

Cognition and Natural Sensory Processing Workshop 2021

(2-4th August)



Cognition and Natural Sensory Processing Workshop

Organisers: Giovanni Di Liberto, Nathaniel Zuk, Michael Crosse, Aaron Nidiffer

Tutorial and resources: Giovanni Di Liberto, Nathaniel Zuk, Michael Crosse, Aaron Nidiffer

When: 2-3rd August (optional Q/A session on the 4th August) 2021

What: Methodologies for neural signal processing in the case of natural scenes and sound perception

How: 50% Lectures, 25% Talks on case-studies, 25% Hands-on tutorials *Where:* Online!

Participants:

- Researchers interested in studying natural speech or music perception with EEG / MEG / ECoG, but have **no experience** with ecologically-valid experiments.
- Researchers **with experience** in continuous sensory perception and tools such as the mTRF-Toolbox, who are interested in deepening their understanding and in expanding their set of tools.

Prerequisites:

- Some experience with neural signal processing (e.g., EEG, MEG, or ECoG).
- Some Matlab experience is required for the hands-on sessions.
- A practical interest in applying these notions.

What will you learn?

Theoretical insights into system identification and multivariate linear methods for neural signal analysis. Practical guidelines on how to prepare, process, and interpret your data. Practical knowledge of tools for neural signal analysis such as the mTRF-Toolbox.

BYOD! Bring your own dataset

We will provide you with guidelines to prepare your own data for the practical sessions. We can then answer your specific question during the Q/A session on day 3. Datasets will be available, if you don't have your own.

Contacts: <u>cnspworkshop@gmail.com</u> <u>https://cnspworkshop.net</u> Twitter: @*CnspWorkshop*



Cognition and Natural Sensory Processing Workshop

Workshop programme (Irish standard time)*

Session 1 (2pm)Investigating auditory processing with natural sound listening paradigms Chair: Mick CrosseIntroductionGiovanni Di Liberto – The CNSP-Workshop: What, why, and how
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Talk 1 (2.10pm) Jonas Obleser – Neural tracking of continuous sensory stimuli
Talk 2 (3.00pm) Edmund Lalor – The Temporal Response Function. Concept and basic research
Hands-on (3.50pm) Demonstration and practice. Environment setup.
Break (4.10pm) Break
Session 2 (4.30pm) Encoding and decoding models for neural signal analysis: Use and interpretation
Chair: Nathaniel Zuk
Talk 1 (4.30pm) Lien Decruy & Joshua Kulasingham – Encoding models
Talk 2 (5.10pm) Laura Gwilliams – Decoding models
Talk 3(5.50pm)Aaron Nidiffer – Stimulus feature extraction
Break (6.30pm) Break
Hands-on (6.40pm) Demonstration and practice + Details on the mini-project (about 1h)

Day 2 (Tuesday)

<u>Mini-Session</u> (3.30pm) break (4pm)	Christian Brodbeck Investigating speech processing with Python and Eelbrain
<u>Session 3 (4.10pm)</u>	TRFs in applied research: Case studies
	Chair: Aaron Nidiffer
Talk 1 (4.10pm)	Sarah Jessen – Speech sound perception in infants

- Talk 2(4.55pm)Elana Zion-Golumbic Auditory attention
- Talk 3(5.40pm)Jens Hjortkjær Auditory TRFs in ageing and hearing impaired cohorts
- Break (6.25pm) Best practices, limitations and future directions
- General discussion (6.35pm). *Please raise your hand and we will enable your microphone.*

Closing remarks

* **2pm Irish standard time** = 6am Seattle = 9am New York = 3pm Roma/Paris = 4pm Moscow = 6.30pm New Delhi = 9pm Beijing = 10pm Tokyo = 11pm Sydney

Day 3 (Wednesday)

