temporal gyrus (aSTG) (1.7%). On the lexical decision task, QED03's response time decreased for both nonwords and real words in the active tDCS condition. Accuracy, however, worsened when discriminating nonwords but improved for discriminating real words. QED05, a 59-year-old male with mild fluent aphasia had a smaller lesion with a total lesion volume of 3.73 cc. This lesion occupied only 3.6% of pOp. In the active tDCS condition, response time decreased for nonwords and increased for real words while accuracy improved for nonwords but decreased for real words. QED06, a 55-year-old male with moderate nonfluent aphasia had a lesion volume of 0.7 cc. This lesion occupied 1.4% of aSTG. In the active tDCS condition, accuracy and response time worsened for discriminating nonwords and real words. Discussion: Task demands and lesion profiles may interact in these outcomes. In this montage, excitability of cortex under anode increases in left frontal areas and decreases in right homologue. Patients with lesions in left frontal gyrus improved on some aspect of the task while the patient with more posterior lesion worsened on the task in the active tDCS condition. After increasing IFG excitability in the lesioned hemisphere, performance associated with the lesioned area improved. The selected montage, however, likely did not affect posterior excitability and excitation of left hemisphere pTr may have prevented balanced activation of the nonlesioned area. We hypothesize that task sensitivities and individual aphasia/lesion profiles may influence findings and should be further examined with this and other montages.

D51 Rethinking Effects of White Matter Tract Disconnection on Post-Stroke Language Impairment

Jason Geller[1], Melissa Thye[1], Daniel Mirman[1]; [1]University of Alabama-Birmingham

Background : Lesion-symptom mapping studies have generally focused on associations between behavioral deficits and grey matter damage, though there is also recognition that white matter damage contributes to language impairment following left hemisphere stoke. White matter damage can be measured with a continuous variable (i.e., percentage of the white matter tract that has been destroyed by the lesion, known as "lesion load") or a binary variable – whether the lesion has severed the tract producing a structural disconnection. Recently, Hope et al (2016) demonstrated that high lesion load does not always lead to white matter tact disconnection, and vice versa. Further, Hope et al. found that a simple binary estimate of structural disconnection explained more of the variance in fluency and naming scores than did lesion load. In the current study, we attempt to replicate and extend this finding by examining lesion load and tract disconnection in three white matter tracts that have been implicated in language processing: arcuate fasciculus, uncinate fasciculus, and inferior fronto-occipital fasciculus (IFOF) using a different sample of stroke patients and language measures. Method: Behavioral and structural neuroimaging data for 128 participants with aphasia following left hemisphere stroke were drawn from a large-scale study. We examined the effect of lesion load and tract disconnection on overall aphasia severity (Western Aphasia Battery – Aphasia Quotient), picture naming (Philadelphia Naming Test), and composite measures of speech production ability (word and nonword repetition, phonological errors in picture naming, etc.) and semantic cognition (Camel and Cactus Test, synonym judgments, semantic category discrimination, Peabody Picture Vocabulary Test, etc.). The composite measures were based on a factor analysis closely related to prior work that captured the independent sub-systems of language. The white matter tracts were taken from the tractography atlas published by Thiebaut de Schotten et al. (2011). Lesions and tracts were spatially normalized to the same stereotaxic space (MNI). Registration and calculation of lesion load and tract disconnection were conducted using the ANTsR package in R. Results: Regression analyses were conducted for lesion load and tract disconnection in each white matter tract. For each language score, we performed forward and backward selection to determine the best fitting regression model. Lesion load damage to the arcuate fasciculus significantly predicted speech production deficit severity and overall aphasia severity, and damage to the IFOF predicted semantic deficit. However, lesion load in the uncincate did not predict any of the language

outcomes. Tract disconnection did not predict any of the language scores. Conclusion: In contrast to Hope et al., lesion load in the arcuate fasciculus and IFOF were predictive of language impairment, but structural white matter disconnection was not. Our results are consistent with a graded disconnection model in which white matter tract effectiveness is related to the overall integrity of the tract. It is also possible that aligning lesion images with a tractography atlas provides a viable estimate of graded tract damage but is not precise enough to reliably estimate tract disconnection, which may require direct individual measurements of white matter integrity.

D52 Formulaic language in bilingual individuals with Parkinson's Disease: A comparison with healthy controls

Binna Lee[1,2], Diana Van Lancker Sidtis[1,2]; [1]New York University, [2]Nathan Kline Institute for Psychiatric Research, Orangeburg, NY

INTRODUCTION Previous studies reported an impoverished production of formulaic language in natural production for English speakers diagnosed with Parkinson's Disease (Bridges et al., 2013; Sidtis, 2012; Sidtis et al., 2015). These findings, which substantiate the notion of subcortical involvement in the modulation and processing of fixed expressions, probed monolingual speakers with Parkinson's Disease (PD) only. Little is known regarding how language performance in two languages might be manifested in PD. The current study aims to explore whether formulaic language performance will differ across the first (L1) and second language (L2) in bilingual speakers with PD. METHOD Participants: Korean-English bilinguals with PD (B-PD group) and matched healthy bilingual controls (B-HC) participated in the study. A group of native speakers of American-English served as an additional healthy control group (English healthy control: E-HC) to determine the extent of L2 competency in the bilingual speakers. Participants in both B-PD and B-HC groups were immigrants in the US and late bilinguals, acquiring Korean as L1 (at birth) and English as L2 (after puberty). Each group consisted of 11 participants and were closely matched on gender, approximate age, and years of education. For the bilingual groups with and without PD, L2 proficiency was controlled for based on a comprehensive language questionnaire and a word translation test in both languages. Procedures: All participants performed three structured tasks and a spontaneous production task. The structured tasks involved auditory picture-matching (comprehension task), retrieval of formulaic expressions with cueing (sentence completion task), and implicit/explicit knowledge on the form of formulaic sequences (judgment-correction task). For each structured task, scores were obtained by calculating percent accuracy. To assess spontaneous production, a conversational speech sample was recorded and transcribed. The proportion of formulaic expressions in each sample was obtained for each participant. Comparisons were made across languages (L1 vs L2) and across groups. RESULTS Findings revealed a significant impairment in both comprehension and production of formulaic language in L1 in the B-PD group when compared with B-HC. Specifically, B-PD scored significantly lower on the auditory picture-matching test in L1 when compared with B-HC. Also, in the conversational sample, B-PD demonstrated significantly reduced proportions of formulaic expressions in L1 than B-HC. There was no difference between B-PD and B-HC regarding the completion task and judgment-correct test in L1. Regarding L2 (English), B-PD performed similarly to B-HC in all tasks, including spontaneous production. When comparing the English performance of both B-PD and B-HC to E-HC group, as expected, the native speakers of English exceeded performance on all three structured tasks. Interestingly, for English production, the proportion of formulaic language was similar across the three groups. DISCUSSION/CONCLUSION The results of this study contribute to the growing body of literature on the impoverishment of formulaic language production following subcortical dysfunction. Additionally, findings here demonstrate a selective impairment of formulaic language in L1 but not L2, further supporting a proposal of L1 implicit language processing relating to basal ganglia. The current study provides a basis for future studies on subcortical lesions associated with bilingualism and language deficits.

D53 Functional contribution of the arcuate fasciculus to language processing: A tractography study in individuals with stroke

Maria V. Ivanova[1,2], Allison Zhong[1], And Turken[1], Brian Curran[1], Nina F. Dronkers[1,3,4]; [1]Center for Aphasia and Related Disorders, VA Northern California Health Care System, Martinez, California, USA, [2]National Research University Higher School of Economics, Center for Language and Brain, Moscow, Russian Federation, [3]University of California, Davis, California, USA, [4]University of California, Berkeley, California, USA

Damage to the arcuate fasciculus (AF) has been linked to deficits of various language abilities: speech fluency, informative content of speech, sentence production, naming, repetition and comprehension at the word and sentence level (Breier et al., 2008; Hope et al., 2016; Ivanova et al., 2016; Kümmerer et al., 2013; Marchina et al., 2011; Wilson et al., 2011). Although there are single reports of excellent recovery from aphasia even following complete disruption of the AF (Gyu & Ho, 2011), the bulk of evidence strongly suggests that the AF is critical for language. What remains to be determined is its specific functional contribution to various language capacities. The current study aims to provide a comprehensive evaluation of the functional role of the AF in language, based on different anatomical models of the tract in both ipsilesional and contralesional hemispheres in a large cohort of individuals with chronic aphasia. METHODS: Patients with aphasia (n=33) following left hemisphere stroke participated in the study. Language abilities were tested

with the Western Aphasia Battery – Revised (WAB-R, Kertesz, 2007). Diffusion-weighted MR imaging was performed on a 3T scanner (64 directions, 2 mm isovoxel, b = 2000 s/mm2, 10 b0 volumes). After pre-processing in FSL and ExploreDTI, tractography based on the spherical deconvolution model was performed using StarTrack. The AF in the left and right hemispheres were then manually reconstructed in TrackVis using a modified 3-segment model (Catani et al, 2005), with a long segment connecting inferior frontal areas with posterior temporal, and two short segments that connect frontal and temporal areas to inferior parietal cortex, and a modified 2-segment model (Glasser & Rilling, 2008), that includes two long segments originating from the superior temporal gyrus (STG) and the middle temporal gyrus (MTG) and both extending into the frontal lobe. The normalized volumes of the different segments of the AF were correlated with scores on different language subtests of the WAB-R while controlling for age, lesion volume, time post-onset and gender. RESULTS: In the left hemisphere, according to the 3-segment model of the AF, the long segment was strongly associated with all WAB-R subtests, including fluency, spontaneous speech, comprehension, repetition, and naming. The anterior short segment was only associated with fluency, while the posterior short segment was associated with comprehension, repetition and naming. According to the 2-segment model, the AF originating from STG was associated with repetition, while the AF originating from MTG was associated with fluency, spontaneous speech, repetition and naming. No significant relationships were observed between volume of the AF segments in the right hemisphere and residual language deficits. SUMMARY: The current study constitutes a thorough evaluation of the AF after stroke, revealing specific linguistic impairments associated with different segments of the tract. For the first time the 3-segment model of the AF was comprehensively evaluated in both hemispheres. This was also the first study of language deficits in stroke to utilize the 2-segment model by Glasser and Rilling. Results indicate critical contributions of different parts of the AF to language comprehension and production.

D54 Neural plasticity and right hemisphere contributions to recovery of sentence comprehension in aphasia: evidence from sentence processing treatment

Elena Barbieri[1], Jennifer E. Mack[1], Brianne M. Chiappetta[1], Eduardo R.H. Europa[1], Cynthia K. Thompson[1]; [1]Northwestern University

Many studies have shown evidence of language recovery and associated neural changes in both the ipsilesional (typically left hemisphere (LH)) and contralesional (right hemisphere (RH)) in chronic post-stroke aphasia (see [1] for a review). A prevailing debate, however, concerns the suitability of tissue within the RH versus LH to support recovery. Some suggest that recruitment of undamaged tissue in the LH results in better recovery [2], with that in the RH reflecting maladaptive neural plasticity, associated with poor recovery [3]. Whereas, others have shown that RH recruitment, particularly within regions homologous to LH language networks, is associated with good recovery [4,5]. The present study examine neural plasticity within both the LH and RH following a 3-month language treatment that targeted production and comprehension of passive sentences (Treatment of Underlying Forms [6]). The study included 18 individuals with chronic stroke-induced aphasia, who were randomly assigned to receive treatment (N=13) or to serve as control participants (N=5). Prior to and following the treatment/control period, all participants' comprehension and production of trained sentences, as well as untrained related and unrelated structures was tested. Participants also performed a block-design sentence-picture verification fMRI task, in which comprehension of active and passive sentences was alternated with blocks of a control condition (scrambled picture presented with reversed speech) and an eyetracking task evaluating on-line processing of active and passive sentences. Results showed significant improvement in comprehension and production of trained passive sentences ($p<.001$), as well as generalization to untrained related structures ($p<.001$) in the treatment group, but not in the control group. Patterns of eye movements during processing of passive sentences also showed emergence of an agent-first strategy for the treated, but not the untreated participants. Neuroimaging data showed upregulation within the LH middle frontal gyrus, RH inferior frontal gyrus, and the superior parietal lobule (bilateral) only in the treatment group, whereas both participant groups showed upregulation within the RH anterior supramarginal gyrus. In addition, region-of-interest (ROI) analyses revealed a positive relation ($p=.029$) between treatment outcomes in comprehension and upregulation in the RH homologue of regions within the sentence processing network [7], but no relation between behavioral gains and activation in regions within a non-linguistic control network (the dorsal attention network). These findings indicate that the RH contributes to the restoration of both offline and on-line processing of complex sentences in chronic aphasia, and provide evidence that RH homologous of language networks, rather than domain-general systems, support recovery [8]. References [1] Hartwigsen, G., & Saur, D. (2017). NeuroImage. [2]. Fridriksson, J., et al. (2012). NeuroImage, 60(2), 854-863. [3]. Heiss, W.D. & Thiel, A. (2006). Brain and Language, 98(1), 118-123. [4]. Kiran, S., et al. (2015). Frontiers in Human Neuroscience, 9. [5]. Thompson, C.K., et al. (2010). Neuropsychologia, 48(11): 3211-3227. [6]. Thompson, C.K., & Shapiro, L.P (2005). Aphasiology, 19(10-11), 1021-1036. [7]. Walenski, M., et al. (submitted). Human Brain Mapping. [8]. Geranmayeh, F., et al. (2014). Brain, 137(10), 2632-2648.

D55 Picture description versus picture naming: assessing language deficits following dominant hemisphere tumour resection.

Sonia Brownsett[1,2], Kori

Ramajoo[1,2], Katie McMahnon[3], Hanna Gauvin[1,2], Greig de Zubicaray[1,2]; [1]Faculty of Health, School - Psychology and Counselling, QUT, [2]Institute of Health Biomedical Innovation, QUT, [3]Faculty of Health, School - Clinical Sciences, QUT

'Picture description' is a valuable clinical tool that is often quicker and easier to complete with patients than impairment-based assessment. In both neurodegenerative disease and post-stoke aphasia, picture-description has been shown to be sensitive to language difficulties (1, 2) and is an excellent predictor of residual language skills in post-stroke aphasia (3,4). Prior to dominant-hemisphere tumour resection, rapid assessment of speech and language skills is essential to informing clinicians of the risk of surgically induced aphasia following removal of eloquent tissue. In addition to the debilitating impact of aphasia on social and financial well-being, McCirt and colleagues (5), suggested that surgically induced aphasia can also impact on survival rates. It is therefore, imperative that surgical planning aims to avoid inducing such deficits and also establishes a baseline assessment of pre-surgical language function in order to accurately report consequences of surgery. A common test of language skills used by neurosurgical teams remains picture naming (6, 7); a test that does not adequately capture language performance per se. A recent study of 5 tumour patients suggested that the use of spontaneous speech analysis was comparable to formal testing in detecting language impairments (8). Methods: We assessed a group of 16 people, following surgical resection of a left-sided tumour, using the Comprehensive Aphasia test (CAT) (9). All patients were assessed between 6-12 months post-surgical removal of a primary tumour, all spoke English as their primary language and were right-handed. The battery included sub-tests of naming and picture description tasks. Naming tasks were scored in a binary method. Transcriptions of the picture description task were analysed using the breakdown of contents recommended in the CAT including: (i) appropriate information carrying words (ICW) (ii) inappropriate ICW; (iii) syntactic variety; (iv) grammatical well-formedness and (v) speed of delivery. Scores were then standardized by converting to t-scores. Results: Using the Comprehensive Aphasia test 8/16 and 9/16 patients demonstrated a language deficit on the spoken and written picture description tasks respectively. In contrast, using the picture naming task, only 1/16 patients presented with a 'language deficit'. Discussion:The subtle language deficits exhibited in people following tumour resection are not always detected using quick comprehensive screening assessments tools and are certainly not adequately detected using picture naming tasks. However, picture description tasks can quickly and reliably demonstrate the presence of language impairment and can therefore be more accurately used to guide surgical decision -making than picture naming tasks. Results can also be used to triage for more extensive formal language testing. Picture description permits language to be explored at a number of different levels from the phonemic to pragmatic and even cognitive skills such as initiation and attention shifting. In this case series, the picture description task has been shown to be more reliable than a picture naming task at detecting the presence of language impairment in patients who have undergone dominant-hemisphere tumour resection.

D56 Relative Contributions of Lesion Location and Lesion Size to Predictions of Varied Language Deficits in Post-Stroke Aphasia

Melissa Thye[1], Daniel Mirman[1]; [1]University of Alabama at Birmingham

Introduction: The past 15 years have seen a rapid increase in the use of lesion-symptom mapping (LSM) methods to study associations between location of brain damage and language deficits, but the prediction of language deficits from lesion location remains a substantial challenge. This study examined two factors that may weaken lesion-symptom prediction: (1) use of mass-univariate voxel lesion-symptom mapping (VLSM) and (2) use of broad language deficit scores. Multivariate LSM (specifically, sparse canonical correlation analysis, SCCAN) may overcome the limitations of the mass-univariate approach and be better able to determine the brain regions that are critical for a particular deficit resulting in improved lesion-symptom predictions. In addition, prediction accuracy may improve for deficits in functional systems compared to broad measures of aphasia severity, and lesion location may be particularly informative for predicting deficits within these systems. The present study used both mass-univariate (VLSM) and multivariate (SCCAN) lesion-symptom mapping and compared prediction of broad measures of aphasia severity with prediction of more specific language deficits. Methods: The data were drawn from a large-scale study of language processing following left hemisphere stroke. Participants (N=128) completed a detailed battery of psycholinguistic tests, which included broad measures of aphasia severity (Western Aphasia Battery Aphasia Quotient, WAB AQ) and object naming ability (Philadelphia Naming Test, PNT). Participants also completed a variety of more specific tests of spoken language, verbal working/short-term memory, and semantic cognition, which were entered into a principle component analysis to calculate deficit scores in each of three functional systems: Semantics, Speech Production, and Speech Recognition. Prediction accuracy was based on 8-fold cross-validation: participants were partitioned into eight "folds" (n=16 each) and, for each fold, VLSM and SCCAN were run on the training set of participants (n=112) to generate a mass-univariate and a multivariate template for each score. For each participant in the withheld test set, the proportion of overlap between the participant's lesion and each template was calculated. Lesion size, overlap proportion, and overlap proportion controlling for lesion size were tested as predictors of each language deficit score. All analyses were implemented in R using the lesymap package. Results: For both VLSM and SCCAN, lesion size alone was a significant predictor of PNT

accuracy, WAB AQ, Semantics, and Speech Production, and explained a greater percentage of the variance for WAB AQ (31%) compared to the other measures: PNT (21%), Semantics (10%), Speech Production (8%), and Speech Recognition (0.1%). After accounting for lesion size, template overlap proportion was a significant predictor of only Speech Production and Speech Recognition deficit scores. Conclusion: General measures of language deficit (PNT and WAB AQ) were substantially predicted by overall lesion size and lesion location (overlap proportion) did not improve prediction accuracy. Only Speech Production and Speech Recognition deficit scores were better predicted by the overlap proportion than by lesion size, possibly because these systems are supported by relatively localized neural systems and may be more resistant to reorganization.

Multilingualism

D57 The influence of bilingual language experience on verbal fluency and brain structure and function

Shanna Kousaie[1], Shari Baum[2,3], Natalie A. Phillips[2,4,5], Vincent Gracco[2,3,6], Debra Titone[2,7], Jen-Kai Chen[1,2], Denise Klein[1,2]; [1]Cognitive Neuroscience Unit, Montreal Neurological Institute, McGill University, Montreal, QC, H3A 2B4, Canada, [2]Centre for Research on Brain, Language and Music, McGill University, Montreal, QC, H3G 2A8, Canada, [3]School of Communication Sciences and Disorders, Faculty of Medicine, McGill University, Montreal, QC, H3A 1G1, Canada, [4]Department of Psychology/ Centre for Research in Human Development, Concordia University, Montreal, QC, H4B 1R6, Canada, [5]Bloomfield Centre for Research in Aging, Lady Davis Institute for Medical Research and Jewish General Hospital/McGill University Memory Clinic, Jewish General Hospital, Montreal, QC, H3T 1E2, Canada, [6]Haskins Laboratories, New Haven, CT, 06511, USA, [7]Department of Psychology, McGill University Montreal, QC, H3A 1G1, Canada

Previous research suggests that bilingualism confers certain advantages in terms of executive control compared to monolinguals; however, importantly, bilingualism has also been associated with disadvantages in some language processes, including lexical retrieval. Poorer lexical retrieval in bilinguals compared to monolinguals is thought to result from competition between the two languages. Within bilinguals, superior performance has been observed in a dominant compared to a non-dominant language, although neuroimaging studies suggest that similar brain regions are implicated in performance across the two languages. Previous studies have compared monolinguals and bilinguals and a native (L1) versus a non-native (L2) language in bilinguals, leaving a gap in the literature with respect to how differences in L2 language experience may impact lexical retrieval. Specifically, how might lexical retrieval differ in relation to when the L2 was learned, or the attained proficiency in the L2? In the current investigation, we examined verbal fluency (letter/ phonemic fluency and category/semantic fluency) in a highly-controlled group of French/English bilinguals. Two groups of participants who were matched in terms of relevant demographic variables as well as general cognitive ability and differed only with respect to when they learned their L2 (17 participants learned their two languages from birth, while 16 participants learned their second language after age 6) underwent structural and resting-state magnetic resonance imaging (MRI) and completed a battery of language and cognitive tasks. Of interest for this investigation is performance on the letter and category fluency tasks, which all participants completed in both English and French. Behaviourally, the groups did not differ in terms of the number of exemplars generated in L1 or in L2 for either letter or category fluency, although performance was better for category compared to letter fluency in both languages, and in L1 compared to L2 for both tasks. Surprisingly, participants performed comparably regardless of when they learned their L2. A whole-brain analysis of grey matter volume (GMV) also revealed no group differences in GMV. However, a whole-brain analysis of GMV in relation to performance revealed a positive association between brain structure and performance in L2 only. Specifically, GMV in the right posterior cerebellum and the left supplementary motor area was associated with better performance in L2 letter and category fluency, respectively, demonstrating that GMV was related to individual differences in performance irrespective of when the L2 was learned. Additionally, we compared GMV in a priori regions of interest based on the literature and found that simultaneous bilinguals had greater GMV compared to late bilinguals in left inferior temporal cortex and bilateral caudate nuclei. Analyses examining resting-state functional connectivity between these regions and the rest of the brain will add to the structural findings by determining the functional networks that are implicated in lexical retrieval, and how these may differ as a function of language and/or L2 language experience. These findings will help to elucidate a more refined understanding of how individual differences in language experience influence language processing, and lexical retrieval more specifically, in both an L1 and an L2.

D58 Pardon My Code-Switching: Electrophysiological Effects of Mixing within the Determiner Phrase

Leah Gosselin[1], Michèle Burkholder[1], Laura Sabourin[1]; [1]University of Ottawa

In multiple Canadian francophone communities, switching between languages within a single sentence (intrasentential code-switching) is regarded as typical linguistic behaviour (Poplack, 1980). While code-switching was originally believed to reflect lack of linguistic competence on the speaker's behalf, recent research suggests that code-switching is rule-governed and systematic. As such, notable regularities have been observed in corpus studies among language-mixers. For instance, in the case of mixing at the level of the determiner phrase (DP), Spanish-English bilinguals typically employ a Spanish determiner with an

English noun (e.g. la house). The opposite direction (e.g. the casa) is disfavoured (Liceras, Fernández Fuertez, & Spradlin, 2005). Since the gender systems in French and Spanish are similar, French-English mixed DPs should carry the same pattern as those in Spanish-English. A handful of studies have examined code-switching more generally, with the use of Event-Related Potentials (ERP). Well-known ERP components may indicate specific reactions to linguistic events such difficulty with semantic integration (Kutas & Hillyard, 1980) or structure violation and reanalysis (Hagoort &Brown, 1999). However, all but one of these studies included bilinguals who did not frequently mix their languages. While most of the literature demonstrates that language-mixing incurs processing costs (indexed by an N400), it is likely that ERP components were impacted by the fact that participants were not habitual code-switchers. To this date, there are no known online studies examining mixed DPs. The current study tests 12 English-French simultaneous and early bilinguals from the Ottawa-Gatineau region, who are habitual code-switchers. Participants read code-switched sentences, via the rapid serial visual presentation paradigm. The conditions of the target DP itself varied according to the language of the determiner, the gender of the noun and the gender-relation between the determiner and noun (match/mismatch). While the participants read these sentences, their neural activity was measured with the electroencephalogram. Preliminary results show significant differences between mixed and unmixed DPs in the 500-700ms time window ($p < .01$). As such, mixed DPs indexed an increased positivity which was distributed equally across the head. Furthermore, results show no significant differences between mixed DPs with an English determiner and those with a French determiner ($p > .23$) at all time windows. Finally, data analysis shows no significant differences between mixed DPs with matching and mismatching gender between determiner and noun ($p > .36$). These results seem to indicate that French-English mixed DPs do not follow the patterns demonstrated by Spanish-English bilinguals in corpus studies: French determiners did not incur less structure reanalysis than English determiners. In parallel, it seems that "gender violations" in mixed DPs are not altogether unacceptable to language-mixers. Furthermore, this study did not find any N400 effects for mixed DPs, which support the fact that previous results in the literature are potentially a consequence of participant samples (i.e. a lack of habitual code-switchers). To conclude, this type of research could give valuable insights into the human language faculty. By demonstrating that code-switching is highly natural and constrained, this project could also help remove the stigma around language mixing.

D59 Working Memory Filtering and Individual Differences in Second Language Aptitude

Chantel Prat[1], Malayka Mottarella[1], Brianna Yamasaki[1]; [1]University of Washington

Individual differences in second language aptitude (L2A) have been linked to working memory capacity (Miyake & Friedman, 1998), although the neurocognitive mechanisms proposed to explain the relation vary. One complication is that the construct of working memory has evolved dynamically, as have the tasks for measuring capacity. Additionally, little work has investigated the shared neurocomputations underpinning working memory capacity and L2A. In the current study, we adopt a selective attention view of working memory, and explore the hypothesis that L2A relies not only on the ability to maintain information in working memory, but also on the ability to flexibly filter or block task-irrelevant information. We propose that such an ability should be reflected by differences in fronto-striatal circuit functioning. To test this hypothesis, 34 adults completed a verbal working memory fMRI task modeled after McNab & Klingberg, 2008, in which words to-be-remembered appeared on a 3x3 grid in locations to-be-remembered. Memory load (3 vs. 5 words) and filtering demands (Filter = remember only words from a particular category vs. No-Filter = remember all words) varied orthogonally. Participants subsequently completed a 4-week French language training program in the laboratory using a virtual immersive software (Prat et al., 2016). Differences in French vocabulary and grammatical proficiency were assessed independently following training. Top-down filtering mechanisms were measured by contrasting activation during "Filter" and "No-Filter" instructions. Activation for the "Filter- 5" condition, in which 3 of 5 presented words needed to be remembered, was compared to the "No-Filter" conditions, which required remembering 3 or 5 words, to assess the effectiveness of filtering. Specifically, poor filtering would result in a Filter-5 condition that more closely resembled a No-Filter 5 condition (with all 5 words remembered); whereas good filtering would result in a Filter-5 condition that more closely resembled a No-Filter 3 condition (with only the 3 task-relevant words remembered). The three fMRI contrasts were then correlated with individual French proficiency following training. Results showed that better working memory filtering, indexed by activity in the left dorsolateral prefrontal cortex (DLPFC), left parietal lobe, and anterior cingulate cortex (ACC), predicted better subsequent vocabulary learning. Better grammatical learning was also correlated with filtering efficiency in the ACC. With respect to top-down preparation during filter instructions, smaller activation changes in the left hippocampus and parahippocampus predicted better vocabulary learning, whereas, greater involvements of bilateral parietal and right fronto-temporal regions predicted better grammatical learning. These results suggest that more effective top-down filtering, involving a network of memory and cognitive control regions, is associated with better L2 learning.

