Localizing covert and overt picture naming processes using MEG

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Background

Numerous hemodynamic studies have mapped out brain regions involved in the process of naming. Nonetheless, the higher temporal resolution in an electrophysiological signal is crucial for identifying the latency and relative order of different word retrieval stages (e.g., lemma selection, phonological activation, etc.). Although several studies have reported event-related potentials time-locked to naming events, fewer studies have investigated modulation of neuronal oscillations both phase-locked and non-phase-locked to picture naming processes. Furthermore, methodological differences in naming paradigm and data processing for the removal of motor artefacts remain critical issues across language production studies. These difficulties identified in the literature call for comparisons between naming methods, as well as the need for valid paradigms eliciting word retrieval processes while avoiding motor artefacts.

Objectives

This MEG study (1) examines the **loci and power modulations underlying semantic interference and phonological facilitation** during covert picture naming, and (2) highlights the similarities and differences in **oscillatory modulations across different covert and overt naming** tasks.

Method

Thirty young healthy adults (22.73 ± 4.36; 20 female) participated in a structural MRI and three picture naming tasks under MEG. Aside from the traditional **overt picture naming**, we included two covert picture naming tasks. One was a **covert picture-word interference (PWI) task** where participants were instructed to ignore the audio distractor word and focus on judging whether the target picture name ends in a target sound assigned for the block by pressing yes/no buttons. By manipulating the semantic and phonological relations between distractor words and target pictures, the covert PWI task was previously validated to elicit both semantic interference (SI) and phonological facilitation (PF) at distinct stages of word retrieval, suggested by distinct optimal onset asynchronies (Wei et al, 2022). The covert PWI also included a "no distractor condition" that was simply **an ending sound matching** task. The other covert naming task required participants to judge whether the target picture name begins with the target sound assigned for the block by pressing yes/no buttons. The **beginning sound matching** design was intended for potential application with stroke patients, as it is an easier task.

Results

Participants performed comparably in overt naming and beginning sound matching tasks, with both being faster and more accurate than the PWI task, in which the SI slowing and PF speeding effects were observed. (Objective 1:) In the MEG source-level data, **semantic interference** during naming was associated with **alpha power decrease** in the frontal, temporal, and inferior parietal regions in both hemispheres, suggesting extra cortical engagement recruited with the presence of a cued competitor for target naming. On the other hand, **phonological facilitation** in naming was accompanied by **alpha power increase** across bilateral frontal and perisylvian regions, reflecting the relative ease in name retrieval with phonological cues. (Objective 2:) Across the **covert and overt naming** tasks, the neuronal oscillations mainly **differed in the motor and occipital cortices** according to the task-specific response planning (e.g., mouth vs. hand movement; attention to beginning sound vs. full phonology activation), while retaining similar word-retrieval neuronal activities.

Conclusion

This study characterized the **neuronal oscillatory modulations underlying interference and facilitation effects during covert naming**. Furthermore, by demonstrating that the main neurophysiological deviation of covert from overt naming lies in the response preparation and visual recognition aspects, the results suggested **promising validity of using the covert naming designs to probe word retrieval processes without verbal motor artefacts** in laboratory settings.