Session 4 (4pm) Q/A session

* **2pm Irish standard time** = 6am Seattle = 9am New York = 3pm Roma/Paris = 4pm Moscow = 6.30pm New Delhi = 9pm Beijing = 10pm Tokyo = 11pm Sydney



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Speaker Line-up

Session 1 Investigating auditory processing with natural sound listening paradigms

Jonas Obleser, PhD



Jonas Obleser researches processes of perception and listening using methods from the cognitive neurosciences. After studying and obtaining his doctorate in psychology at the University of Konstanz, he worked at the Institute of Cognitive Neuroscience, University College London, and at the Max Planck Institute in Leipzig, where he established the research group "Auditory Cognition" (http://auditorycognition.com). Since 2016, he has held the Chair of Physiological Psychology at the University of Lübeck, Germany.

His current research interests include the dynamic changes of brain activity in perception and cognition, and how these processes interact during listening. His research is currently funded by the European Research Council (ERC), among others.

Edmund Lalor, PhD



Ed Lalor is an Associate Professor in the Departments of Biomedical Engineering and Neuroscience at the University of Rochester. The major goal of his lab's work is to develop novel methodologies for neuroscience research and to apply those methodologies to study human sensory, perceptual and cognitive processing in health and disease. This work has led to improved flexibility in the design of experiments aimed at the neurophysiological correlates of attention and multisensory integration and

some novel insights into the neurophysiological specificity of early sensory deficits in disorders such as autism and schizophrenia. In addition, it has provided researchers with the ability to obtain temporally detailed responses to stimuli that are much more naturalistic than those that are often used in EEG experiments. This includes significant recent efforts aimed at understanding the neurophysiology of receptive speech processing and how it is affected by attention and multisensory input. Ongoing work in the lab seeks to continue to develop sophisticated computational modelling frameworks to allow for greater interpretation of noninvasively recorded brain data and to translate these novel modelling methods into impactful research in clinical populations.

Session 2 Encoding and decoding models for neural signal analysis: Use and interpretation

Lien Decruy, PhD



Lien Decruy her background is in Audiology and Neuroscience. In 2014 and 2015, she obtained her Master's degree in Speech Therapy and Audiology Sciences as well as a Postgraduate training in Audiology and Hearing Aid Fitting, both at the KU Leuven in Belgium. Between 2015 and 2019, she was a PhD-student at the Research Group Experimental ORL (ExpORL, Department of Neurosciences, KU Leuven) under supervision of Prof. Dr. Ir. Tom Francart. In her PhD thesis, she focused

on measuring neural tracking of natural speech in normal-hearing and hearing impaired listeners of different ages, providing several first steps towards an objective (EEG) measure of speech understanding. After obtaining her PhD, Lien continued in the field of neuroscience and started in January 2020 as a postdoctoral researcher at the university of Maryland (USA), in the lab of Dr. Jonathan Simon, Dr. Samira Anderson and Dr. Stefanie Kuchinsky. Her research mainly involved the evaluation of a new auditory-cognitive training program for older adults, based on EEG/MEG responses to natural speech (using decoding and encoding models) and pupillometry. In June 2021, Lien started working as a study coordinator and research assistant of the medical ethical committee in the hospital AZ Groeninge Kortrijk, Belgium.

Joshua Kulasingham



Joshua P. Kulasingham is a PhD student in Dr. Jonathan Z. Simon's lab at the Department of Electrical and Computer Engineering, University of Maryland, College Park, USA. His research explores time-locked neural responses to speech, typically in a cocktail party paradigm, using MEG. He works with encoding models (Temporal Response Functions) that estimate cortical responses to relevant features of continuous speech. He has investigated high frequency time-locked responses to speech, and cortical processing of spoken sentences and equations.

Laura Gwilliams, PhD



Laura Gwilliams received her PhD in Psychology with a focus in Cognitive Neuroscience from New York University in May 2020. Currently she is a post-doctoral researcher at UCSF, using MEG and ECoG data to understand how linguistic structures are parsed and composed while listening to continuous speech. The ultimate goal of Laura's research is to describe speech comprehension in terms of what operations are applied to the acoustic signal, which representational formats are

generated and manipulated (e.g. phonetic, syllabic, morphological), and under what processing architecture.

