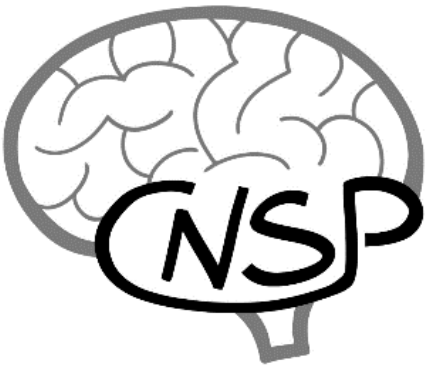


Cognition and Natural Sensory Processing Workshop 2025

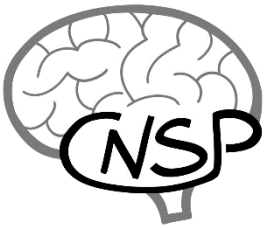
(2–3 September)

2025 Workshop Programme

(All times Irish standard time)

Day 1 (Tuesday 2 September)	
Start (4.00pm)	Introduction and welcome
Keynote (4.10pm)	**Jean-Rémi King** – Emergence of language in the human brain
Break (5.10pm)	...
Tutorial (5.20pm)	**Aaron Nidiffer** – Encoding/decoding models, multivariate analysis, models validation, etc. in the MATLAB mTRF-Toolbox, a beginner's tutorial | data+code
Break (6.20pm)	...
Tutorial (6.30pm)	**Hugo Weissbart** – Bridging complexity in neural dynamics: Non-linear approaches to temporal response function analysis | data | code
End (8.00pm)	

Day 2 (Wednesday 3 September)	
Start (4.00pm)	Welcome
News (4.05pm)	**Giovanni Di Liberto** – CNSP Updates
Keynote (4.20pm)	**Sam Nastase** – Unifying the structures of language in a neural population code
Break (5.20pm)	...
Talk (5.30pm)	**Dana Boebinger** – Rapid and dynamic construction of acoustically invariant speech representations in the human auditory cortex
Talk (6.00pm)	**Ashley Symons** – Towards a behavioural measure of attentional capture by continuous natural speech
Break (6.30pm)	...
Tutorial (6.40pm)	**Maximilian Nentwich** - Modelling recurrent connectivity and temporal response functions data | code
End (8.10pm)	



Cognition and Natural Sensory Processing Workshop

The CNSP initiative aims to develop and collect resources, such as analysis scripts and publicly available neural data, for the study of cognition and natural sensory perception. In doing so, we propose a standardised pipeline for recording, analysing, storing, sharing, and comparing datasets involving natural sensory processing, such as speech/music perception and watching movies. The CNSP workshop 2025 will provide the fundamental insights on the standardised pipeline and analysis scripts via a set of tutorials delivered by organisers, as well as giving space to other tutorials from researchers in the field, providing a comparison of current methodological techniques, as well as proposing new approaches for the field. This fourth edition of the CNSP workshop will also feature two international keynote speakers, who have contributed significantly to the field, and two short talks from rising junior researchers. Please visit our website at https://cnspworkshop.net.

Background:

In recent years, research has demonstrated the importance of studying perception in real-world scenarios involving naturalistic tasks. Recent advances in computational resources, neural signal processing and machine learning have led to the development of research frameworks to quantify neurophysiological activity under such naturalistic conditions. The possibility of carrying out these realistic experiments is ground-breaking, as it leads to datasets that are particularly information-rich and suited to being re-analysed from a variety of angles. Recent attempts to share that type of datasets have resulted in a valuable yet heterogeneous set of publicly available resources, whose strengths are diminished by the lack of a clear domain-specific standardised pipeline and resource sharing approach. The CNSP initiative is collecting and standardising that set of resources, as well as developing and sharing numerous original standardised analysis scripts that serve as tutorials and blueprint for researchers that are transitioning into this rising field of research. This material is designed to be accessible to researchers from a variety of disciplines. Nevertheless, while this makes it easier to analyse the data, researchers must have the appropriate understanding of the core methodological aspects of this analysis pipeline, which is provided in the form of tutorials during the CNSP workshop. In addition, the CNSP workshop 2025 will host international keynote speakers at the top of this field of research, two tutorials that have been selected based on an open call for submission, and two invited speakers who work with continuous neural signals in exciting and groundbreaking manners.

Keynote Speakers

Emergence of language in the human brain

Jean-Rémi King is a CNRS researcher at École Normale Supérieure currently detached to Meta AI, where he leads the Brain & AI team. This team aims to identify the brain and computational bases of human intelligence, with a focus on language. For this, they develop deep learning algorithms to decode and model brain activity recorded with MEG, EEG, electrophysiology and fMRI.