D60 Neural correlates of between-language competition in foreign language attrition *Anne Mickan[1,2], James M. McQueen[2], Vitória Piai[2,3], Kristin Lemhöfer[2]; [1]Max-Planck Institute for Psycholinguistics, [2]Donders Centre for Cognition, Radboud University Nijmegen, [3]Department of Medical Psychology, Radboudumc*

Recent psycholinguistic research suggests that language attrition (i.e. forgetting) is driven by interference and competition from other, more recently used languages (Levy et al, 2004; Mickan et al, 2018). Mickan et al (2018), for example, have shown that retrieval failure in a foreign language can be caused by the recent, repeated practice of translation equivalents in another language, especially another foreign one. Here we aim to track these competition dynamics at the neural level, in an effort to further our understanding of the precise processes underlying foreign language attrition. Twenty-seven Dutch native speakers with knowledge of English (B2-C1) and no prior knowledge of Italian first learned 70 new Italian words. The learning session was spread out over two consecutive days and consisted of a mix of comprehension (multiple choice) and production (picture naming) tasks. One day after the second learning session, they performed naming tasks on half of these words in English. Finally, memory for all initially learned Italian items was tested again, in a delayed picture-naming task. Recall accuracy and (delayed) naming latency, as well as EEG measurements were taken. The latter were recorded during the 2s delay period after picture presentation onset and before speech onset, which is when retrieval and competition-related dynamics should be most evident. Following Mickan et al (2018) we expected more mistakes and slower responses on Italian words that had just been interfered with (i.e. retrieved in English) compared to items in the no-interference condition. On the neural level, we expected two types of modulations: an increase in the frontal N2 amplitude for interfered compared to not interfered items, and an increase in theta power for the interference condition. Both electrophysiological measures have been linked to competition: the N2 is usually interpreted as an indicator for increased inhibition demands, during for example language switching tasks (Kroll et al, 2008). Theta power has been linked to competition increases in studies on retrieval-induced forgetting (Ferreira et al, 2014; Staudigl et al, 2010). Results showed that recall was indeed slower and tended to be less complete for Italian words that received interference than for Italian words that did not. In the EEG, in line with expectations, we found an increased frontal N2 between 200-300ms post picture onset for the interfered items compared to the not interfered items. Unexpectedly, we also found an increased late positivity (400-700ms, central) for the not interfered compared to the interfered items. Finally, again in line with the literature, we observed an increase in theta power for the interfered items from 500ms onwards (central). The fact that the behavioral forgetting effects were accompanied by an increased N2 supports the idea that inhibition is at play in foreign language attrition, most likely as a mechanism to resolve the increased competition from the recent practice of English words. Theta power changes, we propose, index this increase in competition. Results will be further discussed in light of previous research and theories on language competition in multilingual language production.

D61 Linking Second Language Proficiency and Naming Failures in Native Language: An fMRI Study *Katy Borodkin[1], Abigail Livny-Ezer[2,3], Galia Tsarfaty[2], Miriam Faust[4,5]; [1]Department of Communication Disorders, Sackler Faculty of Medicine, Tel Aviv University, [2]Department of Diagnostic Imaging, Sheba Medical Center, [3]Joseph Sagol Neuroscience Center, Sheba Medical Center, [4]The Leslie and Susan Gonda (Golschmied) Multidisciplinary Brain Research Center, Bar-Ilan University, [5]Department of Psychology, Bar-Ilan University*

INTRODUCTION: Individuals differ in how successful they are in second language (L2) learning. Some achieve native-like proficiency, while others are only able to obtain a minimal level of linguistic competence. One of the factors affecting L2 learning outcomes is native language (L1) skills. For instance, it has been demonstrated that low-proficiency L2 learners experience more tip-of-the-tongue (TOT) word finding failures while naming in L1 compared to high-proficiency learners (Borodkin & Faust, 2013, 2014). TOT states arise when a person knows the target word but is temporarily unable to retrieve it. Our research aimed to explore the neural correlates of this difference. METHOD: The sample included 24 undergraduate students, all Hebrew native speakers, who learned English as L2 starting from age 8 or 9 in a school setting. Participants were assigned to low- or high-proficiency group based on the median score on an English proficiency test, which included reading comprehension passages and cloze exercises. During the fMRI scanning session, we employed the TOT experimental paradigm, where participants were asked to covertly name pictures of objects in one run and of famous people in another. The naming responses, all of which were in Hebrew (L1), were categorized as "know", "don't know", or "TOT". RESULTS: TOT responses comprised 10% of all naming responses across the two runs (15 trials per participant, on average). In keeping with previous behavioral findings, low-proficiency L2 learners reported more TOT states in the fMRI task than high-proficiency learners. Regions of interest (ROIs) were established based on word retrieval literature (Indefrey, 2011) and defined using the AAL atlas: left superior temporal gyrus (STG) and left inferior frontal gyrus (IFG; including pars opercularis and pars triangularis), both of which support phonological form encoding, and anterior cingulate cortex (ACC; including anterior, middle, and posterior parts), implicated in selection of multiple lexical competitors. The contralateral regions were also defined as ROIs. In both TOT > know and TOT > DK contrasts,

low-proficiency learners showed reduced activity in the left IFG (specifically, pars triangularis) compared to high-proficiency learners (the difference was marginally significant in the TOT > DK contrast). No differences were observed in the remaining ROIs. CONCLUSIONS: Our research suggests that reduced activity in the left IFG observed in low-proficiency compared to high-proficiency L2 learners on L1 TOT trials can impede word retrieval, leading to more frequent L1 TOT states. Left IFG has been implicated not only in phonological encoding for word retrieval, but in phonological processing more generally. It is thus possible that reduced activity in this area may negatively affect L2 learning outcomes in multiple ways. REFERENCES: Borodkin, K., & Faust, M. (2013). Tip-of-the-tongue (TOT) states and cross-linguistic transfer. Bilingualism: Language and Cognition, 16(4), 914-923. Borodkin, K., & Faust, M. (2014). Native language phonological skills in low□proficiency second language learners. Language Learning, 64(1), 132-159. Indefrey, P. (2011). The spatial and temporal signatures of word production components: a critical update. Frontiers in Psychology, 2, 255.

D62 Beyond dementia: interaction of bilingualism and neurodegeneration

Toms Voits[1], Holly Robson[1], Jason Rothman[1], Christos Pliatsikas[1]; [1]University of Reading

The potential for beneficial consequences of bilingualism on cognition and the brain has been an increasingly debated topic for the past few years. While positive outcomes associated with speaking two or more languages have been widely studied in healthy adult populations (see Lehtonen, 2018, for a review), the literature on bilingualism and the declining brain is much more scarce. In fact, most of the studies within this body of literature are focussed on healthy ageing populations and people with dementia. In these groups several positive effects of bilingualism have been documented, particularly potential neuroprotective effects in healthy populations (Luk et al., 2011), the preservation of cognitive abilities in bilinguals with brain deterioration (Gold et al., 2013), better structural integrity of the brain in bilingual individuals diagnosed with Alzheimer's Disease and Mild Cognitive Impairment (Duncan et al., 2018), and the delay in the onset of dementia symptoms (Alladi et al., 2013). However, not all studies find support for these claims (e.g. Zahodne, 2014). While dementia is the most commonly studied neurological disorder in the context of bilingualism research, studies on interaction between bilingualism and other neurological disorders that lead to the loss of neural tissue, such as Huntington's disease, Parkinson's disease, multiple sclerosis, schizophrenia, psychosis, primary progressive aphasia etc., remain more limited and fragmented. With some exceptions, literature is mostly focused on the effects that age- or disease-related neurodegeneration has on one's languages and associated executive control and not the effects bilingualism may have on the progress of neurodegeneration. Moreover, and although bilingualism is suggested to be beneficial in progressive neurodegeneration, recent evidence has also suggested bilingualism to be factor that predicts enhanced cognitive improvement in individuals who have suffered stroke (Alladi et al., 2016). These results imply potential benefits of bilingualism even on the recovery of patients with acute neural tissue loss, and further open up research avenues encompassing an increasingly wider scope on interactions between bilingualism and neurological conditions. The last comprehensive review on the topic (Paradis, 2008), was published a decade ago, and even so, the focus was on understanding how neurological disorders impair language processing in bilinguals, but not on the effects bilingualism might have on cognition and brain structure. Given the now proposed neuroprotective effects of bilingualism, it is important and timely to re-examine the literature through a new lens . We provide a focused literature review summarizing the available evidence on progressive neurological disorders and stroke in bilinguals and examines whether there are any bilingualism-related effects on the cognition or brain structure and function of these patients. In doing so, we aim to capture the state of the art in bilingualism research of the declining brain and associated disorders, identify the gaps, and suggest the most feasible avenues to fill them in future research.

D63 The relationship between resting state networks and bilingual reading: A preliminary investigation

Jason Gullifer[1,4], Xiaoqian Chai[2,4], Veronica Whitford[3,4], Irina Pivneva[1,4], Shari Baum[1,4], Denise Klein[1,4], Debra Titone[1,4]; [1]McGill University, [2]Johns Hopkins University, [3]University of Texas at El Paso, [4]Centre for Research on Brain, Language & Music

Bilinguals coactivate both languages when reading text in a single language, evidenced by words that share lexical overlap across languages. For example, eye-movement measures have shown that cognates, which share form and meaning across languages (e.g., piano in English and French), result in facilitation relative to language-unique words, whereas interlingual homographs, which share form but not meaning (e.g., chat is a casual conversation in English vs. a cat in French), result in interference. Yet, the magnitude of these cross-language effects varies across individuals as a function of language background and executive control abilities. Bilinguals with higher second-language proficiency experience less cognate facilitation, and bilinguals with higher executive control abilities experience less homograph interference, suggesting that independent mechanisms are responsible for language control depending on the type of coactivation (Pivneva, et al., 2014). Neurocognitive research employing resting state functional connectivity analysis has identified at least eight independent brain networks composed of areas that show synchronous temporal activity. At a broad level, these include the visual, language, sensorimotor, default mode, salience, frontoparietal control, dorsal attention, and cerebellar networks. Connectivity within these networks

is observable even when the brain is at rest (Lee, et al, 2013). Importantly, networks involved in executive control (salience, frontoparietal, and dorsal attention) also play important roles in bilingualism (Kousaie et al., 2017) and are assumed to be highly integrated with the language network for bilinguals (Abutalebi & Green, 2016). To date, no studies have combined these two threads of research to investigate how cross-language activation during bilingual reading maps onto connectivity within resting state networks. Here, we report data from 27 French-English bilinguals who read English sentences containing target French-English cognate, interlingual homograph, and control words while their eye-movements were monitored. In another session, the participants underwent a resting state fMRI scan. In a preliminary analysis, we extracted coarse reading measures (total reading time) for target words and computed difference scores for cognate facilitation and homograph interference. With connectivity data, we conducted an independent component analysis and used spatial mapping to identify likely networks for each component (Calhoun et al., 2001). We then associated the coactivation effects with the connectivity within each network in a second-level analysis. Preliminary results showed that both types of coactivation were related to connectivity in the frontoparietal control network with similar patterns. Facilitation (irrespective of cognates or homographs) was associated with greater connectivity within this network and inhibition was associated with less. These preliminary results suggest a general entrainment between the magnitude of cross-language activation, irrespective of word type, and connectivity within the frontoparietal control network at an individual level. They also support neurocognitive models of bilingualism which predict that language and cognitive systems are highly integrated (Abutalebi & Green, 2016). Future analyses will involve eye-tracking measures that are more sensitive earlier stages of lexical processing (e.g., first fixation and gaze duration) vs. the late stage measure used here (total reading time), as previous studies have shown differences between the two stages in terms resolution of language coactivation.

D64 The Effects of Short-term Literacy Training on Phonological Awareness

Brenda Guerrero[1], Angelique M. Blackburn[1]; [1]Texas A&M International University, [2]Texas A&M International University

The Effects of Short-term Literacy Training on Phonological Awareness Brenda L. Guerrero, Francisco Torres, Brenda L. Hernandez, Lily Gutierrez, Angelique M. Blackburn Department of Psychology & Communications, Texas A&M International University Our aim is to determine the influence of a short-term literacy training on phoneme and letter awareness. Long-term literacy interventions have shown increases in phonological awareness; however, many literacy events occur over the course of only a few days or even just a few hours. Based on an English literacy model, we designed and implemented a Spanish literacy assessment to measure changes in phonological and letter awareness, before and after a five-day literacy training for illiterate Spanish adults (n = 20) at the Laredo Immigration Detention Center. This is a center for detainees in the United States, where the primary spoken language is English; thus, the participants were Spanish speakers with heavy exposure to English. The training included interactive reading activities and focused on writing exercises that were specific to the participants' identities. Our assessment included measures of phonological awareness, including rhyme awareness, letter identification, letter-sound knowledge, and phoneme awareness. Two versions of the assessment were designed and counterbalanced across participants such that no participant completed the same version for both the pre- and post-literacy assessment. Compared to the pre-test assessment, the literacy intervention significantly increased accuracy on the post-test assessment of phonological awareness by 6.0% ($p < .01$). Knowing whether a short-term literacy training increases language skills is critical for educators implementing short-term literacy programs to improve teaching methods.

Signed Language and Gesture

D65 Gesture incongruity effects on speech preserved with verbal but not visuospatial WM load: An ERP study

Jacob Momsen[1,2], Jared Gordon[1], Seana Coulson[1]; [1]University of California San Diego, [2]San Diego State University

The present study investigated the roles of verbal and visuospatial working memory (WM) during the comprehension of speech accompanied by iconic gestures. In previous experiments, participants engaged in discourse comprehension tasks using naturalistic videos while concurrently performing secondary WM tasks to tax either verbal or visuospatial WM resources. These studies suggest a relatively significant role of visuospatial WM in integrating information in co-speech gestures with concurrent speech. However, these studies relied on behavioral responses that occurred after the multimodal discourse. Here we utilize EEG to compare the impact of verbal versus visuospatial memory load on real-time processing of speech in multimodal discourse. EEG was recorded as healthy adults performed a verbal (n=14) or a visuospatial (n=14) WM task. In the verbal condition, participants encoded a series of either one (low load) or four (high load) digits; in the visuospatial condition, they encoded a series of either one or four dot locations on a grid. During the rehearsal period of this WM task, participants observed a video of a man describing objects followed by a picture probe that showed the referent of his discourse. Gestures matched the speech in half of the videos, and mismatched the speech in the other half. ERPs were time-locked to the onset of the final item encoded during the memory task, the first content word in each video, and the onset of the picture probes. ERPs time locked to the final item in the memory encoding task were

measured 200-500ms post stimulus onset. Visuospatial load resulted in a widely distributed positivity, whereas verbal load produced a negativity (Dots: $F(1,13)=18.1$, $p < 0.001$; Digits: $F(1,13)=52.7$, $p <0.001$). Differences in the load effects confirm that partially non-overlapping brain regions were recruited for each memory task. N400 effects for the first content words in the videos were measured 200-400ms post stimulus onset. Repeated measures ANOVA in the digits condition with factors Load (low/high), Gestures (match/mismatch), and ROI revealed an interaction of Gestures by ROI ($F(6,78)=3.54$, $p < 0.05$). An identical ANOVA revealed no significant effects in the dots condition. The N400 effect in the digits condition suggests participants' sensitivity to gestural information was preserved under the imposition of a verbal load. Its concomitant absence in the dots condition suggests co-speech gesture comprehension was compromised by the load on visuospatial WM. The mean amplitude of ERPs to pictures was measured 200-500ms post stimulus onset to index the N300/N400. Pictures elicited no gesture effects in the digits condition. In the dots task, analysis revealed an interaction between Load and Gestures, reflecting gesture effects only in high load trials (($F(1,13)=6.39$, $p < 0.05$). Associated with poor task performance, we hypothesize that gesture effects on pictures emerge when participants were unable to suppress irrelevant gestural information during the videos. Speech-gesture incongruity effects emerged on the speech under verbal load, and on picture probes presented afterwards under visuospatial load. Observed differences of the timing of speech-gesture incongruity effects thus support a dissociation in the contribution of verbal and visuospatial WM to multimodal discourse comprehension.

D66 ERP evidence for implicit co-activation of English during recognition of American Sign Language

Brittany Lee[1,2], Gabriela Meade[1,2], Megan Mott[1], Katherine J. Midgley[1], Phillip J. Holcomb[1], Karen Emmorey[1]; [1]San Diego State University, [2]University of California, San Diego

This study investigated co-activation of English words during recognition of signs from American Sign Language (ASL) by deaf ASL-English bimodal bilinguals (N = 24). Participants viewed pairs of ASL signs and judged semantic relatedness. All of the prime-target sign pairs were form- unrelated in ASL. However, half of the semantically unrelated sign pairs had rhyming English translations (e.g., bar-star) and half did not (e.g., nurse-star). These rhyming English translations contained rimes with both orthographic and phonological overlap. EEG was recorded and time-locked to target video onset. Offline, participants completed a debriefing questionnaire to determine whether or not they had noticed the English rhyme manipulation. They also completed a translation task to ensure that the English translations they provided upheld the intended rhyme manipulation. Classic N400 and behavioral semantic priming effects were observed, with targets in semantically related sign pairs eliciting smaller amplitude N400s and faster RTs than targets in sign pairs that were not related in meaning. While no behavioral effects of English form-relatedness were observed, ERP evidence showed distinct patterns for participants who were aware of the form manipulation in English (N=10) and those who were not (N=14). Participants who reported awareness of the English rhymes showed an effect of form-relatedness between 700-900ms; targets in pairs with rhyming English translations elicited more positive-going ERPs compared to those in pairs with unrelated English translations. This pattern is consistent with a previous study of priming in deaf bimodal bilinguals with English words that had form-related ASL translations (Meade et al., 2017) and may be indicative of an explicit translation strategy. Participants who were unaware of the manipulation (N = 14) showed an earlier effect of English form-relatedness between 300- 500ms. However, the direction of this effect was reversed from what was observed by Meade et al. (2017) for English targets, as ASL targets in pairs with rhyming English translations (e.g., bar-star) elicited more negative-going ERPs than those in pairs with unrelated English translations (e.g., nurse-star). The apparent reversed N400 effect suggests that automatic co- activation of English word forms by ASL primes may inhibit or slow access to ASL targets rather than facilitate access to ASL signs. Thus, implicit co-activation of words and signs occurs bidirectionally, but accessing signs during word recognition appears to be more advantageous for deaf bimodal bilinguals than accessing words during sign processing. Implicit co-activation of the dominant language may aid processing of the less dominant language in both spoken language bilinguals and bimodal bilinguals, but this advantage does not appear to hold in the opposite direction.

D67 ERPs in multimodal language comprehension: How discourse information and synchrony influence gesture-speech processing

Isabella Fritz[1,3], Sotaro Kita[2], Jeannette Littlemore[3], Andrea Krott[3]; [1]Norwegian University of Science and Technology (NTNU), [2]University of Warwick, [3]University of Birmingham

Previous studies have often suggested that gesture-speech synchrony is crucial for the successful semantic integration of iconic gestures into a discourse model due to the ambiguous nature of gestures. The presence of an N400 effect was used as an indicator of integration when comparing match vs. mismatch gestures in relation to speech. But not all gestures synchronise with semantic affiliates (i.e., element(s) in speech related to the gesture's meaning); some precede them. In an ERP study, we tested if preceding verbal discourse that constrains a listener's interpretation of an iconic gesture enables asynchronous gestures to be integrated into a listener's discourse model. We created two-sentence stimuli where the introductory sentence either contained information that was semantically related to the gesture's meaning ("Some of the strawberries in the garden were already

ripe.") or unrelated ("At the beginning of the week the weather was dreadful."). In the target-sentence ("I saw that my uncle … picking …"), the gesture was placed on a content word at the beginning that could not guide the gesture's interpretation (uncle) whilst the target-verb further downstream either semantically matched ("picking") or mismatched ("watering") the gesture. For ERPs time-locked to the gesture's onset, we found an anterior-left negativity with a more negative deflection in the Unrelated Discourse condition (starting at 800 ms). Despite its late onset, which is not uncommon for gesture processing, this effect suggests a more effortful search for a referent in the Unrelated Discourse because discourse information did not provide cues for gesture interpretation. For ERPs time-locked to the target-verb, we did not observe an effect of semantic congruency between the gesture and the verb in the N400 time-window in either Discourse condition. This might be because the gesture does not prime the target-verb's meaning because the gesture's meaning is vague in both Discourse conditions, an explanation in line with results from a behavioural experiment using the same stimuli set. ERPs time-locked to the target-verb showed P600-like mismatch effects for semantic congruency between the gesture and the verb in both Discourse conditions but with different topographical distributions (posterior – Related Discourse; anterior – Unrelated Discourse). We interpreted the P600-like effects as a reanalysis of the gesture's meaning that was triggered after lexical retrieval of the target-verb, i.e. when the verb was mapped onto the discourse model. The different topographies might result from different reanalysis processes based on preceding discourse information, i.e. gestures are perceived as incongruous in the Related Discourse and as unexpected or a poor fit in the Unrelated Discourse condition (cf. van Petten & Luka, 2012). The study suggests that synchronisation between gesture and semantic affiliate is not essential for gesture-speech unification. However, different integration processes seem to occur when gestures are not in synchrony with the semantic affiliate. Based on our findings and the Retrieval Integration Account by Brouwer et al. (2012), we distinguish three different integration processes for asynchronous gestures: search for a referent in preceding discourse (Nref), context driven meaning construction/ semantic lexical retrieval (N400), post-semantic integration into a discourse model (P600).

Computational Approaches

D68 A simulation-based approach to statistical power with ERPs

Chia-Wen Lo[1], Jonathan Brennan[1]; [1]University of Michigan

Replicability in Event-related potential (ERP) studies have drawn increased attention recently (Boudewyn et al. 2017; Cohen 2017; Luck and Gaspelin 2017; Thigpen et al. 2017). ERPs are a spatial-temporal matrix that reflects multiple parameters (e.g. the mean amplitude over time, the latency and duration for a given component, topographical distribution, etc.). Thus, how to ensure that an effect "replicates" across different studies is quite difficult. Further, though most literature reported the f-value or t-value along with their p-value, only 40% of papers reported effect sizes, 56% reported mean values, and 47% reported some estimate of variance (Larson and Carbine, 2017). Rarely reporting such information impedes sample size calculation needed for conducting power analyses (Guo et al. 2014). To our knowledge, few studies examine how large is the effect size that can be reliably detected with standard ERP analyses (e.g. Boudewyn et al. 2017). The goal of the current study is to provide a way to assess statistical power across a range of effect sizes, using the P600 component as a case study. Existing toolboxes, like Besa Simulator, simulate ERPs from scratch by making assumptions about the source model and noise model which may not reflect actual data. We use actual raw single-trial data as the bases for our simulations, allowing for greater fidelity between simulated outcomes, and actual experimental outcomes. In this data-based approach, the simulation is conducted in four stages: (i) single-trial data from an experiment, already preprocessed, are randomly divided into partitions that reflect conditions for each participant, (ii) a stochastic effect E is drawn from a Gaussian distribution and added to each trial in one partition (iii) the data are averaged and a group analysis is conducted as it would be for a typical experiment, and (iv) steps (i-iii) are repeated, yielding a distribution of statistical outcomes where the "true" effect E is known. The distribution of E is parameterized in terms of amplitude, latency, duration, and topography. These can be estimated from the existing literature, or outcomes across a range of values can be compared. We demonstrate the method with data from an N = 43 study designed to test for P600 effects in wh-questions dependencies in Mandarin (Lo and Brennan, 2017). We evaluate the power to detect an effect specific to one target condition compared to two control conditions. Prior literature testing P600 effects in wh-questions indicate an effect of between 1 and 2 μV (e.g. Kaan et al., 2000; Phillips et al., 2005). In the current study, we test a range of effect sizes, ranging from 0.5 to 2 μV while keeping topography and latency fixed (central posterior electrodes, 500-700 ms). Results show power to detect E = 0.5 is 0.09, E = 1.0 is 0.21, E = 1.5 is 0.75 and E = 2 is 0.95. The current study shows that we can quantify the effect sizes in EEG data by a simulation-based approach.

D69 Discern: a computational model of naming deficits in bilingual speakers with aphasia

Claudia Penaloza[1], Uli Grasemann[2], Maria Dekhtyar[1], Risto Miikkulainen[2], Swathi Kiran[1]; [1]Boston University, [2]The University of Texas at Austin

Several factors including the combination of spoken languages, the relative competency in the two languages, and the effect of brain damage in bilingual adults with aphasia (BAA) make it challenging to examine bilingual naming impairment and rehabilitation clinically

without large scale longitudinal studies. DISCERN is a computational model that allows to systematically examine lexical access in healthy bilinguals and BAA, thus offering a potential solution to simulate treatment response and predict optimal rehabilitation outcomes in BAA. The DISCERN model is a neural network simulation of lexical access that consists of three interconnected self-organizing maps: one semantic and two phonological maps for L1 and L2 respectively. All maps are linked by adaptive associative connections and get trained to encode the semantic and phonetic representations of words in both languages (i.e., 651 unique words in English and corresponding translations in Spanish). We used an evolutionary algorithm (Bäck, 1996) to identify the best-fit training schedule (i.e., set of training parameters including number of words trained per simulated year, learning rates and neighborhood size, age, age of acquisition (AoA) and language exposure) that would allow training each individual neural network to effectively simulate each healthy participant's naming performance. Twenty-one healthy Spanish-English bilinguals, one Spanish and one English monolingual were recruited for simulations of healthy naming performance (i.e., Boston Naming test-BNT and a 60-item naming screener) and 24 Spanish-English BAA (34.86 ± 46.61 months post-stroke) for simulations of language impairment (i.e., Pyramid and Palm Trees-PAPT and BNT). The best-fit training schedule allowed simulating naming in the healthy participants, explaining 78% of the variance in their naming scores. This best-fit training schedule was used together with the premorbid data of the BAA (i.e., age, AoA and language exposure) to generate pre-stroke naming models. These models were then lesioned systematically to simulate damage to the bilingual lexical system. Semantic impairment was first modeled by applying noise to the semantic map at different intensities until it matched each patient's post-stroke semantic performance (i.e., PAPT scores). Damage to the semantic map impacted naming in each language (i.e., BNT performance) reflecting naming impairment associated with semantic deficits. Additional damage to the phonetic maps was also able to account for naming deficits in addition to semantic impairment. Post-lesion models with damage to the semantic and phonetic maps accurately matched the post-stroke PAPT scores and lead to a reasonable simulation of bilingual naming impairment for each BAA. These results show how naming impairment of patients with different language impairment profiles can be accurately modeled by applying lesion damage to their individual neural network models. Such individual models of naming impairment in BAA will be used for treatment simulations in future research. Retraining lesioned models in one or the other language can help understand the influence of pre-morbid language exposure, AoA, and other factors on bilingual aphasia treatment outcomes.

D70 Flexible meaning: the neuromodulation of noun meaning by a prior verb

Bingjiang Lyu[1], Alex Clarke[1], Hun Choi[1], Lorraine Tyler[1]; [1]Department of Psychology, University of Cambridge

During the incremental interpretation of spoken language each word that is heard plays a dual role – it is integrated into the ongoing sentential context and places constraints on upcoming words. In the present study we focus on how verbs constrain the semantics of upcoming words by investigating the neural processes that underpin the generation of a verb's semantic constraints [its selectional preferences]and how they modulate the semantics of an upcoming Direct object noun (DO). To do this, participants listened to a set of 360 sentences of the form "subject noun phrase + verb + DO noun" comprised of triplets of verbs and nouns, enabling us to vary the verb's semantic constraints on the DOnoun. Within each triplet we varied the specificity of the verb's semantic constraints. Eg in "The boy tasted the mushroom" the verb constrains towards an edible DO, whereas in "The boy liked the mushroom" the verb provides less specific constraints on the DO. We modelled the semantics of each verb and DOnoun using a state-of-the-art corpus-based topic modelling procedure based on Latent Dirichlet Allocation (LDA). This describes each verb's semantic vector as a probability distribution over semantic topics, reflecting the semantic constraints on the verbs' direct object slots via topics. Differences in these distributions across verbs are then tested against the brain data using RSA . A model of the semantics of the DOnouns were calculated in a similar way. Using these methods we constructed model RDMs [Representational dissimilarity matrices] of the semantic representation of each verb and noun in the sentence, together with entropy and surprisal models of verb semantics and tested them against the EMEG data. The RDM of the representation of a verb's semantic constraints (Vsem) was constructed by calculating the cosine distance between verb topic vectors. The specificity of verb's semantic constraints was captured by the entropy of each verb's topic vector and was used to construct verb constraint strength RDMs (VH). RDMs of semantics of the nouns (Nsem) were calculated in the same way. Verb-weighted noun semantic vector was obtained through element-by-element multiplication between normalized verb topic vector and corresponding noun vector, which was used to construct verb-weighted noun semantics (VWNsem) RDM. These model RDMs were tested against data RDMs from both verb and noun epochs. ssRSA was conducted using 10mm-radius searchlights in bilateral language masks with 60ms sliding time-window length. The results were corrected for multiple comparisons using cluster permutation test (1000 permutations, vortex-wise $p<0.05$, cluster-wise $p<0.05$). The results show significant and early effects of the verb's semantic representations starting before the verb UP, as the target verb emerges from its word initial cohort, and persisting throughout the noun in bilateral MTG/LAG.

Around 100msec later, in LMTG, we see effects of the strength/specificity of the verb's constraints which also persist throughout the noun. Finally, we found strong effects of the verb's modulation of the DOnoun semantics starting from the onset of the noun until its IP involving LMTG, showing the early modulation of a word's meaning by the prior context.