Aaron Nidiffer, PhD



Aaron Nidiffer, Ph.D. is a Postdoctoral Research Associate in the Computational Cognitive Neurophysiology Laboratory of Dr. Edmund Lalor at the University of Rochester. Before moving to Rochester, he completed his doctorate at Vanderbilt University in Nashville, TN under the supervision of Dr. Mark Wallace. His interests lie broadly in speech processing and multisensory perception. His dissertation research focused on how correlations in the audiovisual sensory environment affect perception and object formation. As a postdoc, he is using both complex artificial (e.g., stochastic figure-ground) and natural (e.g.,

speech) signals to explore the neural underpinnings of audiovisual binding and the unique contributions of visual signals to language perception.

Mini Session Investigating speech processing with Python and Eelbrain

Christian Brodbeck, PhD



Christian Brodbeck studies the neural basis of language, and speech processing in particular. When humans listen to speech, the acoustic signal that enters the ears is a complex pattern of air pressure fluctuations. Yet, listeners intuitively and almost instantaneously experience meaning in these sounds. His research focuses on the transformations that happen in the brain to enable this. To study this, he mainly uses MEG and EEG with reverse correlation. Reverse correlation allows us to think of brain responses as a continuous transformation of

the speech signal, rather than relying on pre-defined events in the stimuli. It also allows us to disentangle responses related to different levels of processing, such as the formation of auditory and lexical representations. He uses Python to develop tools to make this research possible, and many of those tools are available in the open source libraries MNE-Python and Eelbrain.

Session 3 TRFs in applied research: Case studies

Sarah Jessen, PhD



Sarah has a background in neuroscience and psychology and currently runs the babylab at the University of Lübeck in Germany. Her research focus is on the neural mechanisms of social and emotional processing in the first year of life, and she uses predominantly EEG but also eyetracking and fNIRS.

Elana Zion Golumbic, PhD



Dr. Elana Zion Golumbic is the head of the Human Brain Dynamics Laboratory at the Multidisciplinary Center for Brain Research at Bar Ilan University. Her research focuses on studying how the brain processes dynamic information under real-life conditions and environments. Specifically, she seeks to understand the neural mechanisms underlying the processing of natural continuous stimuli, with a specific interest in real-life speech. Among the questions investigated in her lab are: *How is information from different senses integrated on-line? How does the brain*

encode competing input from our rich multisensory environments? And what are the mechanisms for managing attention in noisy and cluttered environments? Research in her lab utilizes a range of techniques for recording electric and magnetic signals from the human brain (EEG, MEG and ECoG), alongside a variety of psychophysical tools (eye-tracking, virtual reality, psychoacoustics). Dr. Zion Golumbic is an expert in applying advanced signal processing tools and machine-learning algorithms to human-recorded brain signals, an approach that is critical for furthering our understanding of the underlying neural code and the link between brain operations and human behavior.

Jens Hjortkjær, PhD



Jens Hjortkjær is currently a Senior Researcher in auditory cognitive neuroscience at the Hearing Systems group at the Technical University of Denmark (DTU), and also at the Danish Research Centre for Magnetic Resonance (DRCMR) at Copenhagen University Hospital Hvidovre. He leads the Auditory Cognitive Neuroscience group at DTU Health Technology. His main focus is on using neuroimaging, psychophysics, and computational modelling to understand the auditory system in normal and hearing-impaired listeners. JH studied cognitive psychology and music at Copenhagen University from where he

received his PhD in 2011. After joining the DRCMR, he worked on using functional MRI to study

the auditory cortex and effects of attention on cortical sound representations. He joined DTU as a postdoc in 2013 working on decoding auditory attention from speech-EEG, and worked on cognitive control of hearing aids in the H2020 COCOHA project. He is currently coordinator of the UHEAL project that combines MRI and neurophysiology to investigate auditory nerve degeneration and its consequences in central brain processing and behaviour.

