Cognitive Mode Detectable with Task-based fMRI: Language (LAN)

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INTRODUCTION

Task-based functional magnetic resonance imaging (fMRI) reliably detects a cognitive mode, known as the Language (LAN) mode, that simultaneously engages Broca's and Wernicke's areas. This mode is left-lateralized during language tasks and is also elicited by a variety of other cognitive tasks[1]. Cognitive modes are defined as task-general cognitive/sensory/motor processes which reliably elicit specific blood-oxygen-level-dependent (BOLD) signal pattern configurations. This study will determine the anatomical replicability and functions of the language mode through the analysis of BOLD signal changes induced by various cognitive tasks.

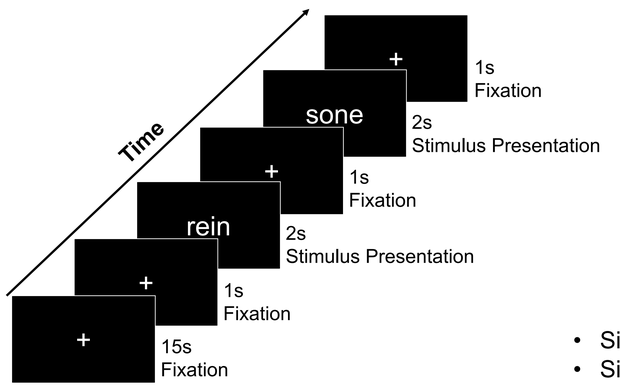
METHODS

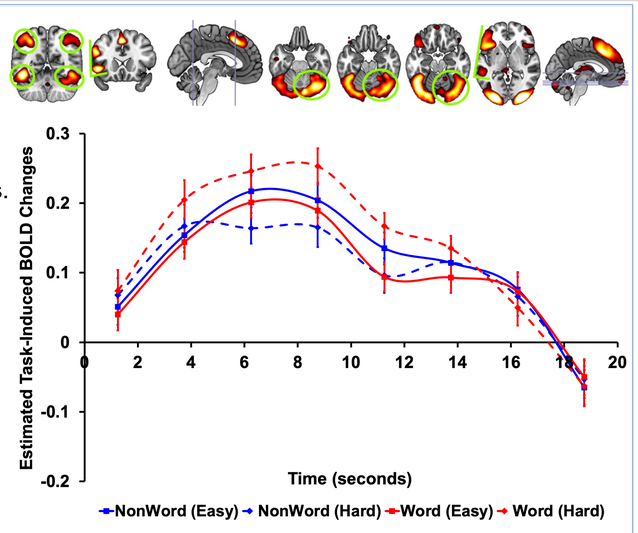
Previous works extracted functional brain networks using constrained principal component analysis for fMRI (fMRI-CPCA)[2]. Corresponding estimated task induced BOLD changes were examined to interpret the role of the LAN mode in each task for healthy controls. A repeated measures ANOVA analysis was used to identify significant interactions and main effects.

RESULTS

Lexical Decision Task

- 59 healthy participants completed the Lexical Decision Task, where they had to decide whether each four-letter sequence represented a real English word or not
- Word and non-word stimuli were shown at two levels of difficulty (Easy vs. Hard) resulting in four task conditions.

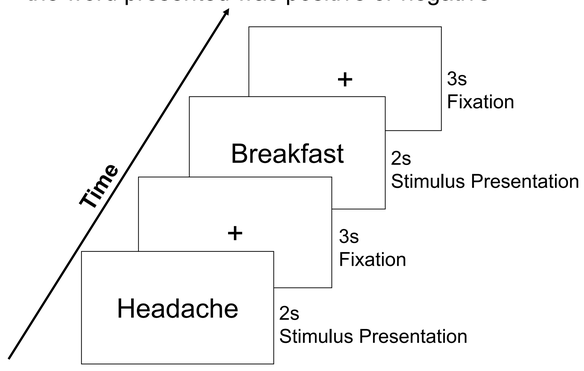


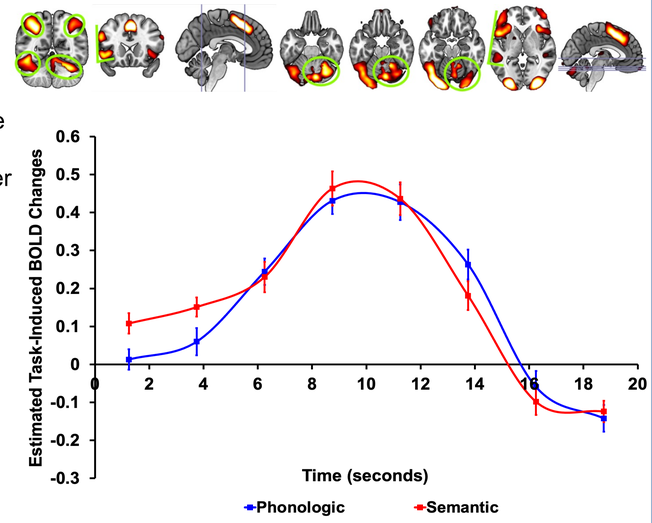


- Significant main effect of difficulty ($p < .01$)
- Significant interaction for difficulty x lexicality x time ($p < .001$)

Syllable Stress Task

- 32 healthy participants were shown 48 two-syllable Dutch words. There were a total of 2 conditions.
- In the phonological condition, participants had to choose where the syllable stress was located
- In the semantic condition, participants evaluated whether the word presented was positive or negative