Poster Session E

Saturday, August 18, 3:00 – 4:45 pm, Room 2000AB

Control, Selection, and Executive Processes

E1 Semantic diversity affects word processing similarly for PWA with and without semantic deficits: Evidence against the semantic control hypothesis

Curtiss Chapman[1], Randi Martin[1]; [1]Rice University

Introduction. Although a benefit for high frequency (HF) words over low frequency (LF) words is ubiquitous in language processing, persons with aphasia (PWA) with multimodal semantic deficits sometimes show reverse word frequency effects (WFEs; e.g., in synonymy judgments; Almaghyuli et al., 2012). Hoffman and colleagues suggest that this reversal results from the greater semantic diversity (SemD; Hoffman, et al., 2011) of HF words – i.e., a greater range of associated semantic representations which become activated during word processing and compete with selection of the target word meaning. Difficulty selecting among competing semantic representations is argued to be part of these individuals' underlying semantic deficit—one of controlled access to semantics (Hoffman, et al., 2011). Our study tested two predictions following from these claims: 1) smaller WFEs should be observed for high than low SemD words, 2) this interaction of frequency and SemD should be greater—with even smaller WFEs for high SemD words—for PWA with semantic deficits than those without, due to their greater sensitivity to competition. Method and Results. Data from 117 PWA from the Moss Aphasia Psycholinguistics Project Database were analyzed, including 81 who had semantic deficits and 36 who did not have multimodal semantic impairments (> 2 sd below control means on verbal and nonverbal semantic tasks). Errors on the Philadelphia Naming Test (PNT) and the Philadelphia Repetition Test (PRT) were regressed on group, SemD, frequency, and their interactions. In PNT and PRT, we observed an effect of group (semantic deficit < non-semantic deficit; p's<.001), a beneficial effect of HF (p's<.001), and no SemD effect (p's>.23). For PNT, we observed the expected interaction of SemD and frequency (p=.001), with larger WFEs for low than high SemD words, but no interactions with group were significant (p's>.59). Interestingly, the SemD x frequency interaction showed a negative effect of SemD for HF words but a positive effect of SemD for LF words. For PRT, we observed a group x frequency interaction (p=.01), but surprisingly PWA with semantic deficits showed a stronger WFE than did those without. There was a marginal interaction between group, frequency, and SemD (p=.06), such that the semantic deficit group showed an interaction between frequency and SemD like that in picture naming (p<.001), whereas the non-semantic deficit group did not (p=.16). However, further analysis revealed no group difference in WFEs for high SemD words, but larger WFEs for low SemD words in the semantic deficit group. Conclusions. As predicted, WFEs were diminished for high SemD words. However, as PWA with and without semantic deficits showed this interaction in picture naming and only WFEs for low SemD words were stronger for those with semantic deficits in repetition, it is unlikely that this interaction arose from semantic control difficulties in those with semantic deficits. Interestingly, the interaction showed that while high SemD hurt performance for HF words, it improved performance for LF words – perhaps because weak activation of associates for LF words aids in their comprehension whereas strong activation of associates for HF words creates competition.

E2 The Lifelong Impact of Language Context on the Neural Correlates of Switching

Alexandra Reyes[1], Angelique Blackburn[1]; [1]Texas A&M International University

Research has shown that bilinguals at times outperform monolinguals on language and non-language switching (e.g., multitasking) tasks, but young adults rarely display this bilingual advantage. Two potential reasons for the lack of effect are that it may only occur in bilinguals who use their languages in a way that employs switching ability and that a lifetime of managing two languages is necessary to observe behavioral differences. Previous studies with young adults showed that language habits affect the neural correlates of cognitive control, even in the absence of observable behavioral differences. The purpose of this study is to determine if the neural correlates of language and non-language switching are affected by a lifetime of engaging in specific language switching behaviors. We are comparing bilinguals who have spent the majority of their lives residing in one of three contexts. In the single-language context, bilinguals are thought to use competitive language control to stay in one language for a long period of time. In contrast, in a dual language context, bilinguals switch languages between conversations throughout the day, which is thought to require reliance on switching mechanisms and a greater degree of competitive control. Finally, in a dense code-switching context, bilinguals switch rapidly within a conversation. This habit is not thought to involve competitive control, but rather, the languages are used cooperatively (Green & Abutalebi, 2013). To assess whether switching between languages in a competitive manner enhances neural networks involved in switching, event-related potentials (ERPs) are being recorded while highly proficient and balanced Spanish-English bilinguals over the age of 50 perform language and non-language switching tasks. On language switching tasks, participants

are cued to switch between naming pictures in Spanish and English. On the non-language task, they are cued to switch between identifying the magnitude or parity of a number. We are specifically observing the N2 switch effect, a negative voltage deflection related to competitive control needed to inhibit irrelevant information when switching out of an active language or task. Dual-language switchers are expected to show the largest N2 switch effect on both language and non-language tasks, because they have engaged and enhanced competitive control by switching languages between conversations throughout their life. We expect behavioral differences to coincide with neural effects in the older adults. The bilingual advantage has been attacked because it is not consistently observed, but finding differences based on age and language habits would explain some of the inconsistencies in the literature. Additionally, understanding variables that moderate the bilingual advantage would advance our understanding of cognitive aging.

E3 Is the Ventrolateral Prefrontal Cortex language-specific or domain-general? An intracranial-EEG study

Marcela Perrone-Bertolotti[1], Samuel El Bouzaïdi Tiali[1], Richard Palluel-Germain[1], Lorella Minotti[2,3,4], Anne-Sophie Job[2,3,4], Philippe Kahane[2,3,4], Monica Baciu[1], Jean-Philippe Lachaux[5,6]; [1]Univ. Grenoble Alpes, CNRS, LPNC UMR 5105, 38000, Grenoble, France, [2]Univ. Grenoble Alpes, Institut des Neurosciences, GIN, 38000 Grenoble, France, [3]CHU Grenoble Alpes, Pôle Neurologie Psychiatrie, 38000, Grenoble, France, [4]INSERM, U1216, F-38000, Grenoble, France, [5]INSERM, U1028, CNRS, UMR5292, Lyon Neuroscience Research Center, Brain Dynamics and Cognition Team, DYCOG, Lyon F-69000, France, [6]Lyon's University, Lyon, France

A broader functional role of Broca's area (i.e., the left ventrolateral prefrontal cortex –VLPFC- including the BA 45A and 45B from Petrides and Pandya, 2002) has been suggested by recent neuroimaging studies. According to findings, VLPFC would mediate integrative non-linguistic processes that are useful for language (e.g., Tate et al., 2014; Nazori & Thompson-Shill, 2016; Novick et al., 2009). In this framework, our present study aim at evaluating the role of the VLPFC and the time-course of its activity within cerebral networks related to a set of linguistic and non-linguistic tasks. We also evaluated the dynamic relation between the VLPFC and core language regions. We explored cerebral activity of patients suffering from refractory epilepsy during their pre-chirurgical intracranial-EEG recording and we specifically focused on the High Frequency Activity (HFA 50–150 Hz) as a proxy of population-level spiking activity (Lachaux et al., 2012). Patients performed five cognitive tasks: i) single words semantic and phonological categorization, ii) attentive sentence reading, iii) delayed matched-to-sample, iv) visual search and v) visual target detection. Our results showed a VLPFC activity across the five tasks in line with results suggesting a broader functional role of this region. During reading, VLPFC present an early strong response (between 200-300ms after stimulus onset) just after the visual word processing (in the ventral occipitotemporal cortex around 150-200ms) and before the responses in core language regions (such as the superior temporal gyrus, the middle posterior temporal gyrus and the opercularis pars of the inferior frontal gyrus in which responses were observed between 300-550ms). Overall, our results suggest VLPFC involvement during the early stage of language comprehension. A possible role of this region could be involved in decision to process an incoming stimulus and to trigger a cascade of high-level processes by top-down activity. Our results point out that the VLPFC function is not restricted to the language domain, in line with other studies suggesting that the VLPFC is a critical part of the domain general network related to cognitive control.

E4 Neural tracking of attended continuous speech in early and late bilinguals

Andrea Olguin[1], Mario Cekic[2], Tristan A. Bekinschtein[1], Mirjana Bozic[1]; [1]Department of Psychology, University of Cambridge, [2]Department of Computer Science and Technology, University of Cambridge

Directing attention to a single speaker in a multi-talker environment is an everyday occurrence that we manage with relative ease. This selective attention results in stronger neural encoding of the attended speech envelope compared to the unattended one (Ding & Simon, 2014). A prominent but controversial hypothesis in the bilingualism literature states that knowing two languages leads to an enhancement in selective attention (e.g., Bak et al., 2014; Krizman et al., 2012, but see Paap et al., 2015) and that learning a language in early childhood (the putative critical period) enhances plasticity in the neural encoding of speech sound (Krizman et al., 2015). We examined how learning two languages in early childhood (before the age of 6) and after the age of 11 influences the underlying neural mechanisms of selective attention, as compared to monolinguals. We predicted that the extent of bilingual experience influences how auditory interference is managed in a cocktail party-paradigm. To test this hypothesis we tracked the neural encoding of attended continuous speech in 22 monolingual native speakers of English, 22 early Spanish-English bilinguals, and 20 late Spanish-English bilinguals; in the context of different types of acoustic and linguistic interference. Participants always attended to a narrative in their native language while four different types of interference were presented to the unattended ear: a different narrative in their native language, a narrative in a language unknown to the listener, a well-matched non-linguistic acoustic interference (Musical Rain), and no interference. The neural activity was recorded by a dense array 128-channel EEG system and cross-correlated with the speech envelopes for both attended and unattended streams. In addition, to directly compare the patterns of encoding for monolinguals, early, and late bilinguals, we used multivariate Representational Similarity Analysis (RSA) to contrast their attentional encoding early and late in the process. Results showed

that there was significantly more robust neural encoding for the attended envelopes than the ignored ones across all conditions in all groups. Critically, we also saw differences between the groups, where native language interference significantly enhanced the encoding of attended speech in monolinguals, but had no such effect in the two bilingual groups. Early bilinguals appear to encode the attended and unattended streams equally when both are in their native language, whereas late bilinguals dissociate native language interference from onset. Taken together, these results demonstrate that top-down selective attention differentially modulates speech envelope encoding in early bilinguals, late bilinguals and monolinguals. They will be discussed in the context of the relevant theories of selective attention and bilingualism.

Phonology and Phonological Working Memory

E5 Resting state and task-related neural oscillations in adults who stutter and controls implicate deficits in sensorimotor integration

Andrew Bowers[1], Dan Hudock[2], Lisa Bowers[1], Heather Ramsdell-Hudock[2]; [1]University of Arkansas, [2]Idaho State University

Introduction: Developmental stuttering is a speech fluency disorder affecting speech-motor timing that often remits in childhood and persists in 1% of adults. Nonword repetition performance is one cognitive-linguistic factor that predicts recovery or persistence and is associated with lower performance at high-loads in adults who stutter (AWS), but it is unclear how the mechanisms underlying stuttering might be related to nonword repetition performance. Recent work suggests that cyclic, oscillatory timing in the dorsal stream is related to nonword repetition load performance, suggesting a potential link between timing for speech production and phonological working memory (PWM). The aim of the current proposal was to determine whether intrinsic differences in oscillatory power in the resting state of AWS were different from those of fluent speakers and related to power and oscillatory timing during a syllable repetition task. Methods: Data was collected from 20 AWS and 20 controls matched for sex, age, and education level. Electroencephalography (EEG) was recorded from 129 channels in a resting-state, eyes-open condition and in delayed 2 and 4 syllable bilabial repetition conditions presented in random order. One channel was used to record myographic artifact. Following analysis methodology used in previous studies, independent component analysis (ICA) was used to identify the same independent component (IC) network in the resting state and task. Spectral power (1-65Hz) using a short fast-fourier transform was used to quantify spectral power in the resting state and in time-periods of interest in the task along event-related spectral perturbations (ERSPs) were computed relative to a 2-second interstimulus interval. Permutation statistics were used to test for the condition and group differences with an FDR correction at $p<.05$. Pearson correlations were used to quantify relationships between baseline and task-related spectral power. Preliminary results: Preliminary data analysis of 7 AWS and 7 controls implicated an IC frontal, temporal, and temporal-parietal network active during the encoding and maintenance task phases (i.e., delta/theta/alpha/beta/gamma ERSPs) that was also associated with lower resting state power in AWS relative to controls (1-65 Hz). A second frontal-parietal network was active primarily during repetition and was associated with higher power in AWS relative to controls (1-65Hz). Dipole estimates for both IC networks were consistent with the dorsal stream, somatosensory association, and prefrontal regions. ERSPs showed group differences in timing of the alpha, beta, and gamma bands ($p<.05$ uncorrected). A right-hemisphere frontal IC cluster showed gamma suppression in AWS not present in any of the controls. Baseline log spectral power was significantly correlated ($p<.05$) with task-related power in the encoding, maintenance, and execution phases of the task in both groups and across both identified networks. There were no group differences in behavioral performance. Conclusions: Although data analysis is ongoing, preliminary findings from 7 AWS and 7 controls suggest that intrinsic resting state differences in power are correlated with power changes in the task and are related to timing differences in ERSPs. Findings will be discussed relative to a dorsal stream sensorimotor integration deficit in AWS on a PWM task.

E6 Investigating brain lateralization during speechreading and reading in deaf adults using functional transcranial Doppler sonography (fTCD).

Eva Gutierrez-Sigut[1,2], Victoria Mousley[2], Laura Monroy[2], Sophie Harte[2], Mairead MacSweeney[2]; [1]University of Valencia, [2]University College London

Among hearing people, the use of phonological information is strongly linked to reading ability. It has been proposed that as reading development progresses, the processing of words becomes increasingly left lateralized due to mapping of orthographic forms onto already left lateralized phonological representations of speech (e.g. Maurer and McCandliss, 2008). Consistent with this hypothesis, greater phonological awareness has been linked with stronger left lateralization for visual word processing (Sacchi & Laszlo, 2016). Furthermore, weaker language lateralization has often been linked to language disorders, including developmental dyslexia (see Bishop, 2013). Reading is a difficult task for most people born deaf (e.g. Conrad, 1979; Traxler, 2000). Knowledge about the phonological structure of words in deaf people is thought to be mainly based upon articulatory feedback from speech and visual information from lip patterns, (i.e. speechreading; Kyle et al., 2016). Support for this hypothesis would come from evidence of left-lateralisation for phonological skills in deaf adults which correlate with speech-related skills, such as speechreading. Here we use functional Transcranial Doppler sonography

(fTCD), a reliable, easy, noninvasive and inexpensive way to establish hemispheric dominance during cognitive tasks (Deppe et al., 2004) to investigate lateralization in adult congenitally profoundly deaf participants (N=14) during a range of different on-line language tasks. We have previously validated these tasks in hearing readers. Specifically, we measured the laterality indices (LIs) during language generation (semantic fluency), on-line reading, speechreading of short stories and rhyme judgement tasks. We investigate the relationships between strength of lateralization for these tasks and performance during the tasks (accuracy) as well as standardized measures of reading and speechreading abilities. Results showed that deaf participants were predominantly left lateralized during the language generation task. This is the gold standard task to establish hemispheric lateralization. The strength of lateralization for the rhyme judgment task was lower but not significantly different from the generation task. Finally, significantly lower LIs were found for both the reading and speechreading tasks than for the generation task. Consistent with previous research with deaf people, behavioural scores on the speechreading test were positively correlated with accuracy during the rhyme judgement and reading tasks. The data suggest a gradation in strength of lateralization depending on the task. We discuss the patterns of lateralization in terms of the language demands of the different tasks (see Bradshaw et al., 2017).

E7 Neurobiological correlates of age-related auditory verbal working memory decline

Maxime Perron[1], Isabelle Deschamps[1], Julie Poulin[1], Pascale Tremblay[1]; [1]Université Laval, Centre de recherche CERVO

Introduction: Normal aging is associated with a decline in auditory verbal working memory (avWM) [1], which has been associated with changes in the structure and function of different parts of the prefrontal cortex. Given the important role that avWM plays in communication, such deficits could lead to communication difficulties (e.g. processing speech in noise). However, the mechanisms through which brain aging affects avWM during language processing have not yet been fully elucidated. The objective of this study was to investigate, using surface-based morphometry, the relationship between brain aging and avWM. Method: 21 adults have been recruited to date (13 F, 52.4±17.4 years, range=21-71 years). The objective is 35. All participants completed a pure-tone audiometry, a speech perception task and a cognitive evaluation, including an evaluation of auditory attention and a test of avWM, the running span test [2], during which they had to recall the last 3 to 6 items digits from lists of different lengths. MRI data were acquired on a Philips 3.0T including a T1 sequence (1 mm3). Analysis: MRI data processing was done with Freesurfer 6. Following pre-processing, images were segmented and parcellated using the Destrieux 2009 parcellation [3]. To investigate avWM decline, first, a series of linear regression were run using SPSS v25, with accuracy as the dependent variable, and age and hearing (pure-tone average (PTA)) as the independent variables. Next, to establish whether the microstructure of the parietal and prefrontal cortex contributes to the age-related avWM decline, a series of moderation analysis were conducted, using the macro PROCESS v2.16.3 for SPSS, with age as the independent variable, accuracy as the dependent variable, and measures of gray matter (volume, thickness, surface) as the moderators. PTA was used as covariate. Results: Controlling for hearing, the results show that age is associated with lower accuracy in the avWM task at span 3 (β=-.006, t=-2.302, p=.034) and 4 (β=-.008, t=-2.311, p=.033). Moderation analysis revealed conditional effects of gray matter on the relationship between age and avWM in the left supramarginal gyrus (SMG) and the left triangular part of the inferior frontal gyrus (IFGt), two regions that have been involved in vWM. The Pick-a-point approach [4] was used to probe these effects. These analyses revealed that, for the SMG, the relationship between age and accuracy was significant only at the lowest level of gray matter volume (β=-.009, t=-2.154 p=.047) and surface area (β=-.009, t=-2.506, p=.023). For the IFGt, this relationship was significant only at the lowest value of gray matter volume (β=-.011, t=-2.363, p=.031). That is, for participants with cortical decline in these regions, age affected accuracy in the avWM task. Conclusion: These preliminary analyses reveal that the microstructure of the parietal and prefrontal cortices is associated with age-related changes in avWM ability. Additional analyses are underway to further examine the avWM, auditory attention and speech perception in aging. References: [1]Hedden T., et al. (2001). Psychology and Aging. [2]Pollack, I. et al. (1959). Journal of Experimental Psychology. [3]Destrieux, C. et al. (2009). Neuroimage. [4]Bauer & Curran. (2005). Multivariate Behavioral Research.

Perception: Speech Perception and Audiovisual Integration

E8 Word Learning Influences Phonotactic Repair: A Granger Analysis of MR-constrained MEG/EEG data

Adriana Schoenhaut[1], Mulliner Cody[3], Ahlfors Seppo[1,2], Gow David[1,2,3]; [1]Massachusetts General Hospital, [2]Athinoula A. Martinos Center for Biomedical Imaging, [3]Salem State University

Introduction. All languages show constraints on how speech sounds are combined to form syllables and words (phonotactic constraints). Evidence for the systematic modification of loan words (e.g. English drive -> Japanese [doraibu]) and perceptual repair of banned onset structures (e.g. sr – perceived as [shr-]) demonstrates that constraints actively influence speech perception. These effects have been alternately attributed to mediation by abstract phonological rules/constraints and to top-down lexical influences on speech perception. To distinguish between these accounts, we examine the behavioral and neural dynamic effects of a specifically lexical manipulation (word

learning) on perceptual repair of banned onset structures by English speakers. Methods: We conducted two experiments. In both, English-speaking participants learned a set of novel words with visual associates (eg sradex). In a behavioral pilot study, subjects performed a discrimination task with pairs syllables from a five step /sr-V/ to a five-step /shr-V/ continuum before and after sleep-consolidated learning of a set of novel words including a subset that contained forms with illicit (/sr-/) onsets. In a subsequent task, a different set of subjects learned a new set of words, again including a subset of words with illicit forms. After sleep consolidation these subjects performed a 2AFC discrimination task involving the same 5-step srV-shrV continuum while simultaneous MEG and EEG data were collected. These neural data were reconstructed in sourcespace and analyzed using Kalman-filter based form of Granger causality analysis. Results: In the behavioral task, subjects showed superior discrimination performance after word learning. A similar behavioral effect was found in the scanning task. Participants were showed lower rates of perceptual repair and were more likely to accept illicit forms (/sr-). Analysis of activation patterns showed involvement of word form areas (supramarginal gyrus, posterior middle temporal gyrus) but not known rule areas (e.g. LIFG, insula, basal ganglia). Granger analysis showed that word learning influenced patterns of influence by word form areas on brain regions involved in acoustic phonetic processing (posterior superior temporal gyrus). Conclusion: Behavioral evidence for an effect of word learning on repair of banned phonotactic patterns is consistent with the hypothesis that phonotactic constraints reflect top-down lexical influences on speech perception. Moreover, the results of Granger analysis are consistent with previous results showing a central rule of top-down influence by word form areas on acoustic-phonetic regions in the Ganong effect and a variety of phonotactic phenomena in speech perception.

E9 Using machine learning to model effects of attention and language-experience on neural phonemic constancy

Fernando Llanos[1], Rachel Reetzke[1], Zilong Xie[1], Liberty Hamilton[1], Bharath Chandrasekaran[1,2,3,4,5]; [1]Department of Communication Sciences and Disorders, The University of Texas at Austin, [2]Institute for Mental Health Research, The University of Texas at Austin, [3]Department of Psychology, The University of Texas at Austin, [4]Department of Linguistics, The University of Texas at Austin, [5]Institute for Neuroscience, The University of Texas at Austin

The acoustic realization of phonemes varies with phonetic context and language experience. Throughout native language experience, listeners develop phonemic representations that are perceptually constant across phonetic contexts (phonemic constancy; Nusbaum & Magnuson, 1997). However, phonemic processing is affected by attention and language experience (Hugdal et al., 2003; Best & Tyler, 2007). Phonemic constancy in a non-native speech context is challenged by the presence of phonemes that are not native or that are phonetically realized in a non-native way. Typically, reduced levels of attention and language-experience manifest in slower and less accurate behavioral responses (Munro & Derwin, 1995). Here, we focus on the impact of attention and language experience in neural phonemic processing. Inspired by research using electroencephalography (EEG) to investigate neural processing of continuous native speech (Khalighinejad et al., 2017), we introduce a machine-learning metric (neural phonemic constancy; NPC) that measures EEG variability across different phonetic realizations of the same phoneme. We examined the effects of attention and language experience in NPC. We recorded EEG responses from fifteen native speakers of English and late Chinese-English bilinguals while listening to 60 audio-tracks of a story recorded in English. Each speech track was mixed with a tone sequence with deviants that differed either in frequency or duration. Listeners were instructed to focus on speech (attended speech condition) or tone sequences (ignored speech condition). We measured attention to the story with comprehension questions at the end of each track. Preprocessed EEG responses were time-aligned to the onset of each phoneme over a 300-ms time window. We trained hidden Markov models to generalize stochastic prototypes of EEG responses to the same phoneme across multiple phonetic contexts. Then, we computed the distance between new EEG responses and their corresponding model prototypes using the posterior log-probability metric (Durbin et al., 1998). Higher log-probabilities indicate that the EEG responses are more prototypical of their phonemic class. To assess neural phonemic consistency across different EEG responses to the same phoneme, we averaged log-probabilities within phonemes in individual participants and conditions (NPC scores). A linear mixed-effects model of NPC scores with language (English/Chinese) and condition (attended/ignored) as fixed effects, and subject and phoneme as random effects, revealed effects of language (English>Chinese; $t=4.42$, $p<0.001$), condition (attended>ignored; $t=6.64$, $p<0.001$), and language-by-condition ($t=5.16$, $p<0.001$). These results show that NPC can capture subtle differences in language- and attentional-driven plasticity. Post-hoc Tukey analyses showed that English NPC scores were higher than Chinese scores in the attended speech condition ($p=0.0012$). This result is consistent with cross-language patterns of correct responses to speech comprehension questions in the attended speech condition. NPC scores were also higher when speech was attended, but only for English listeners ($p<0.001$). This result could be due to a reduction of attentional resources in non-native speech. Finally, English NPC scores were higher than Chinese scores across the English phonemes that are not contrastive in Chinese ($t[508]$, $p=0.001$), but not across the English phonemes that are contrastive in Chinese. This result indicates that the effects of language experience in neural processing are phoneme-specific.

E10 Emotionally expressed voices are retained in memory following a single exposure *YOON JI KIM[1,2], John Sidtis[2,1], Diana Van Lancker Sidtis[1,2]; [1]New York University, [2]Nathan Kline Institute for Psychiatric Research*

Studies in biology suggest the evolutionary significance of voice recognition ability across species as occurring nearly instantaneously between parent and offspring. However, this is rarely taken into account in voice recognition studies, which assume that humans acquire voices as familiar through repeated exposure. Here, we investigate whether humans can acquire a newly familiar voice from a single, 1-minute exposure to spontaneous speech, given a personally engaging context. Although it has been established that emotional experiences are more likely to be remembered and consolidated in memory, little is known about whether emotion advantage holds for voices. To address the effect of emotional context on the acquisition of voices, recognition of emotional and neutral voices was examined at two retention intervals. Listener-participants were presented with a series of emotional and neutral videotaped narratives produced by performers, and tested on the recognition of excerpted voice samples both immediately and a week after exposure. The recognition task was to decide whether they had heard the voice before. Each excerpt contained a voice from an exposed videotaped narrative, but utilized different verbal materials taken from a second narrative provided by the same performer. Results revealed that voices that were exposed during the video session were more often correctly recognized as having been heard before than unexposed voices. Further, participants were more likely to retain memory for voices with emotional, nuanced tones than those in neutral tones. This emotional advantage became notably salient after a one-week delay, reaching statistical significance. These findings provide the first evidence that new voices can be acquired rapidly from one-time exposure and that emotional context facilitates inducting new voices into a repertory of personally familiar voices in long-term memory. The results are concordant with evidence of neurology, lending support to differential brain mechanisms subserving processing of familiar and unfamiliar voices. References Cahill, L., Haier, R. J., Fallon, J., Alkire, M. T., Tang, C., Keator, D., Wu, J., & McGaugh, J. L. (1996). Proceedings of the National Academy of Sciences USA, 93, 8016–8021. Charrier, I., Mathevon, N., & Jouventin, P. (2001). Nature, 412, 873. Heuer, F. & Reisberg, D. (1990). Memory and Cognition, 18, 496-506. LaBar, K. S. & Phelps, E. A. (1998). Psychological Sciences, 9(6), 490-493. Nygaard, L. C., Sommers, M. S., & Pisoni, D. B. (1994). Psychological Sciences, 5, 42–46. Searby, A., Jouventin, P., & Aubin, T. (2004). Animal Behavior, 67, 615-625. von Kriegstein, K., Kleinschmidt, A., Sterzer, P., & Giraud, A.L. (2005). Journal of Cognitive Neuroscience, 17, 367–376.

E11 The Development of Mismatch Response to Vowels and Initial Consonants from birth to 24 Months *Ying-Ying Cheng[1], Chia-Ying Lee[1]; [1]Institute of Linguistics, Academia Sinica, Taiwan*

Mandarin Chinese has relatively simple syllable structure, in which a vowel and a lexical tone are compulsory whereas an initial or a final consonant are optional. Mandarin-speaking children master the vowel production by 3 years of age, but their production of initial consonants does not stabilize until 5 to 6 years. This developmental trajectory supports the phonological saliency hypothesis, which suggests phonological units carry higher saliency should be acquired earlier than less salient ones. The current study examines whether the development of mismatch responses (MMRs) in infancy supports the phonological saliency hypothesis. MMRs to Mandarin vowel and initial consonant contrasts were measured independently by the multi-deviant oddball paradigm in newborns and infants at 6, 12, 18, and 24 months. For vowels, the large deviant "du" (back-high vowel) and the small deviant "di" (front-high vowel) were compared with the standard "da" (front-low vowel). The large deviant du/da contrast elicited a broad positive mismatch response (P-MMR) in newborns whereas mismatch negativities (MMNs) at 6, 18 and 24 months. The small deviant di/da contrast elicited P-MMRs in newborns, at 6 and 12 months, whereas MMNs at 18 and 24 months. As for initial consonants, the large deviant "ga" (VOT=23 ms) and the small deviant "da" (VOT=11 ms) were compared with the standard "ba" (VOT=10 ms). The large deviant ga/ba contrast elicited P-MMRs in newborns, at 6, 12, and 18 months than transitioned to an MMN at 24 months. The small deviant da/ba contrast elicited P-MMRs in newborns, at 6, 12, and 24 months. In summary, MMRs to vowels transition from less mature P-MMR to adult-like MMN at a younger age than MMRs to initial consonants do. Also, MMRs to the large deviant transition from P-MMR to MMN at an earlier age than that to the small deviant does. The developmental trajectories of MMRs support the phonological saliency hypothesis.

