Does the brain recruit the same word representations across language behaviours? A Registered Report MEG study of language production versus perception.

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Traditionally, language production and perception have been studied in isolation, but investigating both behaviours jointly is needed to understand language use in its default context: conversation. Presently, however, the overlap between the modalities of production and comprehension for the basic building blocks of language – words - is unclear. We aim to fill this gap by comparing the spatiotemporal dynamics of word activation between production and perception using MRI-constrained magnetoencephalography. According to (Partial) Separation Models [1, 2], words are activated in a modality-specific manner: temporally, semantic-related information is accessed before sound-related information in production, and vice versa in perception, and spatially: both temporal and frontal brain regions play a role in production, whereas only temporal regions are needed for perception. In contrast to these models, Integration Models [3, 4] predict similar brain dynamics in the temporal and spatial domains in production and perception. In both modalities, the same semantic and sound related information is accessed early and in parallel over distributed fronto-temporal circuits.

To contrast these hypotheses, 40 participants (as established with power analyses using minimal detectable effect sizes) will carry out a production task (picture naming) and a perception task (passive listening) while their MEG is recorded. These two sessions will be carried out on different days, separated minimally by one week, in a counterbalanced order. The same stimuli will be presented in both tasks, with two linguistic manipulations: whether the stimuli are animals or tools (the Meaning manipulation, e.g., 'babouin' (*baboon*) versus 'bouclier' (*shield*)), and whether the stimuli are bilabial- or alveolar-initial words (the Sound manipulation, e.g., 'baleine' (*whale*) versus 'dauphin' (*dolphin*)). The stimuli are controlled on a variety of other psycholinguistic variables. We will rely on established cortical dissociations of these two manipulations [5, 6] as markers for lexico-semantics (Meaning) and phonology (Sound), and (a) contrast their activation time-course between production and perception, and (b) assess whether activation in one behaviour predicts the other behaviour. Regions of interest (ROIs) according to the cortical dissociations will be defined individually within each participant using fMRI localizer tasks, with source-level MEG data used for analysis.

To contrast the source-level activation time course per ROI between modalities, data will be analysed in 25ms time bins using linear mixed effects models. The models will contain the predictors Modality (perception vs production), Meaning (animals vs tools) and Sound (bilabial vs alveolar). The random effects structure will control for participant and item-level variation, as well as random variation associated with the predictors of interest. Partial Separation Models predict that we should see interactions between Modality and Meaning/Sound in specific regions, such that Meaning effects are found prior to Sound effects in production, and vice versa in perception. Additionally, during perception, only ROIs in the temporal cortex should show Meaning and Sound effects. Integration Models predict effects of Meaning and Sound in similar (early) time bins, in both modalities, in frontal and temporal cortex. To assess whether activation relating to the manipulations in one modality can predict the other modality, we will conduct temporally-generalised multivariate pattern analysis, where classifiers will be trained on the Meaning and Sound predictors in one modality and tested on the other modality (and vice versa) at all possible time points. Testing of this accepted Registered Report has begun and preliminary results of the study will be presented. Overall, this study will allow us to address whether words are represented as the same functional units, or rather recruit interacting, but dissociable, processing pathways in each modality.

References

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