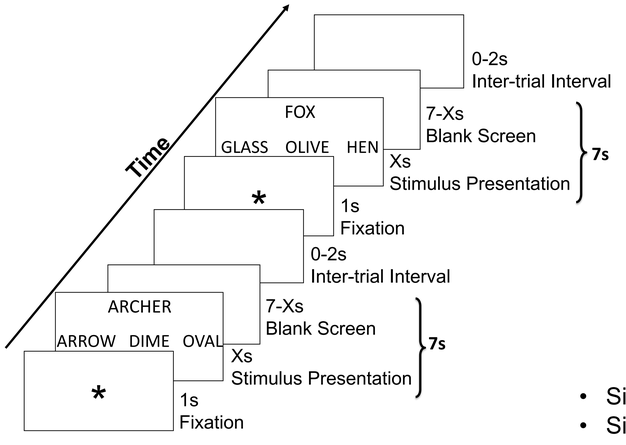


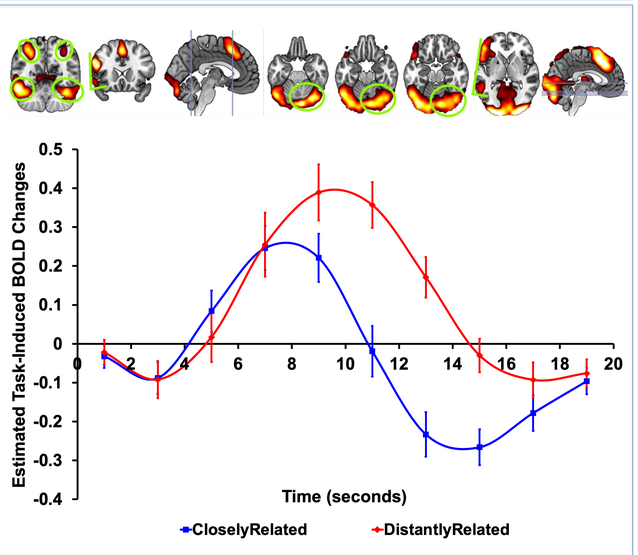


- No significant interactions

Semantic Association Task

- 32 healthy participants were shown three match options for a prompt word and were asked to select the match option that most closely relates to the prompt word.

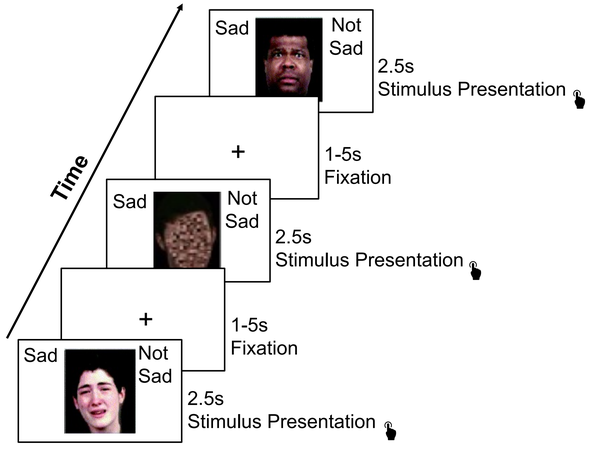


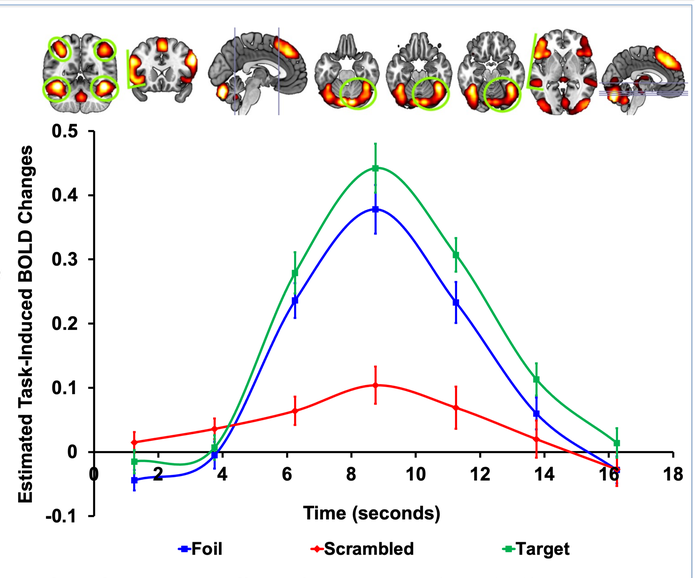


- Significant main effect of task condition ($p < .001$)
- Significant interaction for task condition x time ($p < .001$)

Facial Emotion Discrimination Task

- 21 healthy participants evaluated whether a presented face reflected a particular target emotion or age





- Significant main effect of image type ($p < .001$)
- Significant main effect of discrimination condition ($p < .001$)

CONCLUSION

The LAN mode exhibited distinct replicable anatomical patterns during the LDT, SS, SA, and FED tasks. Its activation during these tasks suggest that this mode is associated with increased and reduced linguistic information processing, possibly including non-verbal communication. Future work may investigate gestures and LAN suppression during linguistic task processing.

REFERENCES

[1] Lavigne, K., & Woodward, T. S. (2018). Hallucination- and speech-specific hypercoupling in frontotemporal auditory and language networks in schizophrenia using combined task-based fMRI data: an fBIRN study. Human Brain Mapping, 39, 1582-1595.

[2] Metzak, P. et al. (2011). Constrained principal component analysis reveals functionally connected load-dependent networks involved in multiple stages of working memory. Human Brain Mapping, 32(6), 856-871.