E12 Formal and temporal predictions in speech perception *Alexandra K. Emmendorfer[1,2,3], Joao Correia[1,2,4], Joëlle Schroën[1], Bernadette M. Jansma[1,2], Sonja A. Kotz[3], Milene L. Bonte[1,2]; [1]Department of Cognitive Neuroscience, Faculty of Psychology and Neuroscience, Maastricht University, Maastricht, The Netherlands, [2]Maastricht Brain Imaging Center, Faculty of Psychology and Neuroscience, Maastricht University, Maastricht, The Netherlands, [3]Department of Neuropsychology and Psychopharmacology, Faculty of Psychology and Neuroscience, Maastricht University, Maastricht, The Netherlands, [4]Basque Center on Cognition, Brain and Language, San Sebastian, Spain*

When processing our environment, our brain makes use of prior knowledge to formulate formal ('what') and temporal ('when') predictions of upcoming sensory events, thereby maximizing the efficiency of sensory processing

and facilitating perception under noisy conditions. These predictions are valuable to perception and skill learning across a number of cognitive domains, including spoken and written language skills. Within the context of language, formal and temporal predictions may be made at the level of the phonotactic probability and syllable stress pattern, respectively. The current experiment aimed to examine the neurophysiological correlates of these prediction in speech perception, and their relationship to reading, phonological, and rhythmic skills. In a passive EEG oddball paradigm, we manipulate formal and temporal predictions in bisyllabic Dutch pseudowords ('notsal' and 'notkal', adapted from Bonte et al., 2005), where deviants differ from the standard (SD) in terms of their phonotactic (formal deviant, FD) and stress pattern (temporal deviant, TD) probabilities. Based on the distributional frequency of the co-occurrence of speech sounds in the Dutch language, the sound combinations '-ts-' and '-tk-' are considered to have high and low phonotactic probability, respectively. Similarly, first syllable stress (SylS1) is considered the more probable stress pattern compared to second syllable stress (SylS2). In four separate experimental conditions, each stimulus functions as standard, formal, and temporal deviant. This allows comparing ERP waveforms elicited for the exact same stimuli across conditions, thereby enabling the investigation of mismatch response in terms of formal and temporal predictability of the stimuli beyond acoustic stimulus differences. Previous studies manipulating phonotactic probability and syllable stress using the oddball paradigm have reported a sensitivity of the mismatch response to these measures. In these studies, high phonotactic probability (e.g Bonte et al., 2005) and second syllable stress (i.e. less probable syllable stress, e.g. Honbolygo et al., 2013) result in increased MMN suggesting distinct processing mechanisms. 24 right-handed, native Dutch speakers (10 male, mean age = 22.6) were included in the current experiment. In addition to the EEG experiment, behavioral tests were administered to test the participants phonological, reading and rhythmic skills. We predict that both formal and temporal deviants will show a mismatch response modulated by the relative predictability of the measures. Additionally, we expect the mismatch response to scale with behavioral scores. Preliminary findings suggest an overall effect of phonotactic probability on peak latency, with effects of stimulus type (deviant vs. standard) on peak amplitude. Furthermore, deviants in the syllable stress also induce increased peak latency and amplitude. This paradigm may later be applied to study the processing of formal and temporal predictions in children with dyslexia, to characterize differences from normally reading children and elucidate the role of formal and temporal predictions in language development. Bonte, M. L., Mitterer, H., Zellagui, N., Poelmans, H., & Blomert, L. (2005). Auditory cortical tuning to statistical regularities in phonology. Clinical Neurophysiology, 116(12), 2765-2774. Honbolygó, F., & Csépe, V. (2013). Saliency or template? ERP evidence for long-term representation of word stress. International journal of psychophysiology, 87(2), 165-172.

E13 Electrophysiological Evidence of Early Lexical Influences on Sub-lexical Processing: Evidence from the Ganong Paradigm

Colin Noe[1], Simon Fischer-Baum[1]; [1]Rice University, Department of Psychology

Theories of speech perception differ on whether there is only feedforward activation from sublexical levels of representation to lexical levels or whether top-down lexical and semantic information can influence sublexical processing. It has been well established that top-down influences bias what subjects report hearing (e.g. Ganong, 1980; Connine & Clifton 1987), but this bias could either reflect top-down processing or bias at a later stage, such as a response selection. Behavioral evidence alone cannot distinguish when exactly top-down influence is biasing perception. Thus, it cannot conclusively rule out response selection bias explanations of top-down influence. The current study looks at a classic effect of top-down influence on sub-lexical perception -- the Ganong lexical effect -- but includes an online measure of sub-lexical encoding, to verify the time-course of the top-down bias effect. Specifically, the current study compares how the N1 ERP waveform, which indexes the encoding of the sub-lexical feature voice onset time (VOT; Toscano et al., 2010), is influenced by Ganong lexical bias. Twenty-one participants participated in a Ganong two-alternative forced choice experiment while having EEG continuously recorded. Participants made stop-consonant voicing judgements on 9 step VOT continua varying between /d/ to /t/ and /g/ to /k/. The VOT continua were embedded into lexically biasing word environments (e.g. /d/-/t/ in dape-tape versus in date-tate). We test whether sublexical processing, as measured by the N1, is sensitive to both bottom-up information, here variations in VOT, and top-down information, here the bias in categorical perception created by the lexical context. Behaviorally, we replicated the Ganong effect, finding that participants were more likely to the familiar word percept with ambiguous VOTs. In terms of ERP, we replicated Toscano et al. (2010), finding a linear relationship between VOT and N1 amplitude. Critically, we observe an effect of lexical context on N1 amplitude, with N1 amplitude of ambiguous stimulus shifted in the direction of the lexically-favored endpoint. For instance, an ambiguous /d-t/ in dape-tape was encoded sub-lexically more like a /t/. Conversely, in date-tate, that same VOT-step was encoded more like a /d/. The main effects of VOT and bias were moderated by an interaction; the top-down influence of lexical context exerts a greater for the most ambiguous VOTs. The magnitude of the lexical bias effect changes over time, first reaching significant levels at a 25-75 msec time window, and then rapidly growing from 100-175 msec. The observation of an interaction of lexical and phonological information early after stimulus

onset which grows over time and is sensitive to stimulus VOT information supports top-down feedback accounts of speech perception.

E14 Neurophysiological correlates of directional asymmetries in adult vowel perception: An auditory brainstem study

Matthew Masapollo[1], T. Christina Zhao[2], Linda Polka[3,4], Lucie Ménard[4,5]; [1]Boston University, [2]Institute for Learning & Brain Sciences, University of Washington, [3]McGill University, [4]Center for Research on Brain, Language & Music, [5]University of Quebec at Montreal

Cross-language studies of vowel perception with adults and infants have consistently shown that for many vowel contrasts, discrimination is easier when the same pair of vowels is presented in one direction compared to the reverse direction. According to one account, these directional asymmetries reflect a universal bias favoring "focal" vowels (vowels with adjacent formants close in frequency, Polka & Bohn, 2011). An alternative, but not mutually exclusive, account is that such effects reflect an experience-dependent bias favoring prototypical exemplars of native-language vowel categories (Kuhl, 1991; Miller & Eimas, 1996). In a recent study designed to distinguish these two accounts, Masapollo, Polka, Molnar and Ménard (2017) identified a region in phonetic space where vowels were consistently categorized as /u/ by both Canadian-English and Canadian-French listeners, while French /u/ prototypes were more focal compared to the English ones. Results showed that English and French listeners performed better at discriminating changes from less-focal to more-focal /u/ compared to the reverse, regardless of prototypicality, supporting the focalization account. The present investigation examined the effects of focalization and prototypicality on subcortical neural encoding and discrimination of vowels. Using a passive oddball/reversed oddball paradigm, we examined the frequency-following response (FFR) in the auditory brainstem to a less-focal/English prototypic /u/ and a more-focal/French prototypic /u/. Sixteen healthy monolingual English speakers were tested. The stimuli were synthesized with the Variable Linear Articulatory Model (Ménard et al., 2004) using the same parameter values from Masapollo et al. (2017). Each vowel was 100-ms long with a 10-ms onset/offset ramp and had a mean fundamental frequency (f0) of 130 Hz. The mean F1/F2 values for the English /u/ prototype were 300 and 979 Hz, and 275 and 746 Hz for the French prototype. All other acoustic properties were identical. We utilized a standard complex ABR recording method (Ground-Forehead, Ref-Right ear lobe, CZ). We conducted two analyses to examine the FFR as a function of stimulus type (English vs. French prototype) and condition (Standard vs. Deviant). First, we conducted a cross-correlation analysis to quantify the overall similarity between the stimuli and the FFR. Overall, higher correlational values were observed for the English prototype than the French prototype, suggesting more robust neural encoding of the native prototype. Yet, at the same time, deviants overall exhibited higher correlational values than standards. This effect was largely driven by the French prototype, suggesting an influence of focalization on discrimination. Second, we examined the magnitude of the individual harmonics in the frequency domain by comparing the spectral peaks at the f0 and the first harmonic (h1) (the peak within the F1 region). For the f0 peak, only an effect of native-language was observed (larger f0 peak for English prototype), whereas for the h1 peak, only a condition effect was observed (larger h1 for deviant than standard). The latter effect was largely driven by the French prototype. Altogether, these findings suggest that the subcortical encoding and discrimination of vowels in adulthood is shaped by a complex interplay between universal biases and experiential influences.

Perception: Auditory

E15 Human cortical encoding of a discrete temporal landmark for processing syllables in continuous speech

Yulia Oganian[1], Edward F. Chang[1]; [1]University of California, San Francisco

A crucial component of the speech signal is its slow amplitude envelope (4-16Hz), and speech comprehension is severely impaired if that temporal envelope is smeared or reduced. Numerous electrophysiological studies have found that brain activity is correlated with the amplitude envelope of speech and that this neural envelope tracking deteriorates when speech comprehension is impaired. A common assumption is that the auditory cortex, in particular speech cortex in the superior temporal gyrus (STG), encodes an analog, continuous representation of the envelope. However, not all periods in the speech signal are equally informative: Discrete landmarks such as amplitude peaks and peaks in rate of amplitude change mark high intensity periods in speech, i.e. stressed syllables, which are most informative for speech comprehension. STG might rely on them to extract information from the speech signal or to segment continuous speech into syllabic units. To test this, we directly recorded neuronal responses from the surface of STG using electrocorticography, while participants (n = 26, 13 right hemispheric) listened to continuous speech. Neural populations in bilateral mid-STG represented the speech envelope. We found that neural responses reflected consecutive evoked responses triggered by local peaks in the rate-of-change of the amplitude envelope (peakRate), but not local peaks in the envelope or its continuous shape. Notably, encoding of peakRate events in mid-STG was anatomically and functionally dissociated from speech onset tracking in more posterior STG and phonetic features encoding in mid-to-anterior STG. To address the role of the envelope in speech comprehension, we analyzed the spectral and phonetic content of speech around peakRate events. We found that peakRate events indicated the timing of consonant-vowel transitions and that the magnitude of peakRate predicted whether a syllable was stressed.

Encoding of peakRate events thus can provide an internal reference point to the temporal structure of a syllable and indicates its prominence within a sentence. A follow-up experiment (n=8, 5 right hemispheric) revealed that STG tracks peakRate not only in speech, but also in amplitude-modulated tones, where they appear in isolation without concurrent spectral changes. By parametrically varying the rate of amplitude change, we found that neural response magnitude monotonically encoded the rate of amplitude change, thus differentiating between stressed and unstressed syllables in speech. Strikingly, we found that two distinct neural populations detected peakRate events at sound onsets and in ongoing sounds: Neural populations that represented sound onsets dynamics (in speech and tones) did not respond to amplitude modulations of ongoing sounds. Neural populations that encoded peakRate in ongoing speech or tones, however, did not discriminate between peakRates at stimulus onset. Overall, our results demonstrate that the representation of speech envelope in STG emerges from its sensitivity to peaks in rate of amplitude change in the acoustic signal. Peaks in the rate-of-change of the envelope function as temporal landmarks, the detection of which cues neural processing towards prominent syllables in the speech signal.

E16 Structural connectivity across stimulation-defined critical language areas

Brian H. Silverstein[1], Eishi Asano[1,2], Yasuo Nakai[2,3], Jeong-won Jeong[1,2]; [1]Wayne State University, Detroit, MI, USA, [2]Children's Hospital of Michigan, Detroit, MI, USA, [3]Wakayama Medical University, Wakayama, JPN

Data from electrical stimulation mapping (ESM) have identified areas critical to language function in the left temporal and frontal lobes, and studies of electrocorticography (ECoG) information flow suggest the areas are functionally connected. Yet, the anatomical pathways, especially between the posterior temporal lobe and both the inferior precentral gyrus (iPCG) and the inferior frontal gyrus (IFG), are unclear. We utilized diffusion tensor imaging (DTI) tractography to investigate the white matter tracts connecting ESM-defined language areas. We hypothesized that the posterior middle and superior temporal gyri (pMTG; pSTG) would project directly to the IFG and iPCG, with a bias towards the iPCG, supporting the ECoG findings. Three Tesla DTI scans were performed on 65 neurosurgical patients (33 males; age: 11.8±SD 3.7 y/o). Our group-level ESM probability map was generated via ESM-based determinations of cortical function in vivo from 100 neurosurgical patients with left hemispheric (LH) language dominance. From ESM and anatomy, we generated 8 LH ROIs in 3 domains: Receptive aphasia: pSTG and pMTG; Expressive aphasia: IFG, anterior iPCG (aiPCG), and two middle frontal gyrus (MFG) sites; Speech arrest: posterior iPCG (piPCG) and middle precentral gyrus (mPCG). All ROIs were used as seeds and targets for performing anatomically-constrained probabilistic tractography. The fiber counts between each pair of ROIs were then normalized by ROI volume. It was found that the pSTG and pMTG are directly connected with both the IFG and piPCG, with a bias towards the piPCG vs. the IFG ($p<.0001$). Fiber count did not correlate with age or gender ($p>.05$, $r<.30$). Notably, these connections followed the arcuate pathway, rather than the uncinate. Across all 8 ROIs examined, the pMTG and pSTG showed similar connectivity profiles; both had the strongest connections to the iPCG, followed by the IFG, and the pSTG/pMTG, with less connections to the mPCG and MFG. Our results demonstrate direct structural connectivity between the pMTG/pSTG and all other ESM-identified language areas. The fiber bundles directly connecting the pSTG with the IFG and piPCG can, in part, support the reciprocal neural interactions which facilitate processing of speech sounds reported in ECoG and fMRI studies of auditory speech perception and articulation. Likewise, the observation of dense interconnecting fibers between 8 ROIs in the frontal and temporal lobes greatly extends a language model beyond the Geschwind model.

E17 Investigating non-verbal vocal communication with fNIRS

Addison Niemeyer[1], Sophie Scott[1]; [1]Institute of Cognitive Neuroscience, University College London

Human perception of non-verbal stimuli is the root of basic behavioural patterns. Sounds that convey the underlying emotions of happiness, sadness, fear, anger, surprise and disgust are integral parts of communication. These sounds may be produced spontaneously, or intentionally in a social situation. A prime example of these sounds is laughter, which is universally recognised and allows for a rare cross-culture investigation of social interactions (Sauter et al., 2010). Examining how humans accurately detect other's emotions by these sounds is necessary to develop a better understanding of social behavioural disorders, such as autism spectrum condition (McGettigan et al., 2013; Hudenko et al., 2013). Previous studies have used fMRI and EEG to study non-verbal communication, but these methods are limited in that they don't allow for natural movement and have less temporal and spatial accuracy which acts as a significant drawback. This experiment investigates the correlation between a participant's conscious perception and neural process in the detection and processing of social and spontaneous sounds. The imaging method fNIRS (functional Near-Infrared Spectroscopy) is used to record neuronal activation patterns of non-verbal vocal communication, and this data is mapped on to anatomical scan specific to the individual (Villringer et al., 1993). Previous tests have indicated that the regions of interest are valid candidates for fNIRS because of their accessible location on the cortex, such as the supplementary motor area, bilateral premotor cortex and right inferior frontal gyrus (Lavan et al., 2017). Results from this test are then compared with the participant's conscious perception of the sounds, demonstrated by a concurrent survey. Using fNIRS to replicate the perception portion of the experiment that was previously completed

with fMRI allows for validation of previous results, with a 19-fold difference in temporal accuracy. Due to the nature of fNIRS, it would be possible to examine the production of laughter, which is extremely difficult to analyse using fMRI because it often involves head movement. Advantages of this method in studying social behaviour include the ability to be used in more naturalistic settings and with an increased variety of clinical populations.

E18 Temporal voice areas exist in autism spectrum disorder but are dysfunctional for voice identity recognition *Stefanie Schelinski[1,2], Kamila Borowiak[1,2,3], Katharina von Kriegstein[1,2]; [1]Max Planck Institute for Human Cognitive and Brain Sciences, [2]Technical University of Dresden, [3]Berlin School of Mind and Brain, Humboldt University of Berlin*

The ability to recognise the identity of others is a key requirement for successful communication. Brain regions that respond selectively to voices exist in humans from early infancy on [1]. Currently it is unclear whether dysfunction of these voice-sensitive regions can explain voice identity recognition impairments. Here, we used functional magnetic resonance imaging (fMRI) to investigate voice processing in a population that has been reported to have no voice-sensitive regions [2] and difficulties in voice identity recognition [3]: Autism spectrum disorder (ASD). Sixteen adults with high-functioning ASD and sixteen typically developing controls (matched pairwise on age, gender, and IQ) participated in two independent fMRI experiments. In the first fMRI experiment (vocal sound experiment), participants passively listened to blocks of vocal (speech and non-speech) and non-vocal sounds (e.g. musical instruments, nature, animals) [4]. In the second fMRI experiment (voice recognition experiment), participants performed voice identity recognition and speech recognition tasks on the same stimulus material [5]. On the behavioural level, the ASD group performed worse as compared to controls in the voice identity recognition task whereas both groups performed equally well in the speech recognition task. In the vocal sound experiment there was greater voice-sensitive blood-oxygenation-level-dependent [BOLD] response along the bilateral STS/STG when participants listened to vocal as compared to non-vocal sounds in the ASD and in the control group. In contrast, in the voice recognition experiment the ASD group showed reduced BOLD responses to the voice identity recognition in contrast to the speech recognition task compared to the control group in the right posterior STS/STG– a region that has been previously implicated in processing acoustic voice features and unfamiliar voices [5, 6]. The right anterior STS/STG correlated with voice identity recognition performance in controls but not in the ASD group. Our results refute the earlier report that individuals with ASD have no responses in voice-sensitive regions [2]. The findings suggest that right STS/STG dysfunction is critical for explaining voice recognition impairments in high-functioning ASD. We provide evidence that voice-sensitive regions in the brain play a critical role in the recognition of vocal identity, beyond their role in discriminating voices from non-vocal sounds. Furthermore, our results suggest that it is the posterior temporal lobe voice region that integrates the acoustic characteristics of the voice into a coherent percept. References [1] Grossmann, Oberecker, Koch, & Friederici (2010). The developmental origins of voice processing in the human brain. Neuron, 65(6), 852-858. [2] Gervais, Belin, Boddaert, Leboyer, Coez, . . . Zilbovicius (2004). Abnormal cortical voice processing in autism. NatureNeuroscience, 7(8), 801-802. [3] Schelinski, Riedel, & von Kriegstein (2014). Visual abilities are important for auditory-only speech recognition: evidence from autism spectrum disorder. Neuropsychologia, 65, 1-11. [4] Belin, Zatorre, Lafaille, Ahad, & Pike (2000). Voice-selective areas in human auditory cortex. Nature, 403(6767), 309-312. [5] von Kriegstein, & Giraud (2004). Distinct functional substrates along the right superior temporal sulcus for the processing of voices. Neuroimage, 22(2), 948-955. [6] Warren, Scott, Price, & Griffiths (2006). Human brain mechanisms for the early analysis of voices. Neuroimage, 31(3), 1389-1397.

E19 Phonetic content of auditory representations *Ryan Rhodes[1], Chao Han[1]; [1]University of Delaware*

Past studies have used the varying standards MMN approach to investigate the content of auditory representations (e.g. Dehaene-Lambertz & Pena, 2001; Shestakova et al., 2002). Different tokens introduce variance in many dimensions simultaneously, such as pitch, timbre, intensity, and VOT. Studies using this paradigm claim that this variance – most of which is orthogonal to phoneme category membership – enforces a phoneme representation. The variance in these dimensions (pitch, intensity, etc.) prevents the auditory processing system from creating a representation that contains phonetic detail. Instead, a phoneme category representation (e.g. /t/) is retrieved from long term memory and used to make predictions about incoming sounds. This experiment investigates the limits of the variance that can be used to enforce a phoneme representation. We used a varying standards MMN design to elicit a within-category MMN effect, which indicates that the representation used by the auditory processing system contains detailed phonetic information about the sound on the dimension that determines category membership. We used a varying standards oddball design, presented in two blocks: a variable-standard condition, and a static-variable condition. Standards and deviants appeared in a ratio of 9:1. All stimuli were single syllable CV tokens (ta). The standards in the variable-standard block varied on a specified acoustic dimension (syllable pitch) while the oddball differed (within-category) on a different dimension (onset VOT). In both blocks, the consonant had a VOT of 95ms for standards and 55ms for deviants. The baseline standard and the deviant had a pitch ranging from 116Hz-97Hz over the syllable. Four other

standard tokens shifted this pitch contour ±10Hz or ±20Hz. EEG data was collected from 20 subjects. Two temporal and spatial regions of interest were identified via PCA: an early component peaking at 200ms (corresponding to P2), and a later component peaking at 300ms (corresponding to N2). A repeated measures ANOVA found a significant main effect of mismatch in both time windows (p = .023 at 200ms; p = .001 at 300ms), but no significant effect of pitch condition or interaction. In the early time window, a paired t-test found a significant within-category MMN in the static pitch condition (p = .027; one-tailed) and no significant MMN in the variable pitch condition (p = .6; one-tailed). In the later time window, t-tests found a highly significant effect of mismatch in both the static pitch (p = .006) and variable pitch condition (p = .003). These results indicate that the auditory processing system was sensitive to a within-category VOT difference despite variance on the unrelated dimension of pitch contour. The presence of pitch variance did not enforce a phoneme representation and cause the auditory processing system to lose phonetic information. References Dehaene-Lambertz, G., & Pena, M. (2001). Electrophysiological evidence for automatic phonetic processing in neonates. Cognitive Neuroscience and Neuropsychology, 12(14), 3155–3158. Shestakova, A., Brattico, C. A. E., Huotilainen, M., Galunov, V., Soloviev, A., Sams, M., Nììtìnen, R. (2002). Abstract phoneme representations in the left temporal cortex: magnetic mismatch negativity study. Cognitive Neuroscience and Neuropsychology, 13(0), 1–5.

Perception: Orthographic and Other Visual Processes

E20 The Role of left Fusiform gyrus in Chinese character recognition: an ERP study using Adaptation Paradigm

Rui Zhang[1], Shujuan Liu[1], Xiangyang Zhang[1], Jianfeng Yang[1]; [1]Shaanxi Normal University

The function of the left Fusiform gyrus is still under controversy that it might be engaged in the orthographic, phonological and semantic processing in visual word recognition. The logographic property of the Chinese characters provides a unique opportunity to address this issue. The current ERP study conducted two experiments to examine the role of the left Fusiform gyrus in Chinese character recognition. Using an adaptation paradigm, the neural adaptation of N170 were examined by manipulating the orthographic, phonological and semantic similarity in a sequence of four continuous presented characters. The Experiment 1 asked participants to perform a phonological detection task after passive viewing four successive characters those shared the orthography (O, pronounced differently with a same phonetic radical), phonology (P, pronounced same without overlapped radicals), and orthography-to-phonology mapping (O-P, pronounced same with a same phonetic radical). The result showed a similar pattern for the bilateral N170 effect that O and O-P similarity evoked a larger N170 adaptation than P similarity, and the difference between O and O-P did not reach significance. It suggested that the left fusiform gyrus was more sensitive to orthographic processing than to phonological processing. Experiment 2 further asked participants to perform a phonological detection task on four successive characters those shared the orthography (O, unrelated meanings with a same semantic radical), semantics (S, related meanings with different semantic radicals), and orthography-to-semantic mapping (O-S, related meanings with a same semantic radical). The result observed a bilateral difference for the N170 amplitude. In the left hemisphere, the PO7 electron showed a larger adaptation effect for S and O-S than for O similarity indicating a regularity effect of the semantic processing on the left fusiform gyrus. On the contrast, the PO8 electron showed a similar adaptation effect for O and S similarity, but a larger adaptation effect for O-S similarity suggesting a regularity effect of the O-S processing on the right fusiform gyrus. In sum, the current study revealed that the left fusiform gyrus was more sensitive to the orthographic and semantic processing than to the phonological processing in Chinese character recognition.

E21 Priming effects between fingerspelled fonts and printed letters

Zed Sevcikova Sehyr[1], Jamie Renna[1], Stephanie Osmond[1], Katherine Midgley[1], Phillip Holcomb[1], Karen Emmorey[1]; [1]San Diego State University

Printed letter recognition plays an important role in reading and follows different phases of processing, from early visual feature detection to the access of abstract letter representations. Masked priming ERP studies provide an insight into these phases through repetition priming effects for single letter targets. Using masked subliminal priming and a letter identification paradigm, Petit et al. (2006) showed priming of abstract letter representations between 220 and 300ms - related letter pairs elicited less positive-going waveforms than unrelated pairs. Fingerspelling occurs frequently in American Sign Language (ASL) and is integral to the lexicon. In a single letter unmasked priming paradigm, we investigated whether fingerspelling fonts and English letters have similar abstract representations and a similar time course of processing. We examined the priming effects between fingerspelled letter fonts, English letters, and across the two systems. Event-related brain potentials (ERPs) were recorded over 29 scalp sites while deaf signers performed a probe detection task (detect the printed or fingerspelled letter Y, 12% of trials). Targets were 23 single letters presented in a typical printed English font or in an ASL fingerspelling font, tested in separate blocks, and presented centrally for 200ms immediately preceded by a clearly visible 100ms prime that was either an English letter or fingerspelled font. Eighteen deaf ASL signers participated in the study. Both English letters and fingerspelling fonts clearly primed English letter targets, indicating that both prime types pre-activated English letter representations. When fingerspelling targets were preceded by letter primes, there was a smaller difference

between related and unrelated pairs suggesting that fingerspelling representations may only weakly pre-activate English letter primes. Recoding English letters into fingerspelling for reading might be inefficient. This result is consistent with a previous study showing that printed words were not recoded into fingerspelling in short-term memory tasks (Sehyr et al. 2017). In regard to the priming of abstract letter representations, only letter-to-letter pairs showed a pattern of priming similar to Petit et al. where related pairs elicited less positive-going waveform than unrelated pairs between 200-300ms. Thus, it appears that abstract ASL fingerspelling and English letter representations are processed differently. A priming effect also emerged at ~250ms whose polarity was consistent with classic repetition effects on the N400 where related pairs elicited less negative-going waveforms than unrelated pairs. We speculate that this effect might reflect strategic access to lexical names of letters triggered by the presence of fingerspelling. Alternatively, this effect might be due to our detection task and the supraliminal character of the primes (i.e., participants covertly named the letter stimuli), or the priming effect arises as a result of more general differences in letter processing between deaf and hearing readers. We addressed the last possibility in a follow-up experiment where we examined priming effects for only the letter-to-letter pairs with 19 hearing English speakers. Preliminary results reveal that English speakers exhibit priming effects for letter-to-letter pairs that are similar to the deaf signers in the original study, thus eliminating the possibility that the priming effect was due to group specific factors.

E22 Asymmetrical connectivity underlying the right visual field advantage in lateralized lexical decision

Jed Meltzer[1,2], Ronald Chu[1,2]; [1]Baycrest Hospital, [2]University of Toronto

The well established right visual field / left-hemisphere (RVF-lh) advantage in word recognition is commonly attributed to the typical left hemisphere dominance in language; words presented to the LVF-rh are processed less efficiently due to the need for transcallosal transfer from the right to left hemisphere. The exact stage for this hemispheric transfer is currently unsettled. Some studies suggest that transfer occurs at very early stages between primary visual regions, while other studies suggest that transfer occurs between the left visual word form area and its right hemisphere homologue. Other accounts suggest independent processing of LVF words within the right hemisphere. The current study explores these conflicting accounts and finds electrophysiological signatures for all of these interactions. Participants conducted a lateralized lexical decision task with both unilateral and bilateral display conditions. Connectivity analyses were conducted from MEG signals that were localized to the: left middle occipital gyrus (LMOG), right middle occipital gyrus (RMOG), left visual word form area (LVWFA) and right visual word form area (RVWA). Results from unilateral trials showed that early information from LVF-rh words is transferred from RMOG to LMOG, and also proceeds intrahemispherically to RVWA. Later waves of connectivity transfer information symmetrically between the two VWFA homologues. Furthermore, bilateral presentations led to reduced interhemispheric connectivity between both homologous ROI pairs. Together, these results suggest that lateralized word recognition involves multiple stages of interhemispheric interactions and that these interactions are reduced when both hemispheres must process their own stimuli simultaneously.

E23 Statistical learning and reading: An information-theoretical perspective

Noam Siegelman[1], Victor Kuperman[2], Ram Frost[1,3,4]; [1]Hebrew University of Jerusalem, [2]McMaster University, [3]Haskins Laboratories, [4]Basque center of Cognition, Brain and Language (BCBL)

In spite of recent evidence tying visual statistical learning (VSL) abilities to reading performance (e.g., Chetail, 2017; Frost et al., 2013), not much is known as to how sensitivity to regularities in the visual modality eventually leads to high-quality orthographic representations. Here, we embrace an information-theoretical perspective which proposes that the link between VSL and reading stems from a joint mechanism of information extraction from the visual array. This view relies on recent findings showing that VSL performance can be explained by the amount of information embedded in the visual stream (Siegelman et al., under review). In the current work we adopt a similar information-theoretical view on reading, which argues that the information present to readers in different orthographies shapes reading behavior. We first present a corpus analysis examining the information structure of five writing systems (Hebrew, English, Spanish, Finnish, and French). Specifically, we examine how surprisal (or (un)predictability) of letter bigrams unfolds within a word (i.e., -log(p(B|A))). We show that languages differ from one another in the overall surprisal level of letter transitions (e.g., transitions are generally unpredictable in Hebrew and much more predictable in English). In addition, different orthographies are characterized by different surprisal trajectories (e.g., whereas English shows a flat trajectory, where all bigrams across a word carry similar surprisal, Hebrew words tend to begin and end predictably, with high surprisal in the middle of a word). Importantly, a simple algorithm can classify an input of surprisal word vectors to one of the five languages, way above chance-level. This shows that the information carried by letter transitions is a stable structural property of a writing system. We then investigate whether this information structure is reflected in reading behavior. We present data from a cross-linguistic eye-tracking reading experiment, in which 50 Hebrew native speakers (Hebrew University students) and 50 English native speakers (McMaster University students) read excerpts of Wikipedia entries in their native language. We show that the surprisal of letter transitions affects reading times in

the two languages differently: Whereas readers of English are strongly affected by letter-level predictability (more surprisal, longer reading time), readers of Hebrew do not show such effect. This suggests that Hebrew readers guess the identity of full words from context, not reverting to letter-by-letter computations, due to the high uncertainty of letter transitions in the language. Together, the results suggest that readers are indeed sensitive to the information structure of their writing system. We discuss future research avenues, towards an integrative theory of VSL and reading.