Unifying the structures of language in a neural population code

Sam Nastase is an assistant professor in the Department of Psychology at the University of Southern California. The core question driving his research is "How do we share our thoughts with one another?"—using language and other coordinated actions. His expertise is in combining deep learning with naturalistic neuroimaging to better answer this question in real-world contexts.

Invited Talks

Rapid and dynamic construction of acoustically invariant speech representations in the human auditory cortex

Dana Boebinger, PhD, is a postdoctoral fellow in the lab of Samuel Norman-Haignere, PhD, at the University of Rochester Medical Center. She received her doctoral degree from Harvard University's Speech and Hearing Bioscience and Technology program, her master's degree in Cognitive Neuroscience from University College London as a Fulbright Scholar, and her undergraduate degrees in Psychology and Music from Florida State University. Her research focuses on how the human brain perceives and understands sounds like speech and music.

Towards a behavioural measure of attentional capture by continuous natural speech

Ashley Symons is a Lecturer (Assistant Professor) at Royal Holloway, University of London. Her research combines behavioural and EEG methods to explore how different individuals navigate the challenges to speech perception, and how speech perception strategies change across the lifespan. She earned her PhD from the University of Manchester under the supervision of Prof Sonja Kotz and most recently worked as a postdoctoral researcher with Prof Adam Tierney.

Hands-on Tutorials

Modelling recurrent connectivity and temporal response functions | data | code

Temporal response functions are widely used encoding models to analyze speech processing. Current methods to compute temporal response functions do not separate immediate sensory responses from recurrent internal dynamics. We recently introduced a vector-autoregressive model with external input (VARX) model that allows separating the internal dynamic from linear input responses (1, 2), by combining Granger analysis and temporal response functions (Figure 1A).

This tutorial applies the VARX toolbox (https://github.com/lcparra/varx) to intracranial EEG data and eyetracking data from an example patient's movie watching and resting state recordings (3). The aim is to provide an introduction to the toolbox and illustrate the utility of the model to remove recurrent dynamics from temporal response functions (Figure 1B), and remove spurious connections from internal dynamics (Figure 1C). The tutorial will give an overview of the toolbox and will demonstrate 1) the effect of including various external inputs on intrinsic connectivity, 2) the effect of modelling intrinsic connectivity on encoding models, 3) how to compare intrinsic connectivity between movies and resting state, and 4) analysis of asymmetric connections.

This introduction will allow users of our toolbox to conduct analysis of intrinsic connectivity and a variety of external inputs from recordings in trial based and naturalistic settings and a variety of recording modalities. The toolbox further offers flexibility in computing the significance of connections, allowing users to implement statistical tests beyond the Granger formalism.

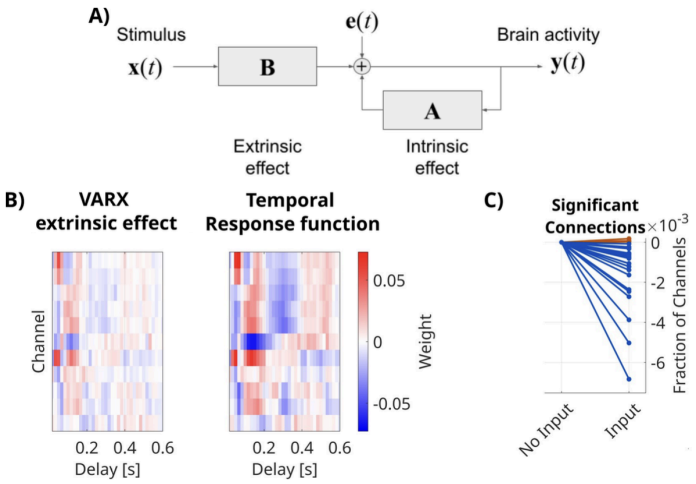


Figure 1: A) Schematic of the VARX model, with filters B for extrinsic effects, and filter A for intrinsic 'connectivity'. B) VARX filter B is shorter and weaker than the temporal response function. C) Including external inputs reduced the number of spurious connections.

Maximilian Nentwich is a post-doc at the Feinstein Institutes for Medical Research (Northwell Health, New York, USA) where he studies multimodal attention in recordings of human intracranial EEG. He is also interested in arousal states and slow fluctuations of brain signals. During his PhD at the City College of New York he analyzed neural responses to visual semantic novelty in movies. The intracranial EEG movie data recorded during his PhD and post-doc will be made publicly available soon.