The Organisers

Giovanni Di Liberto, PhD



Assistant Professor in Intelligent Systems School of Computer Science and Statistics Trinity College Dublin Ireland

Nathaniel Zuk, PhD



Postdoctoral Fellow Edmond & Lily Safra Center for Brain Sciences Hebrew University Jerusalem

Michael Crosse, PhD



Postdoctoral Researcher Microsoft Research USA

Aaron Nidiffer, PhD



Postdoctoral Associate Department of Biomedical Engineering University of Rochester USA

Resources

Check out our resource page at <u>https://cnspworkshop.net</u> We will do our best to continue updating and maintaining that web page in the future.

Data preparation guidelines: You should all have been invited to the document already. If not, please contact us. Here is the link to the document: <u>https://docs.google.com/document/d/1MP-VR5DcljYoxZtXZQdMJII3hkJzCyICIPCM2vQJ3PI/edit</u> ?usp=sharing

Datasets and scripts: <u>Click here to download</u> the zip file containing the folder structure archive that is available at this link (password: "CNSPd@ta2021"). Unzip the archive. The datasets and scripts that you will download should be placed into this folder structure. We are also sharing the following datasets: <u>LalorNatSpeech</u>, <u>LalorNatSpeechReverse</u>, <u>diliBach</u>, <u>musicImagery</u> (password: "CNSPd@ta2021"). Please download the datasets that you intend to use (we advise starting with *LalorNatSpeech*). Copy the dataset files in the corresponding folders according to the indicated folder structure (e.g., */datasets/LalorNatSpeech/dataCND/*). Note that the datasets that were not originally shared by using the CND format were converted to CND for this workshop. The conversion scripts were included in the folder structure (in the folder of each specific dataset), but they will not be needed for the CNSP-workshop tutorials.

Tutorial scripts: These scripts will be available our resource page at https://cnspworkshop.net

Mini-project guidelines: You will receive an invitation to visualise the following document. Here is the link to the document. You'll get access before the start of the workshop. <u>https://docs.google.com/document/d/1c1Hy-txExESgePAXvjf8JywfyMCdBbyrogLU3yiSKuk/edit?usp=sharing</u>

Slack: You should have received a link to join the slack workgroup. If you have not receive it, try this link or contact us.

https://join.slack.com/t/cnspworkshop/shared_invite/zt-tjhvqus5-AUs6pCmNGQDc~pxWI80L7A

Zoom webinar: You should have received an invitation to the scheduled Zoom calls on Monday, Tuesday and Wednesday. If not, please let us know.

Video-recordings will be available after the workshop (only for the presentations where the speakers agreed to the recording). Please contact us if you would like to get a copy soon after the workshop.

Follow us on:

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and on the CNSP google group (the link is on our website). We will keep up to date about future developments as well as future editions of the CNSP-Workshop.

Acknowledgements

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Nate is also supported by the ELSC-SWC Postdoctoral Fellowship at Hebrew University and University College London.

Aaron is supported by NIH grant DC016297.

We thank Jasmine Florentine for designing the CNSP logo! Check out her work at <u>https://www.jasmineflorentine.com</u>

We would like to thank Edmund Lalor, who has supervised all the organisers at some point of their careers and has greatly influenced the work that led to this workshop. We would like to thank Jonas Obleser, Nima Mesgarani, Jonathan Simon, Jens Hjortkjær, Lien Decruy, and Usha Goswami for their early feedback and support. We would like to thank all our speakers for their great help with this first edition of the CNSP-Workshop. Finally, thank you all for your participation! We really hope that this workshop has been helpful and will continue to be helpful with future editions and with the set of resources that we will maintain and update in the foreseeable future with the help of the CNSP community.









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