E24 Electrophysiological evidence for a left hemisphere bias towards letters as early as 100ms

Kurt Winsler[1,2], Stephanie Osmond[1], Katherine Midgley[1], Phillip Holcomb[1], Jonathan Grainger[3]; [1]San Diego State University, [2]University of California, Davis, [3]Aix-Marseille Université

ERP studies of letter and word recognition have found that the brain dissociates between these frequently encountered stimuli and other similarly complex visual stimuli such as symbols or false fonts as early as the N1. This typically left-lateralized effect, often termed an N170 effect, has been taken as evidence of the lower bound on the time course of orthographic processing. The left lateralized nature of these effects agree with other research which has shown that visual linguistic information is faster and more accurately processed when presented to the left hemisphere than the right hemisphere. The current study further examines such hemispheric differences as well as early visual ERP effects by presenting letters and symbols to either the right or left visual field. Additionally, font size was manipulated to probe the lateralization of lower level sensory-perceptual processing. Thirty participants completed a 2AFC character detection task, in which they viewed 216 arrays of three symbols or letters, briefly presented at two degrees to the right or left of fixation. Of these trials, half were presented in a smaller font and half were in larger font, but the center-to-center distance between the characters was preserved. Thus, the design was 2 (presentation side) x 2 (character type) x 2 (character size), with 27 trials per cell. ERP results were analyzed according to electrodes contralateral to presentation side, that is, hemispheric results are comparing right and left electrode sites following presentation to the left or right visual fields respectively. In both hemispheres, larger stimuli elicited more negative-going N170s. Letters generated larger N170s than symbols in both hemispheres, although this effect was considerably greater in the left hemisphere. These findings replicate previous research demonstrating enhanced N170s to letters compared to less familiar stimuli, particularly in the left hemisphere. In keeping with previous research, there were more positive-going P1 waves to the larger stimuli, regardless of which hemisphere it was presented to. However, for stimuli presented to the left hemisphere (i.e. RVF), there were more positive P1s to symbols than to letters. This is evidence that the left hemisphere can show differential activation between letters and other stimuli as early as 100ms. This finding may have important implications for understanding the process of reading and how this skill interacts with hemispheric specialization.

Grammar: Syntax

E25 Interaction of morphological and long-distance dependency processing: MEG evidence

Suhail Matar[1,2], Ryan King[1], Wesley Leong[1], Liina Pylkkänen[1,2]; [1]New York University, [2]NYU Abu Dhabi Research Institute

INTRODUCTION Comprehending an entire sentence requires composition at multiple levels, from morphemes to words, phrases to larger phrases, and the resolution of many types of dependencies. The speed at which all this happens suggests that these mechanisms co-occur and overlap. But while the brain bases of the various levels have all been studied individually, their interaction is not understood. METHOD We addressed how long-distance dependency formation interacts with morphological complexity. Specifically, semantically transparent compounds, opaque compounds and monomorphemic nouns were contrasted in the filler site of so-called right-node-raising constructions, a long-distance dependency in which the filler follows the gap, as in (1) (Leiken et al., 2015). (1) The executive board ridiculed/congregated and the manager criticized the teamwork/chairman/campaign during the meeting. When the verb of the first conjunct was transitive (but not when it was intransitive), the object of the second conjunct had to be linked back to the object position in the first conjunct. MEG measurements (N = 22) on the comprehension of such expressions (46 sets) allowed us to test the spatial and temporal organization of the requisite morphological and syntactic processes, both separately and together. Our analyses covered the entire sentence but here we report only on our results for the target nouns, for space reasons. ROIs included regions previously sensitive to long distance dependencies (LIFG: BA44, BA45, BA47), compound composition (LATL: BA38), and lexical access and syntactic composition (left BA21, BA22, BA37). RESULTS All our effects occurred within the 350-450ms time window, indicating that this time-window is the main temporal locus of a variety of syntactic and morphological operations. Morphological complexity: As in prior work (Brooks & Cid de Garcia, 2015; Flick et al., 2016, subm.), the LATL showed larger amplitudes for transparent compounds compared to opaque compounds or monomorphemic targets at ~350-400ms. A similarly trending pattern was observed in the LIFG at 375-410ms. Dependency: Instead of eliciting increased activation, sentences with dependencies trended towards lower activation both in the LIFG and BA22 at ~400-450ms. Most likely, this pattern reflects not dependency formation, but rather more straightforward composition operations when no dependency needs to be formed. Interaction: In multiple temporal and prefrontal regions, dependency and morphology interacted significantly around 400ms in the following, somewhat complex, way: For monomorphemic

and transparent compound targets, activity was higher in non-dependency contexts (following the trending main effect described above), but for opaque compounds, the opposite was true: there was greater activity for the dependency conditions. Thus, semantic opacity robustly impacted the effect of our dependency manipulation in the 400-450ms time-window, suggesting that retrieval mechanisms of the opaque meaning may occur at this time. CONCLUSION In this study, the effects of two very different composition operations converged on a single word, revealing a morphological effect in the LATL and, in an overlapping time-window, a broadly distributed interaction between morphological complexity and dependency resolution in left temporal and prefrontal cortices. We have provided evidence that language processing mechanisms do not simply co-occur, but rather interact in complex ways.

E26 Predicting what, when, and how in the course of Japanese classifier-noun comprehension

Hiromu Sakai[1], Yohei Oseki[1], Naho Orita[2]; [1]Waseda University, [2]Tokyo University of Science

Predicting up-coming elements is one of the key-features of language comprehension. The question remains to be answered about what types of factors influence prediction how and when in real-time comprehension processes. This study aims to address this issue by examining native speakers' event-related potentials (ERPs) evoked by classifier-noun associations in Japanese, in which classifiers yield strong forward prediction for up-coming nouns [1]. While we replicated previous observations that predictability modulates N400 amplitude, we discovered that word frequency of classifiers is reflected in left anterior negativity (LAN). The overall results suggest that predictability influences language comprehension through the interaction of factors such as prediction strength, predictor frequency, and prediction satisfaction. Japanese is one of the languages that employ classifier systems in counting elements. For instance, "three cars" must be expressed as "san dai-no kuruma (lit. three bodies of car)" and omission or mismatch of classifiers makes the relevant expression ungrammatical. ERP responses to classifier-noun associations were examined in languages such as Chinese or Japanese. Previous researchers observed that prediction dissatisfaction modulates amplitudes of N400 [2], [3] or LAN [4]. In the present study, we selected the following three classifiers: "-tsu (piece)," "-mai (sheet)," and "-dai (body)," based on the analysis of BCCWJ (Balanced Corpus of Contemporary Written Japanese). "-tsu (piece)" is widely used with either concrete or abstract objects and imposes little semantic restrictions on the associated nouns. "-dai (body)," on the other hand, narrowly restricts semantic types of associated nouns and used only with a large machinery such as cars. "-mai" can be used with any kinds of objects so long as they have a flat shape. As one consequence, "-tsu" is by far the most frequent among classifiers and "-dai" is relatively less frequent. Another consequence is that bigram probabilities of classifier-noun associations with "-dai" is much higher compared to the ones with "-tsu". This means that "-dai" yields the strongest prediction but "-tsu" yields the weakest prediction. These properties of classifiers allowed us to manipulate prediction strength (high, mid, low) and prediction satisfaction (satisfied, unsatisfied). Twenty native Japanese speakers participated in the experiment. ERPs elicited by nouns preceded by classifiers showed an interaction with prediction strength and prediction satisfaction. First, centro-parietal negativities in the N400 time window are inversely correlated with the prediction strength. The classifier "-tsu", which triggers the weakest prediction for the up-coming nouns, elicited the largest N400. Second, dissatisfaction of prediction elicited significantly larger N400 with the classifier "-dai" but N400 modulation did not reach significance with other two classifiers. Instead, a significant contrast was observed in left anterior electrodes with the classifier "-tsu". Summarizing, prediction strength and prediction satisfaction modulated N400 whereas the interaction between prediction satisfaction and predictor frequency is reflected by LAN. [1] Yoshida, M., Aoshima, S., & Phillips, C., 17th CUNY Conference on Human Sentence Processing, 2004. [2] Zhou, X., et al., Neuropsychologia 48, 1551-1562, 2010. [3] Chou, C.-J., et al., Journal of Neurolinguistics 31, 42-54, 2014. [4] Mueller, J., et al., Journal of Cognitive Neuroscience 17:8, 1229-1244, 2005.

E27 Producing sentences in the MRI scanner: Effects of lexicality and verb arguments

Atsuko Takashima[1], Antje Meyer[1], Peter Hagoort[1,2], Kirsten Weber[1,2]; [1]Max Planck Institute for Psycholinguistics, Nijmegen, the Netherlands, [2]Donders Institute for Brain, Cognition and Behaviour, Nijmegen, the Netherlands

Neuroimaging studies have shown that a core network of inferior frontal cortex and posterior temporal cortex with a left hemisphere dominance is involved in sentence comprehension as well as production. Most sentence-level production studies in the MR scanner have focused on simple transitive sentence and we know little about the production of sentences featuring verbs differing in argument structure. Here we tested whether brain activation patterns, as measured with BOLD-fMRI, differed when participants were producing sentences which varied in the number of verb arguments (intransitive/transitive/ditransitive verbs). Furthermore, we assessed the effect of lexicality using existing Dutch verbs and pseudoverbs. This was done because processing parts of sentence structure, such as verb-arguments could be lexically-driven. We obtained functional MR images with a 3T scanner while 30 right-handed native speakers of Dutch produced sentences cued by visual input. The stimuli consisted of 18 written existing verbs and 18 pseudoverbs. These (pseudo)verbs were categorised to be used in intransitive, transitive or ditransitive sentences (6 verbs each - verb argument effect). Three geometric figures (circle, triangle, and square)

were used as the nouns filling the roles of the agent and verb arguments. Trials were presented in mini-blocks per sentence structure condition. Each block started with an example for the type of structure to be produced (e.g. "The triangle gives the square to the circle"). On each trial, participants first saw the (pseudo)verb to-be-used in the centre of the screen for 1.5 sec, followed by the three geometric shapes in a horizontal layout for 5 sec. They were instructed to overtly produce a sentence with the same structure as the example, using the (pseudo)verb and the figures. Overall, a verb lexicality effect (verb > pseudoverb sentences) was found in the left inferior frontal gyrus (LIFG) and the left posterior middle temporal gyrus (MTG). Additionally, a more posterior bilateral middle temporal region extending to the angular gyrus showed greater activation during the verb than pseudoverb sentences. A verb argument effect (ditransitive > intransitive) was accompanied by an increase in activation in the left posterior MTG and bilateral precuneus. The left posterior MTG cluster overlapped substantially with the cluster found for the lexicality contrast. Thus, as in single word comprehension, producing sentences showed activation of the core language network in LIFG and left posterior MTG. This was especially the case when the verb was an existing word and the sentence had multiple argument slots to be filled. In summary, we show that the production network overlaps with the comprehension network. As for the lexicality effect, existing words compared to pseudowords have a memory representation with rich lexical-syntactic information activating the core language network during production. Retrieval of more complex lexical-syntactic patterns for sentences with more verb arguments lead to increased activation in the posterior language network related to the lexical-syntactic information stored in the mental lexicon.

Meaning: Lexical Semantics

E28 Dissociating the Role of Repetition and Semantic Association

Neus Ramos Escobar[1,2], Clement Francois[1,2], Mtti Laine[3], Antoni Rodriguez-Fronells[1,2,4]; [1]Cognition and Brain Plasticity Group, Bellvitge Biomedical Research Institute (IDIBELL), L'Hospitalet de Llobregat, Barcelona, Spain, [2]Department of Basic Psychology, Campus Bellvitge, University of Barcelona, L'Hospitalet de Llobregat, Barcelona 08097, Spain, [3]Department of Psychology, Abo Akademi University, Turku, Finland, [4]Catalan Institution for Research and Advanced Studies, ICREA, Barcelona, Spain

Vocabulary acquisition is an essential component of language learning. The word-to-world mapping process in adults requires that learners create new links between arbitrary sounds and symbols and conceptual representations. This is a complex process that involves the initial familiarization (repetition exposure) with the orthographic or phonologic features of the word, an association of the word with the corresponding object or meaning and the final integration of this word to the current lexicon. Here we conducted two new ERP experiments to track the time course and development of the word-to-world mapping process during learning, controlling for the effects of new-word repetition (exposure effects) and conceptual binding (associating the new-word to an existing concept). Specifically, we aimed to investigate on how these processes develop in time (from one day to repeated training along days) and to disentangle the role of simple repetition of new word forms from the process of binding new-words to an existing concept during vocabulary acquisition. With these aims, in Experiment 1, we examined the brain responses of 25 adult participants acquiring a new vocabulary (novel objects with non-word pairs) over five consecutive sessions and a follow-up evaluation 4 months later. Three memory tasks (overt naming, covert naming and recognition tasks) were administered during each session and in the follow-up. EEG was recorded during the first and last training sessions. In Experiment 2 we replicated session 1 of Experiment 1 but, differentially, participants were assigned into two different groups (N=19 in each group). For the Learning Group (LG) the associations object-word were consistent, but for the No Learning Group (NL), the associations object-word were inconsistent (no semantic learning was possible). The ERP results for Experiment 1 revealed a near linear increase on the amplitude of the LPC with repeated exposure to pictures in centro-posterior brain regions. In contrast, a linear decrease on the N400 amplitude at fronto-central sites was observed across training when new-words were associated with a particular meaning (picture). In Experiment 2, both behavioral and ERP data showed evidence of learning with correctly learned associations eliciting a linear decrease of N400 amplitude through training in the LG but not in the NLG. A decrease in the amplitude of the P200 component for new-words in parietal electrodes was also found in the NLG but interestingly, not in the LG. These results provide new evidences regarding the role of semantic integration and repetition effects (familiarization to new-forms) during language learning and how these processes modulated the N400/P2. We also showed evidences that the learning process is boosted when new-words are associated with a particular meaning most probably through faster integration of the new traces into the existing semantic networks.

E29 Network Analysis of Concreteness within Association Modules

Dominick DiMercurio[1], Chaleece Sandberg[1]; [1]Pennsylvania State University

A large body of evidence from neuroimaging meta-analyses (Binder et al., 2005, 2009; Wang et al., 2010), behavioral studies (Binney et al., 2016), and clinical cases (e.g., Jeffries et al., 2007, 2009) suggests that abstract and concrete words are dissociable; furthermore, models of neuroimaging or behavioral data provide further insight into the possible mental organization of this dissociation. For instance, binary classification methods such as

logistic regression (Wang et al., 2013) and support vector machines (SVMs), applied to neuroimaging data, have been used to decode concreteness. On the behavioral end, clustering analyses based on cognitive scores have been used to identify patterns that appear to dissociate concreteness to some degree as well (Troche et al., 2017). To our knowledge, no study to date has used word association to decode concreteness; however, it appears plausible as a word association study (de Groot, 1989) found that concrete words produced more, faster, and less diverse associations than abstract words. Notably, she also found that concrete words strongly cued concrete words, and abstract words cued both types of words. The present study investigates, using free association norms, how abstract and concrete words pattern within semantic domains. We hypothesize that decoding concreteness from features of an association network, as a model of semantic organization, should improve if those features are selected based on measures related to graph communities, which model semantic domains. To test this hypothesis, we developed a 4763-word directed weighted association network from the University of South Florida association norms databases. After extracting communities from the network, we analyzed measures of segregation and integration for each cue and target. For testing the representativeness of the network, we investigated the relative transitions based on concreteness classification and word frequency. In comparison with findings from de Groot, we found that abstract words more strongly cued abstract words and that concrete words more strongly cued concrete words; in addition, we found that target words were of significantly higher frequency than cue words. It is also worth noting that there is a heavy concrete-bias in the norming database, with the bias roughly 6:1 in cue words and 8.5:1 in target words. Overall, we found good performance in SVMs built from distance features to highly segregated cues (69% accurate) or highly integrative targets (64% accurate), comparable to neuroimaging-derived SVMs (60-75% accurate) and higher than SVMs built from distance features to random nodes (50% accurate). From inspection of the communities, some communities seem to be more abstract-biased and some are more concrete-biased; however, the distributions also showed that cue segregation measures were higher for concrete than abstract words and that target integration measures were reverse. In conclusion, these results show that a model based on association norms can discriminate concreteness, semantic domains appear to vary in abstract or concrete content, concrete words tend to be more segregated while abstract words tend to be more integrative, and examining the community structure of semantic networks using graph theory is useful for modeling the organization of the semantic system.

E30 Learning Novel Words with Meanings: The Role of Consolidation in Word Learning and Memory Retention

Yushuang Liu[1], Janet G. van Hell[1]; [1]The Pennsylvania State University

The Complementary Learning Systems Theory (CLS; Davis & Gaskell, 2009) proposes that word learning entails two memory networks. Novel words are initially encoded as episodic memory traces by the hippocampal learning system. After a subsequent period of consolidation, a shift towards more systematic, lexicalized coding of the memory representation in a distributed neocortical network occurs. Previous research examining the CLS and the encoding and consolidation of newly learned words in memory mostly focused on learning new word forms, without explicitly taking semantics into account. Recently researchers have started investigating the role of word meanings. In an ERP study by Bakker, Takashima, van Hell, Janzen, and McQueen (2015), participants learned novel printed words paired with novel meanings on both Day 1 and Day 2. Immediately after word learning on Day 2, participants were administered a semantic priming task, which included words learnt on both Day 1 and Day 2, while EEG/ERPs were recorded. Indexed by N400 and LPC components, Bakker et al. (2015) found that novel word forms learnt on Day 1 had been lexicalized after a 24-hour consolidation period, whereas the semantic integration process has started but was not yet completed. One question that remains to be addressed is the effect of prior language learning experience on acquiring novel words. Bakker et al. (2015) tested Dutch native speakers who were all experienced foreign language learners; they were proficient in English and has also learned German and French as foreign languages. Previous behavioral studies demonstrate an advantage of bilingual speakers over monolingual speakers in learning novel words (e.g., Kaushanskaya, 2012; Kaushanskaya & Marian, 2009; Papagno & Vallar, 1995; Van Hell & Mahn, 1997). This raises the question whether Bakker et al.'s findings generalize to monolinguals with very little prior experience in learning foreign languages. In the current study, we examined novel word learning and consolidation in monolingual English speakers, tested in the United States, using Bakker et al.'s paradigm and recording EEG/ERPs. The N400 responses to novel words learnt on Day 1 patterned with responses to novel words learnt on Day 2, indicating that novel word forms learnt on Day 1 have not been lexicalized and integrated into the monolingual learners' lexical network after 24 hours, in contrast to the experienced foreign language learners tested by Bakker et al. (2015). In terms of semantic integration, when preceded by semantically related words, no evidence of automatic semantic retrieval was observed in the N400 window, regardless whether novel words were learnt on Day 1 or Day 2. However, novel words learnt on Day 1 revealed a stronger reanalysis effect in the LPC window, while novel words learnt on Day 2 only showed

this reanalysis effect when they were preceded by more strongly related prime words. These findings provide further insight into the effect of prior language learning experience on novel word learning and consolidation: neural responses of experienced foreign language learners demonstrate overnight consolidation of novel word forms, but such consolidation effects do not emerge as strongly in monolinguals' neural responses.

E31 Anterior temporal lobe in identification of specific entities

Nicholas Riccardi[1], Rutvik Desai[1]; [1]University of South Carolina

Introduction: The anterior temporal lobe (ATL) has been shown to have an important role in the semantic system. Evidence from neuropsychological and neuroimaging investigations have also demonstrated its role in several other domains, including social and emotional processing, naming of unique entities, sentence processing, and memory. Some past studies have used associative learning paradigms wherein facts are learned about novel stimuli. ATL involvement is attributed to the retrieval of this semantic or social information. Here, we examined the role of the ATL in the identification of specific familiar entities, while controlling for other factors such as semantic retrieval. We hypothesized that the ATL would be involved in the identification of familiar compared to novel entities, even when these conditions are matched for semantic or social content, demonstrating ATL involvement in memory and identification of specific entities separate from semantic retrieval. Methods: Twenty-six healthy adults were trained to recognize 144 previously unfamiliar stimuli from six categories (objects, persons, buildings, words, nonwords, numbers), with no additional information attached. Twenty-four hours after training, subjects were presented with blocks of familiar stimuli along with blocks of novel stimuli from the same categories and had to judge them as either familiar or unfamiliar while undergoing fMRI. Searchlight (5 mm radius) multivoxel pattern analysis (MVPA) was used within a bilateral ATL mask to train a linear support vector machine (SVM) model to classify stimuli as either 'familiar' or 'unfamiliar', using each participant's time course-dependent voxel activations as input. Classification results were evaluated within-subject using 6-fold, leave-two-out cross-validation wherein the model was trained on the voxel patterns from five familiar and five novel blocks of the same category and then asked to classify the two remaining blocks as either familiar or novel. Prediction accuracies were based only on test data and were independent of the training set. To evaluate significance of cross-subject accuracy, the accuracies of every within-subject analysis were averaged for each category separately and subsequently tested against a simulated binomial cumulative distribution with a sample size of n=26 and 2-class classification. Informative voxel clusters were identified via t-tests against chance accuracy, and voxelwise thresholding at $p < 0.001$. Results: The model was able to accurately discriminate between familiar and novel stimuli for each category: persons (82.7%, $p < 0.001$), buildings (82.7%, $p < 0.001$), objects (78.2%, $p < 0.005$), words (80.4%, $p < 0.005$), nonwords (83%, $p < 0.001$), and numbers (79.5%, $p < 0.005$). Searchlight analysis revealed cross-subject clusters of informative voxels for each category, with clusters in the left ATL being associated with verbal stimuli and right ATL with pictorial stimuli. Conclusions: The ATL contains information that identifies specific/familiar entities from novel entities that are visually similar, even when controlling for associated social and semantic content. This holds for a variety of categories, including those with low semantic or social value such as nonwords and numbers. These findings support a role for the ATL in the identification of specific entities that can be dissociated from social and semantic processes.

E32 Frequency, orthographic neighborhood, and concreteness effects in deaf readers of English: An ERP study

Stephanie Osmond[1], Kurt Winsler[2], Gabriela Meade[1,3], Phillip J Holcomb[1], Katherine J Midgley[1], Karen Emmorey[1]; [1]San Diego State University, [2]University of California, Davis, [3]University of California, San Diego

Early event-related potential (ERP) components differ between skilled deaf and hearing readers. For example, a recent ERP study found differences in the N170 to words compared to symbols when comparing deaf and hearing readers (Emmorey et al., 2017). Hearing readers showed a larger difference in N170 amplitude between words and symbol strings, especially over left temporal-parietal sites, while skilled deaf readers showed smaller and less asymmetrical differences. These patterns suggest that during the early stages of processing, hearing and deaf readers differ in the underlying mechanisms involved in visual word recognition. Very little research has compared deaf and hearing readers on language-sensitive ERP components later than the N170. Extending the focus to these later downstream components is important because collectively they reflect important aspects of language comprehension that might also distinguish hearing and deaf readers. Previous ERP studies in hearing English speakers have shown that several word-level variables have a robust effect on ERP components starting around 200 ms after word onset: lexical frequency, or how often a word is encountered in English, neighborhood size, or how many other words the word looks like, and concreteness, or the degree to which the concept that the word refers to is concrete or abstract in nature. These three characteristics have been shown to produce systematic differences in the timing, amplitude, and scalp patterns of various post-N170 ERP components. The current study extended observations of the effects of these variables on ERPs from hearing participants to deaf readers of English. We hypothesized that if the differing pattern of early N170 effects reported by Emmorey et al. (2017) is indicative of a completely different set of reading mechanisms in deaf readers, then later downstream processes involved in reading might also differ between these two groups.

Deaf participants who report American Sign Language as their primary and preferred language, but are also proficient readers of English, were asked to decide if written words presented one by one were real English words [e.g., table] or nonwords [e.g., flark]. Participants pressed only to nonwords [12% of items]. Words varied in lexical frequency, orthographic neighborhood density, and conceptual concreteness. Deaf readers produced a very similar pattern of ERP effects to those seen in hearing readers across the three variables that we manipulated, suggesting that the post N170 mechanisms involved in recognizing visual words are similar for hearing and deaf readers.

E33 Temporal and spatial differences in the lexical and morphosyntactic incongruence processing

María Francisca Alonso-Sánchez[1,2], Lucía Zepeda[1,3], Pavel Prado[3], Pedro Alfaro-Faccio[4], Debra von Chrismar[4]; [1]Escuela de Fonoaudiología, Facultad Salud, Universidad Santo Tomás, [2]Centro de investigación del desarrollo en cognición y lenguaje (CIDCL), Universidad de Valparaíso, [3]Advanced Center for Electrical and Electronic Engineering (AC3E), Universidad Federico Santa María, [4]Instituto de Literatura y Ciencias del Lenguaje (ILCL), Pontificia Universidad Católica de Valparaíso

Background: The language comprehension depends on several factors, among them, lexical and syntax processing. Access to lexical information is generated by activation through the pairing of accumulated information and by the inhibition of lexical entries competing for activation. Moreover, in spanish the assignment of the attribute feature, to the subject or the object in the clause, is determined among others by the gender and number congruency. The aim of this study was to determine the temporal and spatial differences of the lexical and morphosintactic processing. Methods: A study was conducted with event related potentials measurement with two lexical and two morphosyntax incongruence paradigm in 10 healthy subjects. Two lexical conditions were made, in and out of the lexical field incongruence. Otherwise, two morphosyntactic condition were made, gender and gender/number incongruence between the subject and the attribute of the verb. The ERP analysis was made with Brain Analyzer and the inverse solution was made with LORETA. Results: A statistical difference was showed in the latency of appearance of N400 and greater activation of precuneus, orbitofrontal, angular and supramarginal gyro in the condition of incongruence out of the lexical field. On the other hand, the latency of appearance of the P600 in the gender condition was larger (around 800ms) than the gender/number (around 600ms) condition. The activation patterns also show differences. Conclusion: the processing of lexical and morphosyntactic incongruence show a difference temporarily and in the pattern of brain activation.

E34 Rapid meaning access to newly learned words: Evidence from an ERP study

Xiaoping Fang[1,2], Charles Perfetti[1,2]; [1]University of Pittsburgh, [2]Center for Neural Basis of Cognition

Previous studies have shown that meaning access to novel words can become automatic, especially after overnight consolidation. This is usually indicated by the emergence of semantic priming or interference between novel and existing words one or more than one day following the initial learning. The current study aimed to examine the automaticity of meaning access in a more direct way through observing ERPs to novel words that were assigned sensor-motor meanings. While previous studies have used pictures or videos to provide direct sensorimotor input, we taught the novel words with definitions. Participants learned novel words associated with either action or non-action (i.e., static visual) meanings across multiple sessions of training over three days, reaching ceiling performance in both cued-recall and recognition tests. On the fourth day, they performed a meaning judgment task on novel words and existing words presented in auditory modality while ERPs were recorded. The results showed an early semantic effect among novel words, as indicated by a larger negativity for action words than non-action words within N1 and P2 time windows. In contrast, the effect emerged relatively later in existing words (after 300ms). Although novel words and existing words overall were indistinguishable before 500ms, we observed larger frontal negativity and parietal positivity for novel words than existing words within 500-700ms. While the difference in the latency of semantic effects between novel and existing words is likely to be driven by the difference in the uniqueness point of spoken words, the very early effect observed on novel words suggests that specific meaning features are activated rapidly (and arguably automatically) during the processing of the spoken word even though meanings had been learned through definitions. Furthermore, episodic retrieval (observed in a later time window) is involved when such activation is not sufficient to support confident meaning judgments about novel words.