Bridging complexity in neural dynamics:
Non-linear approaches to temporal response function analysis | data | code

This tutorial presents advanced methodologies to extend Temporal Response Function (TRF) analysis beyond its usual linear framework, deepening our understanding of complex neural interactions. Traditionally, TRF derives “evoked potential”-like responses from continuous recordings with arbitrary stimulus signals, accommodating diverse event and predictor structures. We briefly review fundamental usage, including model equation solutions and regularisation strategies—such as incorporating prior spectral information in singular value decomposition-based TRF solutions.

Building on this, we propose using non-linear mappings to synthesise more complex signals, empowering linear convolutional models to extract precise temporal responses to sophisticated neural features, such as phase clustering and phase-amplitude coupling (see Figure 1). We also introduce a technique that modulates samples using ongoing neural phase or other stimulus-bound data, weighting samples entering the TRF decomposition, and enabling hierarchical representations of stimulus dependencies.

Tutorial Structure and Goals:

This interactive Jupyter Notebook tutorial will guide participants through:

- A hands-on introduction to standard and advanced TRF estimation with sample data (only using standard toolboxes for scientific computing, MNE-python used only to load data),
- Implementation and interpretation of various regularisation techniques,
- Application of non-linear TRF mappings (e.g., phase-amplitude coupling) with Python.

Participants will gain practical skills in state-of-the-art TRF methods and an understanding of how such techniques can deepen analysis of neural dynamics.

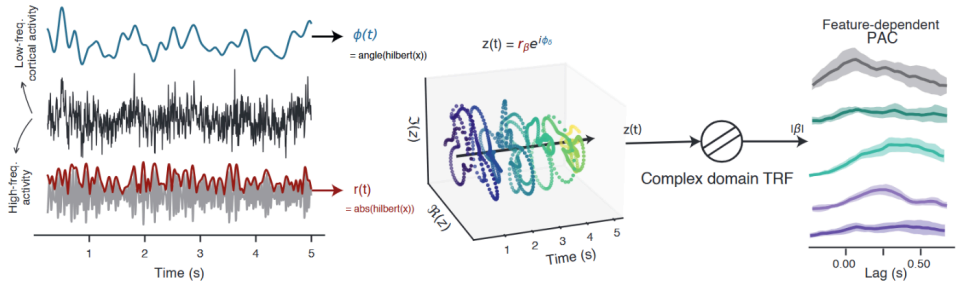


Figure 1: A diagram representing how to compute phase-amplitude coupling elicited by potentially distinct stimuli features using Temporal Response Functions (TRF). The TRF weights are estimated from the regression of the complex analytical signal composed of the phase and amplitude at different frequency bands of one or different M/EEG signals.

Hugo Weissbart is a postdoctoral researcher at the Donders Institute, Nijmegen. His research investigates how predictive neural computations contribute to speech comprehension, focusing on how the brain forms and updates robust linguistic representations in real time. He examines how different levels of linguistic information interact and how slow dynamics modulate oscillatory mechanisms supporting comprehension. Using MEG and naturalistic stimuli, he studies the cortical dynamics underpinning these processes and complement this with computational modeling to explore the mechanisms enabling fast and flexible language understanding.

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Workshop Resources

Shared by Sam Nastase: "Podcast" ECoG Tutorials | "Podcast" ECoG Dataset | "Narratives" fMRI Dataset

Tutorial data and scripts: These materials are also available on our resource page for CNSP 2025. The readme for each repository containing scripts provides setup instructions.

- mTRF-Toolbox (2 Sep): data+code
- Non-linear approaches to temporal response function analysis (2 Sep): data | code
- Modelling recurrent connectivity and temporal response functions (3 Sep): data | code

Zoom webinar: You will receive an invitation to the scheduled Zoom calls on Tuesday and Wednesday.

Discord: Please join our server.

Video recordings will be available after the workshop on the CNSP website.

Where to find CNSP:

✉️ cnspworkshop@gmail.com
💻 https://cnspworkshop.net
github.com/CNSP-Workshop/
𝕏 CnspWorkshop
cnspworkshop.bsky.social

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We thank Trinity College Dublin for offering their resources for managing the registration for the workshop.

We also thank all our colleagues who have engaged in previous CNSP workshops, as well as all the speakers of CNSP 2025 for their key contributions to this year's workshop. Finally, thank you all for your participation! We really hope that this workshop has been helpful and that its future editions will continue to be helpful.

Finally, our thanks to Jasmine Florentine for designing the CNSP logo! Check out her work on her website.