Mads Jensen, Rasha Hyder and Yury Shtyrov
Detecting specific neurolinguistic processes using MEG: MVPA analysis of intertrial phase coherence of brain responses to words reliably classifies multiple levels of language processing

Abstract:
Neural processing of language is still among the most poorly understood functions of the human brain, whereas a need to objectively assess the neurocognitive status of the language function in a participant-friendly and noninvasive fashion arises in various situations. Here, we propose a solution for this based on a short task- and attention-free recording of MEG responses to a set of spoken linguistic contrasts. We used spoken stimuli that diverged lexically (words/pseudowords), semantically (action-related/abstract) or syntactically (grammatically correct/ungrammatical). Based on beamformer source reconstruction we investigated inter-trial phase coherence (ITPC) in five canonical bands (alpha, beta, and low, medium and high gamma) using multivariate pattern analysis (MVPA). Using this approach, we could successfully classify brain responses to meaningful words from meaningless pseudowords, correct from incorrect syntax, and semantic differences. The best classification results indicated distributed patterns of activity dominated by core temporofrontal language circuits and complemented by other areas. They varied between the different neurolinguistic properties across frequency bands, with lexical processes classified predominantly by broad gamma, semantic distinctions – by alpha and beta, and syntax – by low gamma and beta feature patterns. This latter contrast was particularly informative since it used distinct sound patterns, ruling out the possibility that MVPA simply fits the data and suggesting that this approach is able to detect genuine neurolinguistic process. Crucially, all types of processing commenced in a near-parallel fashion from ~100 ms after the auditory information allowed for disambiguating the spoken input. This shows that individual neurolinguistic properties take place simultaneously and involve overlapping yet distinct neuronal networks that operate at different frequency bands.