Meaning: Combinatorial Semantics

E35 The influence of word imageability on the N400 effect: Preliminary results

Marilyne Joyal[1], Sonja A. Kotz[2], Christophe Lenglos[1], Emmanuelle Renauld[1], Maximiliano A. Wilson[1], Shirley Fecteau[1]; [1]Université Laval, [2]Maastricht University

Introduction: Word imageability is the extent and easiness of a word evoking mental imagery. Behavioral studies showed that individuals are more accurate and faster to process higher than lower imageable words in different tasks probing semantics. The N400 effect is an index of semantic processing, as measured by the amplitude difference between two semantic conditions (here, associated and non-associated words). However, event-

related potentials (ERPs) associated with word imageability in semantic tasks remain to be elucidated, notably during normal aging. In this experiment, we examined the influence of word imageability on behavioral responses and the N400 effect in healthy elderly participants. We hypothesized that participants will show better behavioral performance for higher than lower imageable words. Further, in line with this expected behavioral difference, we predicted that the N400 effect will differ in size between high and low imageable words. Methods: ERPs were recorded in thirteen elderly participants (mean age=72.8 y.o.; sd=4.3) while they performed a semantic judgment task. Participants were invited to determine if two words presented sequentially were associated or not (e.g. truth – honesty). Imageability (high and low) and association (associated and non-associated) were orthogonally manipulated. Experimental conditions were matched by word frequency, length in letters, orthographic neighborhood size and association strength. ERPs were recorded from 64 scalp positions with Brainvision Recorder software and Brainamp MR Plus amplifiers by Brain Products GmbH. We calculated performance accuracy, RTs (in ms) on accurate responses, and the N400 effect using a time-window of 300 to 600ms post-stimulus onset on four regions of interest (ROIs) encompassing left/right anterior and left/right posterior ROIs. Results: Preliminary behavioral data indicated that participants were more accurate and showed shorter RTs in the high-imageable condition as compared to the low-imageable condition for both associated and non-associated words. The amplitude of the N400 effect was smaller in the high-imageable condition than the low-imageable condition for each of the four ROIs. Conclusion: These preliminary results suggest that there is differential semantic processing for high and low imageable words in elderly participants. Results are in line with the view that perceptual information of concepts influences semantic word processing. Further, this behavioral difference may relate to the reported N400 effects. This difference in the ERP response, that is, a smaller N400 effect for higher than lower imageable words however remains to be further investigated in different aging cohorts.

E36 Catecholaminergic modulation of the semantic processing in sentence comprehension *Yingying Tan[1], Peter Hagoort[1,2]; [1]Max Planck Institute for Psycholinguistics, Nijmegen, The Netherlands, [2]Donders Institute for Brain, Cognition and Behaviour Centre for Cognitive Neuroimaging, Radboud University, Nijmegen, The Netherlands*

Introduction Catecholamine (CA) neurotransmitters (especially dopamine and noradrenaline) have long been implicated playing a critical role in executive control and decision making [1]. Recently, evidence from neurodegenerative patients and healthy population suggested that CA also affects language processing [2, 3]. However, the question of what kind of influence the CA might exert on language is still open. The present study investigated this question by examining the effects of 20 mg of methylphenidate (MPH), which is a catecholamine agonist, on EEG response related to semantic processing. MPH could block CA neurotransmitters reuptake and thus lead to increased extracellular CA availability. Examining the effect of MPH on semantic processing could help us better understand the neurobiological and neuropharmacological mechanisms underlying language processing. Methods 48 healthy native Dutch speakers were tested in two pharmacological conditions (MPH vs. Placebo), using a within-subject, double-blind, randomized design. In each condition, participants read 180 sentences with half of the sentences were semantically congruent while the other half sentences were not. In order to examine whether the MPH effect is goal-dependent, for half of the sentences (a block design), participants had to judge whether the sentence is semantically congruent (Semantic-task); while for the other half, participants only have to judge whether a probe word presented after the sentence was of the same font size as the sentential word (Font-task). In the latter task, processing the semantic content of the sentence was task-irrelevant. Participants' brain responses were recorded from 28 EEG electrodes. Results & Discussion In the placebo condition, we replicated the classical N400-LPC (late positive complex) effect in the Semantic-task. Moreover, participants showed a smaller N400 effect in the Font-task than in the Semantic-task, indicating a shallower semantic processing. Most importantly, we observed an interaction of MPH×Congruency×Task in the 100–150 ms, N400, and LPC time-windows. Only in the Font-task, a stronger N400-effect was obtained in the MPH condition than in the Placebo condition. In the Semantic-task, however, the N400 effect was attenuated in the MPH condition but this attenuation might be a carryover from the earlier 100-150 ms time window. In this early time period a MPH-induced negative deflection in the semantic congruent condition was observed. In addition, the LPC effect, which was only observed in the Semantic-task, was greater in the MPH condition than in the placebo condition. Our results demonstrated a clear neuropharmacological effect on language processing. Modulations of the dopamine and/or noradrenaline levels influence sentence-level semantic processing. Results from the Font-task contradicted the general hypothesis that CA promotes goal-relevant processes, while inhibiting goal-irrelevant information. The results indicate that CA-related neurotransmitters provide a relevance signal that enhances semantic integration operations. The Basal Ganglia projections to Frontal Cortex might mediate the language processing effects of these neuropharmacological agents [4]. References [1] Cools, R., & D'Esposito, M. (2011). Biological Psychiatry, 69, 113-125. [2] Copland, D. A., et al. (2009). Cortex, 45, 943-949. [3] Grossman, M., et al., (2001). JoNS, 184, 123-130. [4] Hagoort, P. (2014). Current opinion in neurobiology, 28, 136-141.

Meaning: Discourse and Pragmatics

E37 Pragmatic language comprehension in the adolescent brain

Salomi S. Asaridou[1], Özlem Ece Demir-Lira[2], Julia Uddén[3], Susan Goldin-Meadow[2], Steven L. Small[1]; [1]Department of Neurology, University of California, Irvine, [2]Department of Psychology, The University of Chicago, [3]Department of Psychology, Stockholm University

Adolescence is a period during which social interactions, especially with peers, become increasingly important. Mastering pragmatic language comprehension, i.e. the ability to interpret language in its communicative context, is therefore a crucial part of adolescent development. Despite its behavioral significance, little is known about the neural underpinnings of pragmatic language understanding in adolescents. Here we aimed to identify the brain networks recruited when adolescent listeners make pragmatic inferences during discourse comprehension. We used dialogues consisting of questions and direct replies (requiring no inference) or questions and indirect replies (requiring inference with or without affect). Given the fact that social-cognitive skills (such as Theory of Mind, ToM), and social-affective skills (such as empathy) are necessary for pragmatic inferences, we hypothesized that listening to the indirect-affective replies would engage regions important in ToM and empathy, including the medial prefrontal cortex (mPFC) and the temporo-parietal junction (TPJ). We collected fMRI data from 23 typically developing adolescents (14 male, mean age 15y;8m) as they listened to short question-answer dialogues. While the answers were the same across conditions, the meaning differed as a function of the preceding question. We constructed three conditions: (1) Direct, requiring no inference (Q: "Why do people use baby shower gift lists?" A: "It is difficult to choose a present for a baby"). (2) Indirect-informative, requiring inference, but without affect (Q: "Do you know what gift you're getting for Matilda's baby shower?" A: "It is difficult …"). (3) Indirect-affective, requiring inference to save face (Q: "Did Matilda like the onesie I gave her at the baby shower?" A: "It is difficult …"). Participants' empathy skills were assessed with the Adolescent Empathy Quotient and entered as a covariate in the analysis. A significant effect of indirectness (Indirect-Affective and Indirect-Informative vs. Direct replies) was found in the right superior temporal gyrus/sulcus (STG/STS) and right middle temporal gyrus (MTG). Contrasting affective with non-affective replies (Indirect-Affective vs. Indirect-Informative and Direct) revealed increased activation in the bilateral STG/STS, MTG, cerebellum, left superior frontal gyrus (lSFG), left angular and supramarginal gyri, right middle and inferior frontal gyri. Indirect replies that differed in affect (Indirect-Affective vs. Indirect-Informative), and thus controlled for inference, preferentially engaged the lSFG, right posterior cingulate, right supramarginal gyrus (rSMG), and the right mPFC/ACC. Additionally, adolescents with higher empathy skills showed decreased activation for affective vs. direct replies, in the rSMG. Conclusions. When listening to dialogues that require affective pragmatic inference, adolescents recruited a wider "social brain network," including prefrontal areas such as the mPFC, SFG, and ACC. Furthermore, individual differences in empathy modulated brain activation to these dialogues in the rSMG (part of the right "TPJ"), an area involved in perspective-taking. Interpreting affective/face-saving replies elicited the strongest activation, reflecting how salient the opinions and perspectives of others are in adolescence. Although indirect replies overall elicited right-lateralized temporal activation, adolescent activity for affective-indirect replies was less lateralized than previously reported in adults. This suggests that the neural developmental trajectory from adolescence to adulthood may entail increasing hemispheric specialization for processing different aspects of communicative tasks.

E38 In search of association patterns between perisylvian white matter tracts and different speech genres

Georgia Angelopoulou[1,2], Dimitrios Kasselimis[1,3], Erin Meier[3], Sofia Karanassou[4], Yue Pan[2], Dimitrios Tsolakopoulos[1], Zoi Nikitopoulou[4], Ioannis Evdokimidis[1], Swathi Kiran[3], Constantin Potagas[1]; [1]Eginition University Hospital - National and Kapodistrian University of Athens, [2]College of Health & Rehabilitation, Boston University, [3]University of Crete, [4]Panteion University of Athens

The contemporary consensus about the neural underpinnings of language is that a left-lateralized network consisting of two streams, supports processing of verbal information and language production. Despite the available fMRI and lesion data in the literature, few studies have thus far investigated the association between speech variables and the integrity of white matter tracts contributing to this network, in healthy population. The aim of this study is to assess the relationship between structural coherence of such tracts and rate of speech during two distinct elicitation tasks. For this purpose, 26 healthy participants were asked to produce speech samples under two conditions: description of a picture, and free narration of a personal event. Audio files were transcribed and speech rate was calculated (words per minute). T1 MRI and Diffusion Tensor Imaging (DTI) were acquired using 3T Phillips scanner, for all participants. DTI data analysis, including preprocessing (brain extraction using BET) and Tract-Based Spatial Statistics (TBSS), was performed in order to calculate mean-FA and all-FA values. Then, FA values for specific tracts of the left hemisphere, were calculated based on Catani's Atlas (Catani & Schotten, 2008), for each participant. Paired-samples t-test results showed that there are significant differences between the two conditions, with the picture description task eliciting higher mean speech rate. Imaging data analyses revealed different association patterns between specific regions of the arcuate fasciculus and speech rate, between the two elicitation tasks. In particular, regression models showed a significant contribution of the FA of the anterior segment of the left arcuate fasciculus on speech rate during narration,

but not picture description, after controlling for the mean FA, age, and years of formal schooling. Overall, our data suggest that the amount of words produced during a given time frame may depend on condition, and furthermore provide indications for a relationship between the integrity of specific white matter tracts and this particular language variable. This latter relationship is also shown to be differentiated, depending on the genre of the elicitation task.

E39 Integrating speaker and meaning in individuals with and without Autism Spectrum Disorder: evidence from eye-tracking and ERPs

Mahsa Mirza Hossein Barzy[1], Jo S Black[1], David M Williams[1], Heather J Ferguson[1]; [1]University of Kent

Evidence suggests that while comprehending language, people build mental models that include knowledge about the speaker. For instance, using event related potentials (ERPs), a semantic anomaly type response (i.e. N400 effect) was observed when typically developing (TD) adults listened to sentences in which the content of the message mismatched the voice of the speaker (van Berkum, et al., 2008). It is claimed that individuals with Autism Spectrum disorders (ASD) have difficulties integrating information from the context to build pragmatic mental models while comprehending language (Happe´, 1996). Hence, in this study we examined whether adults with ASD exhibit comparable integration and anticipation processes for speaker and meaning as TD adults. Experiment 1 employed the visual world paradigm, and tracked the timecourse of anticipatory biases to meaning based on a speaker's voice. Forty-eight participants (N=24 in each group) listened to sentences, in which the voice of speaker was either consistent or inconsistent with the intended message (e.g. "On my last birthday, I got an expensive electric shaver/car" in a child or an adult's voice), and concurrently viewed visual scenes that depicted these consistent/inconsistent objects alongside distractor objects. Participants' eye movements were recorded and they were asked to select the picture that best matched the audio description. Behavioural results showed that all participants were slower to select the correct object when it was inconsistent with the speaker's voice than when it was consistent, though this difference was greater in the TD group than the ASD group. Eye-tracking results revealed a visual bias towards the object that was consistent with voice of the speaker from at least 600ms before the disambiguating word onset (i.e. "shaver/car"), showing that participants rapidly integrated the speaker's voice and used this to anticipate the content of forthcoming language. In Experiment 2 we used recorded ERPs to explore how consistency between the voice of speaker and the message influences integration processes. Forty-eight participants (N=24 in each group) listened to sentences of the same type as in Experiment 1 (e.g. "I tried to refresh my lipstick in front of the mirror" in a man or a woman's voice). EEG activity was recorded from 32 electrodes, time-locked to the onset of the disambiguating target word, which was either consistent or inconsistent with the speaker's voice. A third sentence condition included a semantic anomaly (e.g. "I tried to refresh my seashell in front of the mirror"), and thus provided a baseline of anomaly detection effects on the N400 for comparison with speaker consistency effects. Results revealed an enhanced N400 for inconsistent sentences relative to consistent sentences, which was comparable to the N400 elicited by anomalous sentences. Further analyses examine group differences in the timecourse of these effects in both experiments. Overall, these results show that contrary to previous suggestions of pragmatic dysfunction, people with ASD are sensitive to integration between speaker and meaning.

E40 Effect of functional style incongruency on language comprehension: an ERP study in Russian

Anna Yurchenko[1], Mira Bergelson[1], Olga Dragoy[1]; [1]National Research University Higher School of Economics, Russian Federation

Introduction: Electrophysiological studies across languages have previously shown that processing words that violate the semantic context of a sentence elicits an N400 effect (a negative deflection peaking around 400 ms poststimulus) compared to semantically congruent counterparts (Friederici et al., 1993; Kutas & Hillyard, 1980; Wicha et al., 2004, etc.). In addition, the amplitude of N400 can be modulated by an (in)congruency between the target word and its wider discourse context (Van Berkum et al., 2003), real-world situation (Hagoort et al., 2004), a speaker's voice (Van Berkum et al., 2008), etc. However, little is known about the effects of the functional style on online language processing. In this study, we explored neurophysiological effects of a mismatch between the target word and the functional style of the preceding context (Experiment 1) compared to effects of semantic violations (Experiment 2), using the methods of event-related potentials (ERPs). Methods: The participants in Experiment 1 were 24 healthy right-handed adults aged 18–28 years (mean = 22 years; 15 females). The materials included 40 pairs of sentences in standard Russian (a) and 40 pairs of corresponding sentences in Russian slang (b). Each pair differed in a single word that either matched or violated the functional style of the context. a. During a joyful preference game the clerks/*dudes were composing fables about the employees. b. Getting high on the pontoon the dudes/*clerks were telling stories about the mollies. Twenty four healthy right-handed individuals aged 18–42 years (mean = 23 years; 23 females) participated in Experiment 2. The stimuli were designed similarly to those in Experiment 1, with the pairs of sentences differing in a single word – consistent or violating the semantic context (c–d). c. The child washed the scoop/*curve in the sea. d. The racer passed the curve/*scoop very fast. In both experiments, participants were asked to listen attentively to the sentences and to perform an unrelated task, judging the presence/absence of a word in the preceding sentence after 25% of stimuli. The EEG was recorded using 128 high-impedance ActiCap

active electrodes (Brain Products Gmbh, Germany) mounted on an elastic cap. The differences between the experimental conditions were analyzed using repeated measures ANOVAs. Results: The statistical analysis revealed similar patterns for processing words that violated the functional style and the semantic content of a sentence – both kinds of violation elicited a negative deflection in the 300–500 and 500–800 ms time windows with a maximum over central, centro-parietal and parietal electrodes (all p-values < 0.05), compared to the congruent condition. Discussion: Functional style violations affect the course of online processing similarly to mismatches between a word and its semantic context. Processing sentences containing words that were not consistent with the functional style of the previous sentence was characterized by the N400 effect, which was compatible to the time course and scalp distribution of the 'semantic' N400. These results suggest similar neurophysiological mechanisms underlying processing semantic and functional style incongruencies.

Language Therapy

E41 Classification of fMRI Data in Aphasia Based on Task, Time Point, and Subject

E. Susan Duncan[1], Steven L. Small[2]; [1]Louisiana State University, [2]University of California, Irvine

Introduction: Functional magnetic resonance imaging (fMRI) investigations of people with aphasia typically try to identify group characterizations of behavioral deficits or therapeutic improvement. Previous work in healthy individuals has demonstrated that fMRI can reliably distinguish among them across different tasks and time points. In the present study, we hypothesized that task-(in)dependent fMRI could reliably distinguish among individuals with aphasia at various time points during a treatment study. We seek to identify whether we can train a classifier to reliably separate fMRI samples based on subject, task, or time point (pre- vs. post-therapy). This work is ultimately intended to better understand patterns of functional connectivity associated with recovery. Methods: Nineteen subjects with post-stroke aphasia were scanned under two conditions (rest, speech observation) on ≥ 6 occasions over 18 weeks as part of a larger behavioral therapy study. Up to 3 baseline and 3 post-therapy scans were collected for each subject. We used FreeSurfer and the Connectome Mapping Toolbox to parcellate anatomical data into 82 cortical/subcortical regions, facilitated by Virtual Brain Transplant. Functional data were pre-processed using AFNI and FSL and nonlinearly aligned to a common template (ANTs). We applied a General Linear Model to remove nuisance regressors (motion; signal from white matter, ventricles, lesion) as well as stimulus timing for task-dependent fMRI. These residual time series were bandpass filtered (0.01-0.1 Hz). Scans were excluded if they had ≤ 3 minutes of uncensored data (<0.3 mm or degrees of motion), resulting in 132 data sets from 14 subjects. We extracted average time series from each of the 82 brain regions for each of the functional runs. Each of these 132 time series was mean-corrected and used to calculate a correlation matrix using the statistical language R. Ninety percent (n=118) of these correlation matrices were randomly selected to train a support vector machine (linear kernel; scikit-learn) to classify the remaining 14 matrices according to either task (n=2; rest, observation), time point (n=2; pre vs. post-therapy), or subject (n=14). Due to their probabilistic nature these analyses were repeated 100 times using different sets of training/testing data. Results: Identification by task was inconsistently above chance (M= 59.8%; SD= 4.1; range= 48.6-74.3), as was identification by time point (M= 61.4%; SD= 3.7; range= 52.1-70.0). Identification by subject was nearly perfect (M= 96.7%; SD= 1.8; range= 91.4-100). Discussion: The intrinsic organization of the brain is strongly subject to individual variation. However, it appears to be less distinctive in response to task, suggesting that observations from resting state fMRI are relevant for understanding changes in brain organization that underlie behavioral improvement on a task. This is beneficial given the potential limitations of individuals with aphasia to participate in task-based fMRI. Failure to divide the group based on time point (pre- vs. post-therapy) suggests that patterns of plasticity are not necessarily common across participants and should be viewed in relation to behavioral change. These findings highlight the importance of characterizing treatment- or recovery-induced changes in functional connectivity on an individual basis and suggest a foundation for personalized medicine.

E42 The effects of different exercise intensities on word learning in ageing: a randomised controlled trial.

Marie-Pier Mc Sween[1,2,3,4], Katie L. McMahon[3], Jeff S. Coombes[4], Kylie Maguire[4], Amy D. Rodriguez[1,5], Kirk I. Erickson[6], David A. Copland[1,2]; [1]School of Health and Rehabilitation Sciences, The University of Queensland, Brisbane, Australia, [2]UQ-CCR, The University of Queensland, Brisbane, Australia, [3]Centre for Advanced Imaging, The University of Queensland, Brisbane, Australia, [4]School of Human Movement and Nutrition Sciences, The University of Queensland, Brisbane, Australia, [5]Centre for Visual and Neurocognitive Rehabilitation, Department of Veterans Affairs, Atlanta, USA, [6]The Department of Psychology, The University of Pittsburgh, Pittsburgh, USA.

Background: There is increasing interest in whether exercise can be used to address age-related cognitive decline and enhance cognitive recovery after neurological injury. Recent studies show positive impacts of acute exercise on aspects of cognition including language learning and memory. In healthy young adults, a single bout of intense physical exercise has been shown to benefit vocabulary learning when compared to a sedentary or moderate intensity exercise group. However, it is not known whether these effects also occur in healthy older adults and the level of exercise intensity necessary to enhance new word learning in healthy older adults is yet to be established. Thus, the aim of this study was

to investigate the effects of different intensities of acute exercise on new word learning performance of healthy older adults. Methods: Sixty healthy older adults (mean age= 66; range= 60-78; gender= 43F/17M) were recruited to participate in this between-group randomised controlled trial. Participants attended three visits within a 3-week period and completed baseline cognitive assessments (including a baseline word learning task) and fitness assessment (VO2peak). Moreover, participants engaged in either stretching (38 minutes), moderate-intensity cycling (30 minutes at 55-65% Heart Rate (HR) max), or high-intensity cycling (4x4 minutes at 85-95% HRmax interspersed with 3x3 minutes at 50-65% HRmax), followed by an associative word-learning task in which 15 familiar objects paired with legal non-words were randomly presented in five blocks. A recall task was completed after each block. Blood samples were taken immediately before exercise, after exercise and after word learning. Results: Proportional data were arcsine transformed and then submitted to repeated measures ANOVA with recall accuracy as the dependent variable, intervention group and recall trial (1-5) as independent variables and VO2peak and baseline word learning performance as covariates. Preliminary analyses of immediate recall data (trials 1-5) showed a significant three-way interaction between recall trial, intervention group and baseline word learning performance ($F(7.5, 121.052)=7.512$, $p<0.005$, $\eta^2=0.320$). In participants with lower baseline word learning performance, there were main effects of recall trial ($F(4, 88)=7.267$, $p<0.005$, $\eta^2=0.248$) and intervention group ($F(2, 22)=6.041$, $p=0.008$, $\eta^2=0.355$), with recall accuracy in the moderate and high intensity groups being superior to the stretching group. In low baseline performers, there was also a significant interaction between intervention group and VO2peak ($F(3, 22)=4.520$, $p=0.013$, $\eta^2=0.381$). However, in participants with higher baseline word learning performance, there was no effect of recall trial, intervention group or interaction between intervention group and VO2peak. Conclusion: This study was the first to investigate different intensities of acute exercise, including high-intensity interval training, on new word learning success in healthy older adults. The results suggest an overall interaction between intervention and immediate word learning performance, however, this influence of exercise varies as a function of baseline word learning capacity and does not favour a specific intensity level. Further analysis of the relationship between exercise-induced changes in biomarker levels and word learning success will provide information on potential underlying neurophysiological mechanisms responsible for exercise-induced word learning enhancement in healthy older adults.

Language Disorders

E43 Aphasia therapy results in differential changes in functional connectivity depending on treatment response

Jeffrey P. Johnson[1], Erin L. Meier[1], Yue Pan[1], Swathi Kiran[1]; [1]Boston University

Functional neuroimaging studies of persons with aphasia (PWA) have linked post-stroke and post-treatment language improvements to regions in both hemispheres, suggesting that recovery does not hinge exclusively on the preservation of one or even a few specific regions. Thus, network-based analyses may improve our understanding of language recovery. To this end, we investigated longitudinal changes in task-based functional connectivity (FC) in treated and untreated PWA. Treated patients (TxPWA, n=26) were scanned on an overt picture naming task before and after 12 weeks of semantic feature analysis-based anomia treatment; untreated patients (unPWA, n=10) were scanned before and after 12 weeks without intervention; and 17 healthy controls were scanned at a single time point. TxPWA were trained and scanned on 36 items from two semantic categories; unPWA and controls were scanned on comparable item sets (i.e., pseudo-trained sets). Thirty-eight anatomical regions of interest (ROIs) were selected for FC analyses based on studies of naming and semantics. ROIs were specified according to the AAL Atlas, though patients' left-hemisphere ROIs were modified to account for their lesion. The CONN toolbox was used to estimate pairwise (i.e., ROI-to-ROI) correlations in the BOLD signal associated with naming trained/pseudo-trained items and to perform second-level analyses to identify differences in FC within and between groups. Eighteen TxPWA were identified as treatment responders based on achieving an effect size >4 in at least one trained category (Gilmore et al., submitted); the eight remaining TxPWA were identified as nonresponders. Prior to treatment, TxPWA had significantly lower FC than controls, particularly among bilateral frontal and left temporal and parietal regions. After treatment, there were fewer differences between the groups, suggesting normalization of function in TxPWA. TxPWA also had greater connectivity than controls between left supplementary motor area and right superior frontal gyrus (above results significant at $p<.05$ after analysis-level FDR correction). In treatment responders, FC associated with left inferior frontal gyrus pars orbitalis (LIFGorb) and right temporal pole (RTP) increased significantly after treatment ($p<.05$, seed-level FDR correction), while unPWA and nonresponders showed reductions in FC at the same threshold. Inspection of uncorrected results revealed a predominant trend of increased FC in responders, especially involving right frontal and left temporal and parietal ROIs; in contrast, nonresponders had reduced FC among these regions and increased FC involving LIFG pars triangularis and left inferior temporal gyrus. Consistent with prior studies, individuals with aphasia had reduced FC relative to controls, which normalized as

a function of treatment. Both unPWA and nonresponder TxPWA showed reduced FC as a function of time. Further, responders and nonresponders had distinct patterns of changing connectivity: effective treatment was associated with increased FC in regions critical to naming recovery (LIFG) and integration of semantic information (RTP); ineffective treatment was predominantly associated with reduced FC. This is the first report of differential changes in functional connectivity as a function of treatment response and between patients who improved in treatment versus untreated patients. Implications for reorganization of function after rehabilitation will be discussed.

E44 Continuous theta burst stimulation over right pars triangularis facilitates naming abilities in chronic post-stroke aphasia by enhancing phonological access *Denise Y. Harvey[1,2], Joely A Mass[1], Priyanka P Shah-Basak[1], Rachel Wurzman[1], Olufunsho Faseyitan[1], Daniela L Sacchetti[1], Laura DeLoretta[1], Roy H Hamilton[1]; [1]Department of Neurology, University of Pennsylvania, [2]Research Department, Moss Rehabilitation Research Institute*

Repetitive transcranial magnetic stimulation (rTMS) has been used experimentally to facilitate naming abilities in individuals with chronic post-stroke aphasia. However, due to the relative infancy of rTMS as a treatment for aphasia, the field has yet to establish criteria for determining who is a good candidate for this treatment approach. To better understand who is most likely to benefit from rTMS therapy, we explored whether variability in rTMS response is related to the severity and/or type (i.e., locus) of naming impairment. Eleven participants with chronic post-stroke aphasia received continuous theta burst stimulation (cTBS) – an inhibitory form of rTMS – to the right hemisphere homologue of Broca's area (i.e., right pars triangularis [rPTr]) and a control site (i.e., vertex) administered in separate sessions. Prior to stimulation, we obtained two baseline measurements of picture naming ability to determine the extent and type of naming impairment. Items presented for naming during stimulation were those that were named incorrectly in one or both of the baseline sessions (i.e., inconsistent versus wrong items, respectively). Baseline naming impairment severity was operationalized as the percentage of erroneous responses averaged across the two baselines. To identify the primary locus of naming impairment, we conducted in-depth analyses of participants' error profiles (i.e., semantic versus phonological errors). The findings revealed that, relative to vertex stimulation, cTBS of the rPTr improved naming of inconsistent, but not wrong, items for individuals with more severe baseline naming impairment, as assessed via a median split of baseline naming performance ($p = .04$). Interestingly, however, naming impairment severity was not significantly correlated with cTBS-induced naming improvements across all participants ($p = .80$). Instead, we found that the extent of phonological access impairment was marginally correlated with overall naming improvements following rPTr stimulation ($p = .057$), but not vertex ($p = .85$). Critically, naming improvements among these individuals specifically manifested in fewer errors arising at this stage of the production system, i.e. significant decrease in phonological ($p = .04$), but not semantic ($p = .56$), errors following cTBS of the rPTr. Neither the degree of phonological nor semantic access impairment predicted changes in naming performance following cTBS of the vertex (p's > .12). To our knowledge, this is the first study to examine the characteristics of naming impairment in aphasia as it relates to variable TMS treatment outcomes. The findings from this research not only lay the groundwork for incorporating cognitive models of word retrieval failure in future studies of TMS in aphasia, but they also have the potential to inform the stratification of patients into effective TMS protocols. In the current study, we provide evidence that individuals with word retrieval deficits localized to phonological access may be optimal candidates for TMS treatment protocols involving inhibitory stimulation of the rPTr.

E45 Neural Correlates of Impaired Emotional Prosody Recognition in Acute Right Hemisphere Stroke *Shannon M. Sheppard[1], Lynsey M. Keator[1], Bonnie L. Breining[1], Kevin Kim[1], Sadhvi Saxena[1], Donna Tippett[1,2,3], Amy Wright[1], Argye E. Hillis[1,2,3]; [1]Department of Neurology, Johns Hopkins University School of Medicine, Baltimore, MD 21287, [2]Department of Physical Medicine and Rehabilitation, Johns Hopkins University School of Medicine, Baltimore, MD 21287, [3]Department of Cognitive Science, Krieger School of Arts and Sciences, Johns Hopkins University, Baltimore, MD 21218*

Fully comprehending language requires understanding semantics and syntactic structure and perceiving subtle prosodic cues. Damage to right hemisphere (RH) regions is associated with difficulty understanding emotional prosody – the expression of emotion in speech (Dara et al., 2014). Some studies have implicated damage to RH temporal regions (Ross & Monnot, 2008, Wright et al. 2018) in affective prosody recognition impairments. Yet, other studies, often with heterogenous participant pools, have not found a clear link (Breitenstein et al. 1998). Schirmer and Kotz (2006) proposed a RH ventral stream (sound to meaning) for processing emotional prosody recognition projecting from the superior temporal gyrus (STG) to the anterior superior temporal sulcus (STS). Evaluative judgments are subsequently made in frontal regions. This proposed stream is analogous to the LH ventral stream for speech processing. The aim of the current study was to investigate the relationship between recognition of emotion and lesion location in individuals with acute right hemisphere strokes using lesion mapping. Participants with RH damage following ischemic stroke were identified. The acute time point (within five days of stroke) included 20 participants (nine women) aged 23-85 years ($M = 59.74$; $SD = 13.95$). The chronic time point (six – twelve months post-stroke) included five participants (three women) (mean age at acute time point = 47.60; $SD = 14.98$).

All participants received an acute MRI scan, including diffusion-weighted imaging (DWI). Areas of acute ischemia were identified and traced on DWI images. An emotion recognition test was given at both time points; participants listened to semantically neutral sentences spoken with emotional prosody and selected the corresponding emotion from six choices (happy, sad, angry, afraid, surprised, bored). DWI Trace images and lesion tracings were normalized, and proportion of damaged tissue in each of the parcels in the JHU atlas (Mori et al., 2008) were calculated for each participant. Associations between emotion recognition errors and the percentage of voxels damaged were identified. Z-scores were corrected for multiple comparisons; resulting statistical maps were thresholded using 2000 permutations (one-tailed $p < 0.05$). Acutely, emotion recognition was below that of controls (mean accuracy of 54.58% +/-SD 18.48% vs. 82.50% +/- SD 5.12%). Impaired emotional prosody recognition accuracy at the acute time point was associated with greater damage to the right posterior STG (Z = -2.69). Longitudinally, the three (of five) participants who demonstrated acute impaired emotional prosody recognition (> 1 SD below the mean from a group of healthy age-matched controls) all three showed improvement at the chronic time point. Only one improved to normal (83.3% accuracy). The lesion mapping results indicate the right posterior STG plays a critical role in the comprehension of emotional prosody, consistent with the RH ventral stream hypothesis of emotional prosody recognition. Longitudinal results demonstrate emotional prosody can improve from acute to chronic stages of recovery, but not all participants will achieve recovery to normal limits. Future research will further examine neural regions critical for specific components of emotional prosody, and the neural correlates and patterns of recovery in RH stroke.

E46 Bilingualism delays age of symptom onset in the language variant but not the amnestic variant of Alzheimer's dementia

Jessica de Leon; [1]

Bilingualism may be a contributor to cognitive reserve and therefore serve as a protective factor against the onset of Alzheimer's dementia (AD). However, results have been mixed. Whereas some studies have shown up to a 5-year delay in symptom onset for bilingual speakers, others have found no difference in the age of symptom onset between speaker groups (i.e. mono- versus bilingual speakers). Historically, AD was viewed as a single diagnostic entity; however, in the past several decades, research has demonstrated that AD comprises a spectrum of distinct clinical variants, including but not limited to, logopenic variant primary progressive aphasia (lvPPA) and amnestic AD. The amnestic variant of AD is characterized by episodic memory deficits and bilateral hippocampal and mesial temporal lobe atrophy. The language variant of AD, lvPPA, is characterized by impaired phonological processing (i.e. impaired repetition and word retrieval), with left temporo-parietal atrophy. Though these two variants share the underlying neuropathology of amyloid-beta plaques and tau tangles, they differ in the primary affected neural network (memory versus language). To date, studies have yet to delineate the effects of bilingualism within different AD variants. Therefore, the aims of this retrospective study were twofold. First, we examined if the proportion of bilingual and monolingual speakers were comparable across clinical variants, in a cohort of well-characterized patients who were diagnosed with either amnestic AD or lvPPA (based on established clinical and imaging criteria). We predicted that our speaker groups would not differ on the basis of clinical diagnosis. Second, we examined the effect of bilingualism on age of symptom onset, with the prediction that bilingual speakers in each clinical variant would show a delay in symptom onset relative to monolingual speakers. We identified 40 bilinguals (24 with amnestic AD and 16 with lvPPA) and 240 monolinguals (184 with amnestic AD and 63 with lvPPA), via chart review. Within clinical variant, the bilingual speakers did not differ from monolingual speakers by sex, years of education, handedness or neuropsychological measures; however, as expected, our groups differed by immigrant status ($p < .0001$). Results indicated that the proportion of bilingual and monolingual speakers were comparable across the clinical variants. With regard to a potential delay in symptom onset, results indicated a significant, 5-year delay in age of symptom onset for bilingual relative to monolingual speakers with lvPPA (64 for bilinguals, 59 for monolinguals, $p = 0.03$), but such an effect was not observed in the amnestic AD cohort. Moreover, the effect of bilingualism on age of onset was independent of other cognitive reserve variables (i.e. education, sex, and immigrant status). Contrary to our hypothesis, results from our cohort suggest that bilingualism may serve as a unique cognitive reserve variable in lvPPA, but not in amnestic AD. One possible explanation for this finding may be that bilingualism has distinct effects on the specific neural networks underlying the manifestation of these different clinical variants. Future research should investigate the neural mechanisms by which bilingualism contributes to cognitive reserve for select clinical populations.

E47 Explicit synchrony of speech and gestures in autism spectrum disorder

Inge-Marie Eigsti[1], Wim T. J. L. Pouw[1]; [1]University of Connecticut

Individuals with autism spectrum disorder (ASD) have difficulty with the temporal coordination of gestures with speech (Canfield & Eigsti, 2016; de Marchena & Eigsti, 2010; Silverman et al., 2010). Such impairments could primarily reflect language deficits (Kelly, Ozyurek, & Maris, 2010) or motor control deficits (e.g., McAuliffe et al., 2017; Vanvuchelen, Roeyers, & De Weerdt, 2007). This study examines the production of co-speech 'beat' gestures within a sensorimotor synchronization framework (Repp, 2005). Results are informative about a) the source of gesture impairments in ASD and b) individual differences in

speech-gesture synchrony. Participants were adolescents ages 11-17 with ASD (n=9) or typical development (TD; n=10), and 11 TD adults. ASD/TD adolescents did not differ in age, nonverbal IQ, gender, or standardized language scores, p's>.15. All participants completed a sensorimotor integration task in which they recited six nursery rhymes (Jack Sprat could eat no fat, etc.). They were told to simultaneously "beat" along with their writing hand, as if hammering a hammer. Performance was digitally recorded for subsequent coding. Adolescents also completed standardized assessment of executive functions, including D-KEFS Verbal Fluency (generate items in a semantic category). To date, one rhyme has been analyzed (Jack Sprat); final analyses will include all six rhymes. We obtained a pixel change time series from the video data (25f/s) using frame differencing (Brookshire et al., 2017; Romero et al., 2017). Beat gestures were identified from this time series in ELAN (Crasborn et al., 2006). The apex of the downbeat was operationalized as the peak deceleration of pixel change. For each downbeat, the pitch (F0) peak of the temporally-closest voiced speech event was determined. Each speech-gesture pairing yielded a temporal difference score (peak deceleration to peak pitch). All groups produced a similar number of beat gestures; ASD-adolescents M = 16.22, TD-adolescents = 15.09, Adults = 16.09. A mean negative asynchrony was observed in all groups (e.g, beat peaks preceded spoken pitch peaks): ASD-adolescents M(SD)=-66(43) ms; TD-adolescents -52(29) ms; adults -16(27) ms. Group was a significant predictor for gesture-speech synchrony (lme regression analysis), 2(5)=9.06, p=.01. Both adolescent groups differed from adults, and TD-adolescents asynchrony fell midway between (ASD vs. adults, p=.006; TD vs. adults, p=.02; ASD vs. TD, p=.61). Asynchrony was correlated with verbal fluency at the trend level, r(18)=-.42, p=.09; greater fluency tended to be associated with more synchronicity. In this small sample, asynchrony was not correlated with ASD severity. The current study extends the literature on gestures and sensorimotor synchronization by studying explicit synchrony in ASD, a disorder characterized by impairments in gesture production. Rather than tapping to an external beat, participants gestured with a self-generated spoken rhythm. These preliminary results suggest significantly greater asynchrony in adolescents compared to adults, and raise the possibility of increased asynchrony in ASD. This pattern of results suggest that motor control deficits may play a critical role in gesture impairments in ASD.

E48 Bimodal language in post-ictal aphasia: a descriptive study

Alexia Fasola[1,2], Marion Tellier[3], François-Xavier Alario[2], Carlo Alberto Tassinari[4], Agnès Trebuchon[1]; [1]Aix Marseille Univ, INSERM, INS, Inst Neurosci Syst, Marseille, France, [2]Aix Marseille Univ, CNRS, LPC, Marseille, France, [3]Aix Marseille Univ, CNRS, LPL, Aix-en-Provence, France, [4]Department of Neurological Sciences, University of Bologna, Bologna, Italy

Introduction A pathological model of language deficits is drug-resistant epilepsy, which is known to induce impairments in verbal memory, naming or spontaneous speech. These deficits are typically described in inter-ictal states (i.e. between epileptic seizures). Drug-resistant epilepsy patients also show substantial language deficits (e.g. anomia) during the seizures and in the periods following them, called post-ictal states. Such post-ictal aphasia episodes have received very little attention and were the focus of the current research. We investigated jointly the production of speech and co-speech gestures, owing to the multi-modal nature of conversation and verbal interactions. Our exploration was mostly descriptive, addressing the following open questions: Is the production of co-verbal gestures modified during post-ictal states? Is there a difference between frontal versus temporal lobe seizures? Methods Patients We tested 12 drug-resistant epileptic patients (6 females), native speakers of French, right-handed with left hemisphere language dominance (mean age of 36; IQ above 80). They were tested during pre-surgical diagnostic investigations, therefore under drug restriction, with surface and intra-cerebral activity constantly monitored, and videotaped round-the-clock. We gathered data from a total of 21 seizures inducing post-ictal language deficits. Seven of them originated from left fronto-insular lobe and 14 started from the left anterior-basal temporal lobe. Experimental Design During testing, patients had to memorize, in 30s, a highly detailed picture to later describe what they had seen. The goal was to elicit a monologue that would be rich in speech and in co-speech gestures. We compared post-ictal to inter-ictal conditions in the same individual. We quantified the verbal flow in words per second. Following previous classifications, co-speech gestures were coded according to two categories: "Rhythmic" gestures are produced in support of speech building, presumably for the benefit of the speaker; "illustrative" gestures are produced to illustrate the speaker's speech, presumably for the benefit of the interlocutor's comprehension. EZ localizations were determined by experienced epileptologists. To simplify anatomical variables, each the left fronto-temporal area is divided in 5 sub-regions: anterior temporal (LTA), posterior temporal (LTP), temporo-basal (LTB), insular (LI) and inferior frontal (LF). Results During post-ictal compared to inter-ictal episodes, left temporal lobe epileptic patients show a slight decrease of verbal flow combined with a trend for an increase of rythmic gesture production, and a decrease of illustrative gesture production. For left fronto-insular lobe epilepsy patients, the modulation of communicative patterns was not straightforward. Discussion Communication patterns suggest a distinction in the use of rhythmic and illustrative co-speech gestures linked to reduced verbal flow in temporal lobe epilepsy patients. This contrast between co-speech gestures categories is congruent with previous literature in which rhythmic gestures has been linked to lexical retrieval processes. Further establishing the

existence of a facilitative role of co-speech gestures during language difficulties could be useful in the context of multimodal language therapies for temporal lobe epilepsy patients.

E49 Speech compensation behavior for unexpected errors is related to language performance beyond repetition skill in aphasia

Lorelei Phillip[1], Roozbeh Behroozmand[1], Julius Fridriksson[1]; [1]University of South Carolina, Columbia, South Carolina

In aphasia, deficits in sensorimotor integration have been implicated as underlying impairments in speech function. Sensorimotor integration is the means by which movements are guided by sensory information and is critical for ensuring the accuracy of those movements. Impairment of this system has been implicated in conduction aphasia in particular, namely for that population's marked difficulty with speech repetition despite relatively spared production and comprehension. As a result, repetition tasks are often used as a measure to probe the integrity of sensorimotor mechanisms and their deficits in speech. What is less well known is the extent to which these deficits are common across aphasia types and how this manifests behaviorally in areas other than speech repetition. As a result, our goal was to determine whether there was a relationship between a behavioral correlate of sensorimotor integration and performance on a variety of language tasks. Participants performed a speech task under the altered auditory feedback (AAF) paradigm to examine their vocal compensation behavior as a marker of sensorimotor integration. During this task, participants sustained vocalizations of a speech vowel sound while their auditory feedback was randomly altered by pitch shift stimuli at +/- 100 cents. The on-line compensatory vocal motor responses to AAF were recorded and the peak compensation level for each trial was extracted and averaged across trials for each participant. Average compensatory responses were extracted separately for trials with upward and downward pitch shift stimuli. Correlation analysis was used to examine the relationship between vocal compensation behavior and the clinical measures from the Western Aphasia Battery – Revised (WAB-R) scores. A total of 15 individuals with chronic post-stroke aphasia took part in this study, 4 of whom had anomic aphasia, 7 of whom had Broca's aphasia, and 4 of whom had conduction aphasia (mean age = 59.1 years, range = 46 – 80). Significant correlations were found between speech compensation on upward-shifted trials and spontaneous speech ($r = -.635$, $p = .011$), repetition ($r = -.713$, $p = .003$), naming ($r = -.562$, $p = .029$), and quotient ($r = -.688$, $p = .005$) scores on the WAB-R. No significant correlations were found between speech compensation on downward-shifted trials and language measures. An expected correlation was found between speech compensation behavior and speech repetition. However, our findings demonstrate a relationship between other measures of language ability including naming, a combination of discourse content and fluency, and overall aphasia severity. Not only that, this relationship is evident for individuals with a variety of aphasia types. Interestingly, these relationships were only significant for compensation on the upward-shifted trials and not for the downward-shifted trials, which could be a result of the salience of the stimulus. Further research is needed to clarify those differences and to examine sensorimotor integration deficits across aphasia types more closely.

E50 Cortical entrainment of continuous speech envelope is preserved in non-fluent variant PPA

Heather Dial[1], Benjamin Zinszer[1], Bharath Chandrasekaran[1], Maya Henry[1]; [1]University of Texas at Austin

Introduction Primary progressive aphasia (PPA) is a disorder characterized by a gradual loss of speech and language functions resulting from neurodegenerative disease (Mesulam, 1982). In the nonfluent/agrammatic variant (nfvPPA), the primary features are apraxia of speech and/or agrammatic production, with comprehension deficits observed in a subset of patients (Gorno-Tempini et al., 2011). Recent evidence suggests low-level auditory processing impairments are also present in nfvPPA (Grube et al., 2016). Despite evidence of impairments in auditory processing and language comprehension, there is a paucity of research examining the underlying basis for connected speech comprehension deficits in these patients. In the current study, we examined continuous speech processing in nfvPPA using behavioral and neurophysiological measures. We related EEG signals to a continuous speech stream using temporal response function (TRF) modeling, a recent innovation in EEG analysis that directly compares continuously varying aspects of a stimulus with fluctuations in a participant's EEG signal (DiLiberto et al., 2015). We used amplitude envelope as the stimulus model, which prior research has related to speech comprehension (e.g., Ding & Simon, 2014). Recent research demonstrated TRF model changes with language impairments, such as dyslexia (DiLiberto et al., 2018). Therefore, this approach has the potential to inform our understanding of the mechanisms supporting comprehension of continuous speech in nfvPPA. Method Five participants with a nfvPPA diagnosis (71-78 years old, M = 75; Mini-Mental State Exam scores ≥ 22), consistent with current diagnostic criteria, and 14 neurally-healthy, age-matched controls (61-77 years old, M = 71) participated in the current study. Participants listened to 15 one-minute segments of the audiobook Alice's Adventures in Wonderland, and answered two multiple-choice questions after each segment. While participants listened to the story, EEG responses were continuously collected using a 32-channel electrode cap. We compared the amplitude envelope (absolute value of Hilbert-transformed stimulus) to EEG responses using the TRF model. EEG data predicted by the TRF were compared to observed EEG data via Pearson's correlation, providing a measure of model fit (r). We predicted that

nfvPPA participants would (a) demonstrate impaired comprehension of continuous speech, and (b) diverge from healthy age-matched controls in the relation between the EEG and amplitude envelope, reflecting impaired low-level auditory processing. Results Data from individuals with nfvPPA were compared to controls using Crawford and Howell's (1998) modified t-test. For comprehension accuracy, 3/5 participants scored significantly lower than controls ($p's < .01$), indicating impaired comprehension of continuous speech. In contrast, r values relating the envelope to EEG data were not significantly different from controls for nfvPPA participants, suggesting relatively intact low-level auditory processing. Conclusion Overall, we demonstrate intact processing of envelope cues, a feature shown to contribute to speech comprehension, suggesting that language comprehension impairments in nfvPPA are caused by higher-level linguistic processing impairments. One potential reason for the difference between the current study and Grube et al. (2016) is that EEG responses were analyzed independently of behavioral responses, eliminating confounds associated with response decision-making. In ongoing research we plan to examine higher-level linguistic models (e.g., Broderick et al., 2018) in nfvPPA.

E51 Production and Perception of Sentence Focus in Individuals with Parkinson's Disease Who Speak Mandarin

Xi Chen[1,2], Diana Van Lancker Sidits[1,2]; [1]New York University, [2]Brain and Behavior Laboratory, Geriatrics, The Nathan Kline Institute

INTRODUCTION Parkinson's disease (PD) is a progressive neurodegenerative disorder which not only disrupts patients' physical mobility, but also causes impairment to patients' speech prosody in functional communication due to a deficient subcortical system. Previous studies have examined prosody in PD speech, but most of these addressed non-tone languages, resulting in a lack of evidence for individuals with PD speaking tone languages. In a tone language, the mechanism of pitch variability is more complex since pitch is used to discriminate both lexical and intonational information. Given a more complicated sentence context in a tone language, such as a sentence with a contrastive focus on a particular word, it might be more challenging to fulfill the target since speakers not only have to realize the particular pitch contour of the words to distinguish lexical meanings, but also must produce intonational contrasts for a particular discourse purpose. It is not known if individuals with PD speaking a tone language will be successful in producing and perceiving sentence focus. In the present study, we examined the performance of Mandarin-speaking PD individuals in producing and perceiving contrastive sentence focus. Since previous studies have reported differential effects of speech tasks in speech-disordered populations, we compared performance in elicitation and repetition. METHODS Speakers' production and perception tasks Sixteen Mandarin-speaking individuals with PD and 21 age-matched healthy controls (HC) described pictures showing activities of animal figures, first, with neutral focus. The experimenter then asked three questions referencing contrastive content in the picture, in order to elicit the focused lexical item (subject, verb, or object). The correct answers featured a different contrastive sentence focus. The participants then listened to sentences with various contrastive focus recorded by the experimenter and repeated those sentences. All participants' utterances were recorded. For the speakers' perception task, all the speakers listened to a new set of sentences with different focus conditions recorded by the experimenter and identified which one of the three words carried the sentence focus. The cognitive status of the participants was evaluated. The PD speakers scored lower than HC. Healthy listeners' perception task Sixty-four healthy native Mandarin speakers listened to utterances produced by the PD and HC speakers. They were asked to identify the position of the sentence focus and give ratings to the prominence of the focus for each utterance. RESULTS The PD speakers received lower scores than the HC speakers in listeners' identification and goodness ratings. Both groups had better performance in repetition than in elicitation in terms of listeners' identification and goodness ratings. Regarding goodness ratings, the performance of PD speakers demonstrated larger difference between the two speech tasks, indicating a greater task effect. In addition, the PD speakers showed intact perception of sentence focus despite the potential presence of cognitive impairment. CONCLUSION Mandarin-speaking PD speakers were less successful in producing clear and accurate contrastive sentence focus but were preserved in the ability of perceiving contrastive sentence focus. A task effect was found, with better performance on repeated than elicited speech, as is consistent with previous studies.

Language Development

E52 The Relationship Between Socioeconomic Status and White Matter Coherence in Pre-Reading Children: A Longitudinal Investigation

Ola Ozernov-Palchik[1,4], Elizabeth S Norton[2], Yingying Wang[3], Sara D. Beach[1], Jennifer Zuk[4], John D. E. Gabrieli[1], Nadine Gaab[4]; [1]Department of Brain and Cognitive Sciences and McGovern Institute for Brain Research, Massachusetts Institute of Technology, Cambridge, MA, [2]Department of Communication Sciences and Disorders, Department of Medical Social Sciences, and Institute for Innovations in Developmental Sciences, Northwestern University, Evanston, IL, [3]College of Education and Human Sciences, University of Nebraska, Lincoln, NE, [4]Harvard Medical School, Boston, Massachusetts Boston Children's Hospital, Boston, MA, [5]Laboratories of Cognitive Neuroscience, Division of Developmental Medicine, Department of Medicine, Boston Children's Hospital, Boston, MA

Reading is a learned skill crucial for educational attainment. Children from families of lower socioeconomic status (SES) tend to have poorer reading outcomes and

this gap widens across years of schooling. Reading relies on the orchestration of multiple neural systems integrated via specific white-matter pathways, but there is limited understanding about whether these pathways relate differentially to reading performance depending on SES background. Kindergarten white-matter coherence and second grade reading outcomes were investigated in an SES-diverse sample of 121 children that was divided into higher-SES (n = 61) and lower-SES (n = 60) groups. The three left-hemispheric white-matter tracts most associated with reading were examined: arcuate fasciculus (AF), superior longitudinal fasciculus (SLF), and inferior longitudinal fasciculus (ILF). Children from lower-SES families had significantly reduced fractional anisotropy (FA) in the occipitotemporal segment of the left ILF in kindergarten. In lower-SES children, but not in higher-SES children, higher FA in this segment in kindergarten was associated with better second-grade reading outcomes. Random forests classification revealed that the parental reading history, IQ, home literacy environment, and FA in the right SLF discriminated with 78% accuracy between lower-SES children who developed into good versus poor readers in second grade. These results have implications for understanding the role of the environment in the development of the neural pathways that support reading, and the possible neural mechanisms of successful reading development in children from lower-SES backgrounds.

E53 Ortho-semantic learning of novel words in English-speaking Grade 3 students

Alena Galilee[1], Lisa Beck[1], Catherine Mimeau[2], S. Hélène Deacon[1], Aaron J Newman[1]; [1]Dalhousie University, Halifax, Nova Scotia, Canada, [2]Université Laval, Quebec City, Canada

INTRODUCTION: It has been proposed that the field of reading development should move from examining established knowledge in domain of orthography and semantics to assessing children's capacity to learn the meaning of both spelling and meaning of new words, referred as ortho-semantic learning (Deacon et al., 2012). Initial findings suggest that learning measures predict gains and transfer of skills in reading development (Tucker et al., 2016). However, no studies to date have investigated brain mechanisms underlying such learning, which could provide more insight on the role this type of learning plays in reading. OBJECTIVE: In this study, we investigated the ERP activity associated with ortho-semantic learning of spellings and meanings of novel English words. In this preliminary analysis, we focused on the temporal-occipital N170 component associated with early stages of visual word recognition; this component has been shown to have sensitivity to letter strings relative to false fonts (print tuning) and to words relative to consonant strings (lexical tuning). The N170 has also previously been found to be predictive of readiness to read and word reading fluency in young children (Korinth et al., 2012, Eberhard-Moscicka et al., 2015). METHOD: Fifteen native English-speaking children in grade 3 (8-9 years old) participated. All completed standardised behavioural assessments of language. In addition, children completed a learning task in which they learned novel word spellings and meanings by reading short stories. Immediately after learning, participants completed a lexical decision task (LDT) in which they were presented with real words, novel words from the learning task, non-words, consonant strings, and false fonts. RESULTS: After the learning task, participants' accuracy for spelling and meaning of the novel words was above chance (54% and 83%, respectively). In the LDT, participants correctly identified 61% of novel words and 87% of real words. For the amplitude of the N170, false fonts were significantly smaller from real words ($p=0.03$), novel words ($p=0.007$) and non-words ($p=0.01$). CONCLUSIONS: These findings suggest that children were able to learn the spellings and meanings of novel words. Additional analyses on a larger sample will examine relationships between individual differences in word reading, ortho-semantic learning, and the N170 component.

E54 Early interactive acoustic experience with non-speech modulates phase synchronization of evoked gamma to speech at 18-months-of-age

Silvia Ortiz-Mantilla[1], Teresa Realpe-Bonilla[1], April A Benasich[1]; [1]Center for Molecular and Behavioral Neuroscience, Rutgers University Newark, NJ, USA

Over the first year of life, infants establish the foundations for learning their native language by constructing language-specific phonemic maps within auditory cortex. It has been widely demonstrated that cortical effects of sensory input are continuously modified by both maturation and experience. During early development the auditory cortex is highly plastic, making infancy a privileged period for optimizing language mapping. We have shown that interactive acoustic experience (between 4- and 6-months-of-age) with temporally modulated non-speech stimuli containing acoustic cues important for speech, enhances the efficiency of infants' acoustic processing of both trained and novel untrained non-speech at 7-months-of-age (Benasich et al., 2014). Neural mechanisms underlying these training effects were also investigated through measures of oscillatory power -- infants who underwent an early interactive experience displayed a left lateralized increase in gamma power during tone discrimination (Musacchia et al., 2017). Furthermore, at 9-months-of-age, infants who participated in the interactive acoustic experience showed an increase in high-gamma power in auditory cortices, suggesting that early auditory engagement might facilitate establishment of enduring phonemic representations (Ortiz-Mantilla et al., 2018). In this study we examined the longitudinal impact of interactive non-speech auditory experience on processing of speech syllables at 18-months-of-age. Infants were presented with a consonant-vowel contrast varying in voice-onset time (da/ta) using a passive oddball paradigm and then compared to a cross-sectional group of 18-month-old naïve controls with no such experience. Dense-array

EEG (124-sensor net) was collected and mapped onto age-appropriate brain templates. Source modeling placed dipoles in both auditory cortices. Temporal-spectral analyses were conducted in source space, within the 2 to 90Hz frequency range, using 1Hz-wide frequency bins and time resolution of 50ms. Phase coherence was evaluated by examining consistency of phase alignment across trials using inter-trial phase locking (ITPL). Permutation testing identified clusters of significance between the groups for processing of the standard stimulus. We found that infants with previous acoustic experience display greater gamma phase synchronization in left auditory cortex than naïve controls. These results demonstrate that experience-dependent effects that generalized to speech at 9-months (Ortiz-Mantilla et al., 2018) continue to have an effect on processing at 18-months of age. This is clearly shown in response to the standard stimulus, which is critical to the construction of cortical maps that support rapid discrimination of incoming deviant stimuli. Early gamma responses, that tend to be time- and phase-locked to transient auditory stimuli (evoked gamma), reflect engagement of the sensory auditory cortex in stimulus processing, and have been proposed to index learning and experience in the auditory cortex. Our results suggest that active auditory experience may confer a significant speech processing advantage, by providing more temporal stability of the oscillatory gamma responses across trials. Interactive non-speech auditory experience might therefore, facilitate neural plasticity and support more efficient processing of speech in the left auditory cortex during the time infants are acquiring their native language.

E55 Developmental changes in neural connectivity of semantic processing in youths with autism and typically developing youths

Min Liu[1], Susan Shur-Fen Gau[1,2,3,4], Tai-Li Chou[1,3,4]; [1]Department of Psychology, National Taiwan University, Taipei, Taiwan, [2]Department of Psychiatry, National Taiwan University Hospital and College of Medicine, Taipei, Taiwan, [3]Neurobiology and Cognitive Science Center, National Taiwan University, Taipei, Taiwan, [4]Graduate Institute of Brain and Mind Sciences, National Taiwan University, Taipei, Taiwan

Youths with autism spectrum disorders (ASD) and typically developing (TD) youths have shown differential meaning processing and brain activation. Youths with ASD rely more on lower-level visual processing during semantic judgments, which is related to greater activation in the cuneus. In contrast, TD youths engage more in the higher-level processing of retrieving or selecting semantic features, which is related to greater activation in the inferior frontal gyrus (IFG). However, it is not known how functional connectivity with these regions changes between TD and ASD youths, and whether differential functional connectivity is age-dependent. The present study thus aimed to explore age-dependent functional connectivity of semantic processing in TD and ASD youths. The participants were divided into the ASD and TD groups, with each group divided into two age groups (child, adolescent). They were asked to judge whether written word pairs were related in meaning within an MRI scanner. The psychophysiological interaction (PPI) analysis was conducted to explore functional connectivity that examined dynamic interaction between brain regions. There were three major findings. First, for the ASD children, two significant connections were found between the inferior frontal gyrus (IFG) and right inferior parietal lobule (IPL) and between the cuneus and right IPL, which suggests a visual-based processing during semantic judgments. Second, for the TD children, a significant connection was found between the cuneus and middle temple gyrus (MTG), which suggests a direct mapping between orthography and semantic representations during semantic judgments. Third, for the TD adolescents, a significant connection was found between the IFG and MTG, suggesting more elaborate semantic representations that require greater engagement of selection processes in the TD adolescents. In conclusion, our results imply different patterns of functional connectivity during semantic processing between ASD and TD youths. The ASD children may rely on visual/perceptual processing to meet the demands of the semantic task. The TD children may rely on bottom-up visual information to access semantic knowledge, whereas the TD adolescents may use a top-down controlled process to retrieve semantic knowledge. Keywords□semantic; functional connectivity; age; fMRI

Multilingualism

E57 Learning to Read a Second Orthography Recruits the Visual Word Form Area and a Broader Reading Network

Lea Martin[1,2], Corrine Durisko[1,3], Michelle W. Moore[4], Julie A. Fiez[1,2,3]; [1]University of Pittsburgh, PA, [2]Center for the Neural Basis of Cognition, University of Pittsburgh, PA, [3]Learning Research and Development Center, University of Pittsburgh, PA, [4]West Virginia University, Morgantown, WV

Introduction: A region within the mid-fusiform gyrus, the visual word for area (VWFA), appears to support word recognition as an individual attains reading fluency. Questions remain about why this tissue specifically appears to facilitate fluent reading. Some theories posit that the VWFA responds to orthographic information because most orthographies share similar visual characteristics (e.g., line junctions). Other theories suggest the VWFA functions as a bridge between visual recognition regions and spoken language regions. In an effort to test these competing theories and to better characterize the role played by different mapping principles across orthographies, we created and examined four artificial orthographies across several studies to investigate behavioral and neural measures of learning in adult participants who acquired a second, visually distinct orthography for English. Methods: We collected behavioral and neuroimaging data from two groups of subjects trained for two weeks (initial training) to acquire basic reading proficiency in

either KoreanFont or FaceFont, two alphabetic systems wherein English phonemes are represented by letters borrowed from the Hangul alphabet and face images, respectfully. In addition, two groups of subjects were followed for six weeks (initial training and four weeks of extended training) as they learned to read HouseFont, an alphabetic system wherein house images represent English phonemes, and Faceabary, an alphasyllabic system wherein face images represent English syllables. Participants underwent neuroimaging scans before and after training. Results: Participants were able to acquire basic reading proficiency from initial training. In the extended training for HouseFont and Faceabary participants improved in reading accuracy and reading speed, with no evidence of a learning plateau. Neuroimaging data acquired at the end of initial training indicated that there was an increase in activity for an individual's trained font in the vicinity of the VWFA. Faceabary participants displayed increased activity in the right mid-fusiform after training, consistent with bilateral activation patterns seen in other alphasyllabic writing systems. Increased VWFA activity correlated with an increase in reading fluency. Neural changes within the broader reading network indicated that Faceabary, the alphasyllabic system, more strongly engaged the semantic reading network. Conclusion: Native English speaking adults maintain the ability to learn a second, visually distinct orthography for their native language, suggesting that the neural substrates underlying reading ability remain flexible even into adulthood and after initial literacy is established. While orthographic learning was associated with increased VWFA activation for all the orthographies we investigated, the differences in mapping principles between orthographies drove the specific utilization of the broader reading network. These patterns of response have several implications: 1) the VWFA retains flexibility with regard to the type of stimuli it can utilize as orthographically meaningful; 2) reading fluency in a newly learned orthography is associated with changes in the VWFA (both unilateral changes in alphabetic systems and bilateral changes in alphasyllabic systems); 3) differential recruitment of the broader reading network is dependent on the mapping principles, with semantic network recruitment occurring more strongly for alphasyllabic systems.

E58 Model of weighted phonological similarity for predicting bilingual lexical retrieval

Danielle Fahey[1]; [1]*University of South Carolina*

Introduction: Listeners decompose words into phonological representations, linking phonemic representations to concepts (Levelt et al., 1999). Bilingual speakers are thought to have one concept connected to two separate phonological representations for translational equivalents (Kroll & Stewart, 1994). To predict how quickly bilingual speakers will retrieve words in their first (L1) or second language (L2), neighborhood effects are often used to quantitatively evaluate the differences between words in the two languages of interest, comparing addition, deletions and subtractions from orthographic representations (Peeters et al., 2013). However, bilingual speakers have been shown to expand phonemes across languages, such that overlapping phonemes are perceived as a single phoneme in both languages (Flege, 1995). Because bilingual speakers assimilate phonological features across languages, studies predicting aural word retrieval should model weighted featural similarity based upon perceived featural differences. This study asked participants to rate Spanish-English cognate differences, and modeled featural perception, weighting different phonological characteristics. The resulting model can be used to predict perceived phonological similarity in studies of bilingual lexical retrieval. Methods: Thirty-five Spanish-English bilingual participants heard 150 Spanish-English cognates, and rated similarity on a 7-point Likert scale in Qualtrics. Phonology change from English to Spanish was analyzed as: stress change (StrC), number of syllables (SNC), and syllable stress location (SCL). Consonant and vowel changes were analyzed as follows, and summed to weight each type across a cognate set: consonant additions/deletions (CAD); consonant substitutions with a voicing or manner change (CSubSame); consonant substitutions with a place change (CSubDiff); consonant changes to onset (COns); consonant changes to coda (CCoda); vowel additions/deletions (VAD); vowel substitutions within similar space (VSubSame); vowel substitutions to different space (VSubDiff); changes to stressed vowels (VStress). Results: Repeated measures linear regression of mixed effects showed the following factors significantly affected similarity rating: SCL ($p<0.001$), CAD ($p<0.001$), CSubDiff ($p<0.001$), CCoda ($p=0.001$), VAD ($p<0.001$), VSubSame ($p<0.001$), VSubDiff ($p<0.001$), and VStress ($p<0.001$). All parameter weights were negative, except for the effect of VSubSame. Similarity rating = 5.4484 - .4671xSCL - .5505xCAD - .7637xCSubDiff - .1456xCCoda - .3224xVAD + .2977xVSubSame - .2430xVSubDiff - .5133xVStress Conclusions: Results demonstrate that greater phonological distance, as measured by changes to cognates' stress placement, syllabification, consonants or vowels, causes lower ratings of cognate similarity. However, close phonetic substitutions accounted for no difference, or even perceived similarity. These results are important because they extend the results of Flege (1995) and others to categorical perception of L1 lexical items instead of L2 items only. Further, categorical perception of phonological features applies across cognates, suggesting that merely quantifying phonological differences apparent to monolinguals is not enough to provide a strong prediction of bilingual lexical retrieval. Thus, subphonemic similarity should be used when predicting cognate similarity, and the above model may be used to rate similarity across Spanish-English words.

E59 Using the EAR to Track Bilingual Language Use

Alessandra Macbeth[1], Michelle Bruni[1], Emily N. Mech[1], Justin T. Sarkis[1], Alexander Karan[1], Megan L. Robbins[1], Christine Chiarello[1]; [1]University of California, Riverside

There is great diversity in the daily language experiences of bilinguals. Investigations of the cognitive and neural correlates of bilingualism rely on self-report language history questionnaires (LHQs) to estimate the extent to which each language is used in various situations, and with various conversational partners, the frequency of language switching, etc. Because it is difficult to assess the validity of such questionnaire responses, unwanted variance may be introduced in our investigations of the cognitive and neural bases of diverse bilingual experiences. We will report on real world language use in a linguistically diverse sample of university students by employing an experience sampling method using the EAR (electronically activated recorder [1]). This initial investigation had two objectives: (1) to document the variety and frequency of multilingual language use in a linguistically diverse sample; and (2) to assess the correspondence between self-reported and actual language use. The findings will provide the foundation for a broader research program to explore the relationship between daily bilingual language experiences and their cognitive and neural correlates. UCR (mainly English dominant) students wore the EAR (cell phone with the EAR app) for 4 consecutive days as they went about their daily lives, and completed the LHQ [2] upon returning to the lab. The app makes 40-second auditory recordings, every 12 minutes during waking hours. Participants pause the device if they wish to have a private conversation, but are unaware of when the device is recording. Each participant's speech was transcribed and coded to quantify the frequency of use of various languages, the settings in which the speech occurred, the frequency of language switching, etc. We also coded the language used by the participant's conversational partner(s). Participant speech recordings were acquired at home (50%), in a public place (28%), in transit (19.2%), or in class (2.8%). Initial data (N = 15) indicates that our bilingual participants, and their conversational partners, used a language other than English (Spanish, Burmese, German, Korean, Mandarin, Vietnamese) approximately 10% of the time, although this differed for self-reported English dominant vs non-English dominant participants (4% vs 32%). Self-rated proficiency was somewhat greater for English than for another language (6.95 vs 5.86; 7-point scale). There was no relationship between self-rated proficiency and the amount of time the bilinguals actually spoke either of their languages (r's < .16). However, self-report of the amount of non-English speech did predict the extent of participant (r = .55) and partner (r = .62) actual use of the language. Our bilingual participants only engaged in language switching 3% of the time, and this was only weakly related to their self-report of language switching frequency (r = .26). Our preliminary findings suggest that the validity of self-report bilingual questionnaires is variable. More in-depth analyses of the transcript data should reveal additional nuances of bilingual language experiences. The EAR method appears to be a promising tool for investigating bilingual language use "in the wild."

E60 Electrophysiological correlates of first and second language: A within-subjects view of semantics and grammar

Sarah Grey[1]; [1]Fordham University

This study addressed two main gaps in electrophysiological research on second language (L2). First, most ERP research on L2 sentence processing has either examined L2 compared to 'L1 literature' (e.g., Batterink & Neville, 2013) or compared the L2 group to a separate L1 group (e.g., Bowden et al., 2013). Using these designs, deviations in L2 from L1 patterns have led to claims about qualitative and quantitative differences in L2 (Morgan-Short, 2014). However, even L1 processing deviates from 'the norm' (e.g., Grey et al., 2017; Pakulak & Neville, 2009) which complicates interpreting between-subjects L1/L2 differences as being due to a 'deviant' L2. This issue can be addressed using within-subjects designs, though little L2 research has done this. A second gap is that most L2 ERP sentence processing research has focused on grammar. There are few reports of L2 sentence-level semantic processing and conclusions from these studies are vague (e.g., Bowden et al., 2013; Ojima et al., 2005). The present study examined participants' L1 and L2 sentence processing, within-subjects, and using EEG/ERP. To add to the small amount of L2 ERP research that has probed sentence-level semantics, the study tested both semantics and grammar. Twenty English L1 speakers (M age = 19.4) who learned Spanish as a L2 were tested. EEG was recorded while participants read correct sentences or sentences with grammar or semantic errors. Participants completed the task in L1 and L2 (different sentences across L1/L2; lists and L1/L2 order counter-balanced across subjects). For grammar, results showed P600s for both L1 and L2. For semantics, results showed no ERP effects in either L1 or L2. Closer inspection of individual-level ERP patterns using a Response Dominance Index (RDI; Tanner & Van Hell, 2014) revealed more nuanced information. RDIs capture individual ERP patterns that may not be reflected in group patterns. RDIs for L1 semantics revealed that about half of participants showed an N400, but the other half showed a P600 in response to semantic errors. This pattern for semantics held true also for L2 - many participants showed N400s, but about half showed P600s. RDIs for L1 grammar showed highly uniform responses - most participants were P600-dominant, and this held true also for L2 grammar. The findings from this within-subjects study indicate that participants employed similar mechanisms for their L1 and L2 grammar (P600s) and that individuals were quite uniform - as shown by the RDI analysis - in employing P600-related mechanisms for both L1 and L2. For L1 and L2 semantics, RDI analysis revealed that some individuals showed the classic response

to semantic processing (N400), but about half showed P600s, indicating a qualitatively different processing approach within these individuals. Overall, the findings have theoretical implications regarding how L2 and L1 compare across different domains, particularly regarding the processing routes that individuals take during sentence comprehension.

E61 Neurobiological signatures of L2 proficiency *Henry Brice[1], W. Einar Mencl[2], Stephen J. Frost[2], Atira S. Bick[1,4], Jay G. Rueckl[2,3], Kenneth R. Pugh[2,3], Ram Frost[1,2]; [1]The Hebrew University of Jerusalem, [2]Haskins Laboratories, [3]University of Connecticut, [4]Hadassah Hebrew University Medical Center*

This study presents data from the first epoch of a large-scale longitudinal neuroimaging investigation of second language (L2) acquisition. The study tracks parallel cohorts of English L1 speakers immigrating to Israel learning Hebrew as an L2, and Hebrew L1 speakers immigrating to the United States and learning English as an L2. The parallel structure of this design allowed us to pull apart language effects (English vs. Hebrew) and proficiency effects (L1 vs. L2). We examined the processing of words in both L1 and L2, in both auditory and visual modalities. Subjects performed animacy judgements on printed and spoken words. Following Perfetti and colleagues' (2007) theoretical framework, we considered the neural changes associated with acquisition of L2 reading proficiency, as a process of accommodation, in which L2 circuits diverge from reading circuitry in L1, or assimilation, a process of convergence of L1 and L2 processing. Indeed, evidence from Chinese and English bilinguals has shown that greater L2 reading proficiency is associated with assimilation-greater convergence in the processing of L1 and L2 stimuli (Cao, Tao, Liu, Perfetti, & Booth, 2013). Similarly, Preston et al. (2015) have shown that a convergence of print and speech processing in L1 predicts reading ability in early readers. The measure of print and speech convergence across a network of reading areas in the brain has also been shown to be relatively invariant to cross linguistic differences (Rueckl et al., 2015), but has not been looked at in L2. In our study, the pattern of print/speech convergence across the parallel cohorts of L2 learners shows differences across the different regions of the reading network, with greater convergence for L2 in the left inferior frontal gyrus, a region tied to effortful language processing, but greater convergence for L1 in left-hemisphere posterior regions of the inferior parietal cortex and the fusiform gyrus, both tied to skilled reading processes. This is the first time that print/speech convergence has been examined in L2. Our findings suggest then that there is a shift in the weight of processing between L1 and L2. Whereas for L1 print/speech convergence is greater in posterior regions of the brain and is driven primarily by automatic skilled reading, for L2 print/speech convergence is greater in frontal regions of the brain, due to effortful processing in L2.

E62 Neural plasticity of language production networks associated with language learning *Kshipra Gurunandan[1], Manuel Carreiras[1,2], Pedro M. Paz-Alonso[1]; [1]BCBL - Basque Center on Cognition, Brain and Language, San Sebastián, Spain, [2]Ikerbasque - Basque Foundation for Science, Bilbao, Spain*

Verbal fluency (VF) tasks have long been used to study cognitive-linguistic processing and its impairments. However, the study of the functional networks underlying VF task performance is more recent, and few fMRI studies have looked at bilingual language production networks and their modulating factors using this task. A study with high proficient early bilinguals (Perani et al., 2003) found an effect of the age of acquisition of a second language (L2) in the activation patterns, but while proficiency is known to play an important role in language organization, it is as yet unknown what effect L2 proficiency has on the language production networks. Our previous study on language learning in adulthood found considerable neural plasticity of speech and reading networks as a function of L2 proficiency and here we looked at whether or not the same principle and result profiles apply to the production networks. Our study was aimed at investigating the differences in language production networks in adults at different stages of acquiring a L2. We examined 1) regional patterns of task activation during production, 2) laterality of the language production networks, and 3) the effect of increasing task difficulty on these two groups. Thirty-four adult (mean age = 46.5 years, 17 male) native speakers of Spanish (L1), either at the intermediate or advanced levels of learning Basque, underwent functional MRI scanning while performing semantic and phonological verbal fluency tasks in their L1 and L2. Behavioral results showed a group by language interaction, with similar performance in the L1 and differential performance in the L2 between the intermediate and advanced language-learning groups. fMRI results revealed 1) stronger engagement of right-hemispheric regions for phonological versus semantic VF tasks in the advanced group across languages; 2) no significant changes in the laterality of L2 production networks with increasing L2 proficiency; and 3) widening group differences in the recruitment of the L2 production network as a function of task difficulty. In conclusion, our study revealed less proficiency-dependent plasticity of the language production networks compared to speech and reading comprehension, in line with previous speculations of the fixedness of language production networks (Gaillard et al., 2000) now extended to L2 acquisition.

E63 The bilingualism effect on executive control: language production vs. language comprehension *Lu Jiao[1], Cong Liu[2], Baoguo Chen[1]; [1]Beijing Normal University, [2]South China Normal University*

There is a debate about the relationship between bilingualism and domain-general executive control (Bialystok, 2017; Paap et al., 2015). The dominant viewpoint proposed that bilingualism exerts a positive influence on executive control, and such bilingualism effect is

closely related to the inhibitory control mechanism for language switching in bilinguals. However, supporting evidences for this viewpoint mostly come from language production studies, few study investigates the role of language comprehension on executive control in bilinguals. Although both languages are co-activation in both prodution and comprehension, language production and comprehension involve different language processes. Language comprehension involves bottom-up processes, whereas language production involves top-down processes. Our study conducted two ERPs studies to investigate and compare the bilingualism effect from language production and comprehension on executive control task. In study 1, we interleaved picture-naming task (i.e., language production task) with a nonverbal flanker task, and asked a group of Chinese-English bilingual to respond to both tasks. There were three blocks, i.e., L1 block, L2 block and mix block. There is no language switching in L1 block and L2 block, whereas in mixed block, the target language switched between L1 and L2. In each trial, participants firstly named the picture in target language, then performed the flanker task by pressing corresponding button. The ERP amplitude analyses for flanker task focused on P300 component. A repeated-measures ANOVA with the three within-subject factors congruency (congruent, incongruent), language (L1, L2, and mix), and brain region (frontal, fronto-central, central, and central-parietal). The results showed the mean amplitude in mix block was significantly smaller than L1 and L2 block in incongruent trials, whereas there was no difference among them in congruent trials. Study 2 followed the similar procedure as study 1, but replaced picture-naming task with visual picture-word matching task (i.e., language comprehension task). In this matching task, a picture accompanied with a written word appeared on the screen, and participants needed to judge and make an orally report. The mean amplitude results in study 2 showed that there was only a significant difference between mix block and L1 block in incongruent trials, consistent with the effect of language production, but no difference between mix block and L2 block. All these results indicated that both in language comprehension and in language production, bilingual context exerted an effect on executive control, especially in conflict resolution.

E64 Associations Between Degree of Bilingualism, Executive Function, and Brain Maturation in English-Spanish Bilingual Children

Marybel Gonzalez[1], Tamar Gollan[2], Anders Dale[2], Terry Jernigan[2]; [1]Children's Hospital Los Angeles, [2]University of California, San Diego

Children who are raised bilingual can vary individually across language skills and experience, including vocabulary skill, the extent they practice and hear one language relative to another (i.e., language balance), and language mixing practices. The associations between language characteristics, executive function, and brain maturation were examined in 48 English-Spanish bilingual children ages 5 – 13 years of age. Bilingual children were compared to an age-matched English monolingual group of 53 children. Children were recruited across San Diego County, California. Executive function measures included response inhibition, inhibitory control, and cognitive flexibility. Expressive vocabularies in both languages were obtained in bilinguals using the Multilingual Naming Test (MINT). Parental report assessed the degree of language experience in one language relative to another, based on questions of language use in the home and school environment. Language mixing practice was also assessed via parental report of whether the child mixed words or sentences from both languages in speech. Diffusion-weighted images (DWI) were obtained for both groups. Bilingual children underperformed on executive function tasks compared to the monolingual children. Socio-economic status (SES) mediated group differences in cognitive flexibility, however not for inhibitory control performance. Within the bilingual group, more balance in language experience predicted better response inhibition performance, while lower frequencies of language mixing predicted better inhibitory control. Further, a measure of white matter maturation, fractional anisotropy (FA), was compared in bilingual children to monolingual children in white matter fiber tracts chosen a priori. Monolingual children showed higher FA (more mature values), in the superior longitudinal fasciculus (SLF) compared to the bilingual group, independent of SES. While there were no group differences in the whole segment of the inferior fronto-occipital fasciculus (IFOF), post-hoc analysis revealed monolinguals had higher FA in the anterior and middle IFOF, while bilinguals had higher FA in the posterior IFOF. Within the bilingual group, higher FA in the anterior cingulum was predicted by more balanced vocabularies in the two languages, independent of age and sex. There was an interaction effect of language experience balance by the rate of language mixing on FA in the anterior cingulum. Specifically, the association between higher FA in the anterior cingulum and more balance in language experience was evident in bilinguals with reported low rates of language mixing, while the association was weaker in bilinguals with reported high rates of language mixing. A similar interaction effect on FA in the anterior cingulum trended for vocabulary balance by the rate of language mixing. Findings from this study support a relationship between individual differences in degree of bilingualism, executive function, and brain maturation.

History of the Neurobiology of Language

E65 Aphasia rehabilitation: what we learn from neurolinguistics

Sylvie Moritz-Gasser[1,2,3]; [1]University Department of Speech-Language Therapy, University of Montpellier (France), [2]Neurosurgery Department, Hospital Gui de Chauliac, Montpellier, [3]Institute of Neuroscience of Montpellier (INM), INSERM U1051

At the end of the 19th century, pioneering studies introduced a localizationist and static view of brain functioning according to which some circumscribed cortical areas would process determined functions. This view prevailed during a long time, but the advent of new means of brain study profoundly questioned these propositions, highlighting a connectionist and dynamic brain organization in functional networks. Connectomics attempts to describe these networks constituted of cortical structures interconnected by white matter fascicles. We present here, after a brief history of the evolution of knowledge in this field, a connectomic model of functional brain organization of language based on intraoperative brain mapping performed during awake surgery and brain imaging studies. Leaving definitively the static view of localizationism, we suggest that this dynamic networks-based view of language functioning in the brain brings a valuable insight into speech-language therapy with aphasic persons. Advances in neurolinguistics indeed compel speech-language therapists to reconsider their intervention with aphasic people: if speech-language therapy has been shown to be effective, the efficiency of one therapeutic strategy over another remains a matter of debate, and conventional therapies have so far not really proven their worth. Because clinical presentations are infinitely various, the time has come to consider how to build a specific rehabilitation programme for each aphasic person. We specifically bring clinical and theoretical-based hypotheses about the mechanisms underlying anomia, a central feature in aphasia, explaining its links with other aphasic symptoms and then why restoring lexical access is absolutely essential in the context of aphasia rehabilitation. We then propose a neurolinguistics-based methodology to design individualized rehabilitation programmes, targeting linguistic-related cognitive impairments underlying this symptom from which ensues the whole aphasic clinical presentation. This methodology is in line with the theoretical impairment-based cognitive approach, and indicates that speech-language therapy for aphasic people should absolutely be based upon a comprehensive knowledge not only of psycholinguistic models of language processing and current models of cognitive functioning but also of functional neuroanatomy, in order to get an in-depth understanding of the clinical presentation. We finally present the results of a pilot study based on this methodology, and conclude that speech-language therapy strategies for aphasic persons should be designed from a scientifically sound methodology, based on current neurocognitive and neurobiological models of language processing. By developing and using this methodology, professionals would be led to build their own specific rehabilitation programme for each patient.

Author Index

Authors are indexed by abstract number, not page number. *Italic* abstract number indicates first author.

E

F

G

H

I

J

K

L

M

N

O

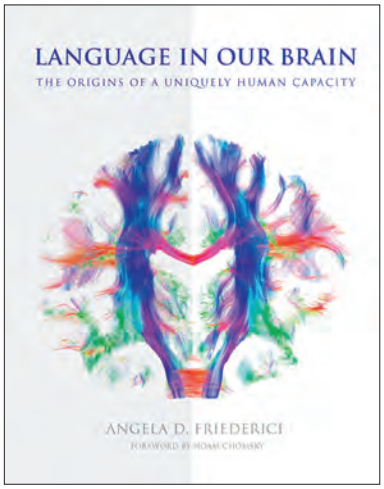
P

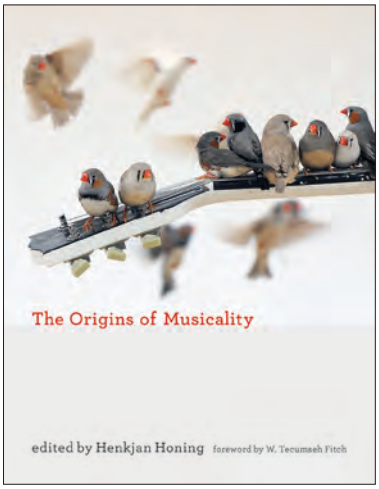
Q

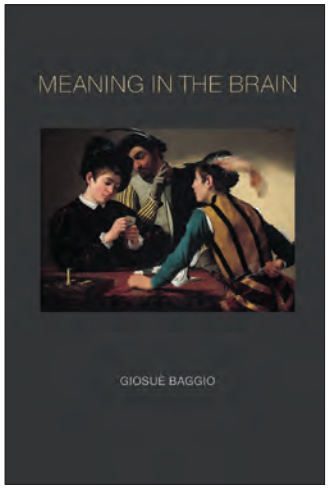
R

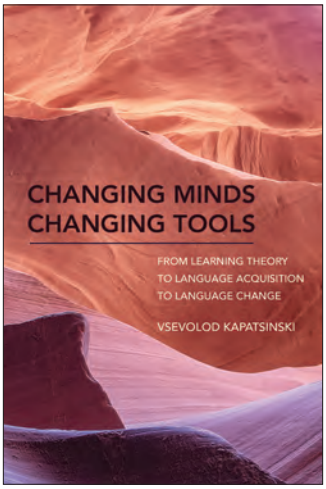
S

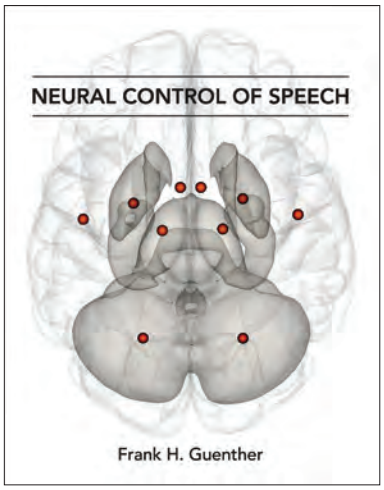
The MIT Press

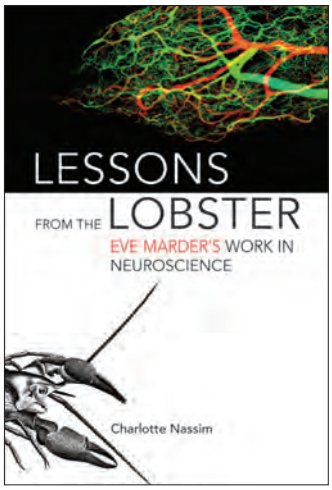


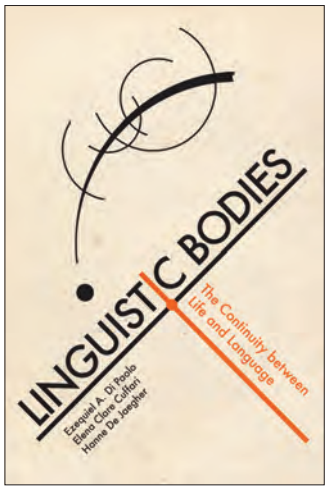












Language in Our Brain

The Origins of a Uniquely Human Capacity

Angela D. Friederici

foreword by Noam Chomsky

A comprehensive account of the neurobiological basis of language, arguing that species-specific brain differences may be at the root of the human capacity for language.

$45.00 | £35.00 | cloth

Neural Control of Speech

Frank H. Guenther

A comprehensive and unified account of the neural computations underlying speech production, offering a theoretical framework bridging the behavioral and the neurological literatures.

$63.00 | £49.00 | cloth

The Origins of Musicality

edited by Henkjan Honing

Foreword by W. Tecumseh Fitch

Interdisciplinary perspectives on the capacity to perceive, appreciate, and make music.

$50.00 | £40.00 | cloth

Lessons from the Lobster

Eve Marder's Work in Neuroscience

Charlotte Nassim

How forty years of research on thirty neurons in the stomach of a lobster has yielded valuable insights for the study of the human brain.

$27.95 | £22.00 | cloth

Meaning in the Brain

Giosuè Baggio

An argument that the meaning of written or auditory linguistic signals is not derived from the input but results from the brain's internal construction process.

$65.00 | £50.00 | cloth

Linguistic Bodies

The Continuity between Life and Language

Ezequiel A. Di Paolo, Elena Clare Cuffari, and Hanne De Jaegher

A novel theoretical framework for an embodied, non-representational approach to language that extends and deepens enactive theory, bridging the gap between sensorimotor skills and language.

$45.00 | £35.00 | cloth

Changing Minds Changing Tools

From Learning Theory to Language Acquisition to Language Change

Vsevolod Kapatsinski

A book that uses domain-general learning theory to explain recurrent trajectories of language change.

$45.00 | £35.00 | cloth

New in paperback

Creating Language

Integrating Evolution, Acquisition, and Processing

Morten H. Christiansen and Nick Chater

foreword by Peter W. Culicover

A work that reveals the profound links between the evolution, acquisition, and processing of language, and proposes a new integrative framework for the language sciences.

$30.00 | £24.00 | paperback

mitpress.mit.edu


Join Us
in Helsinki, Finland
for SNL 2019
August 20-22, 2019