



The Language Network in Task-Based fMRI

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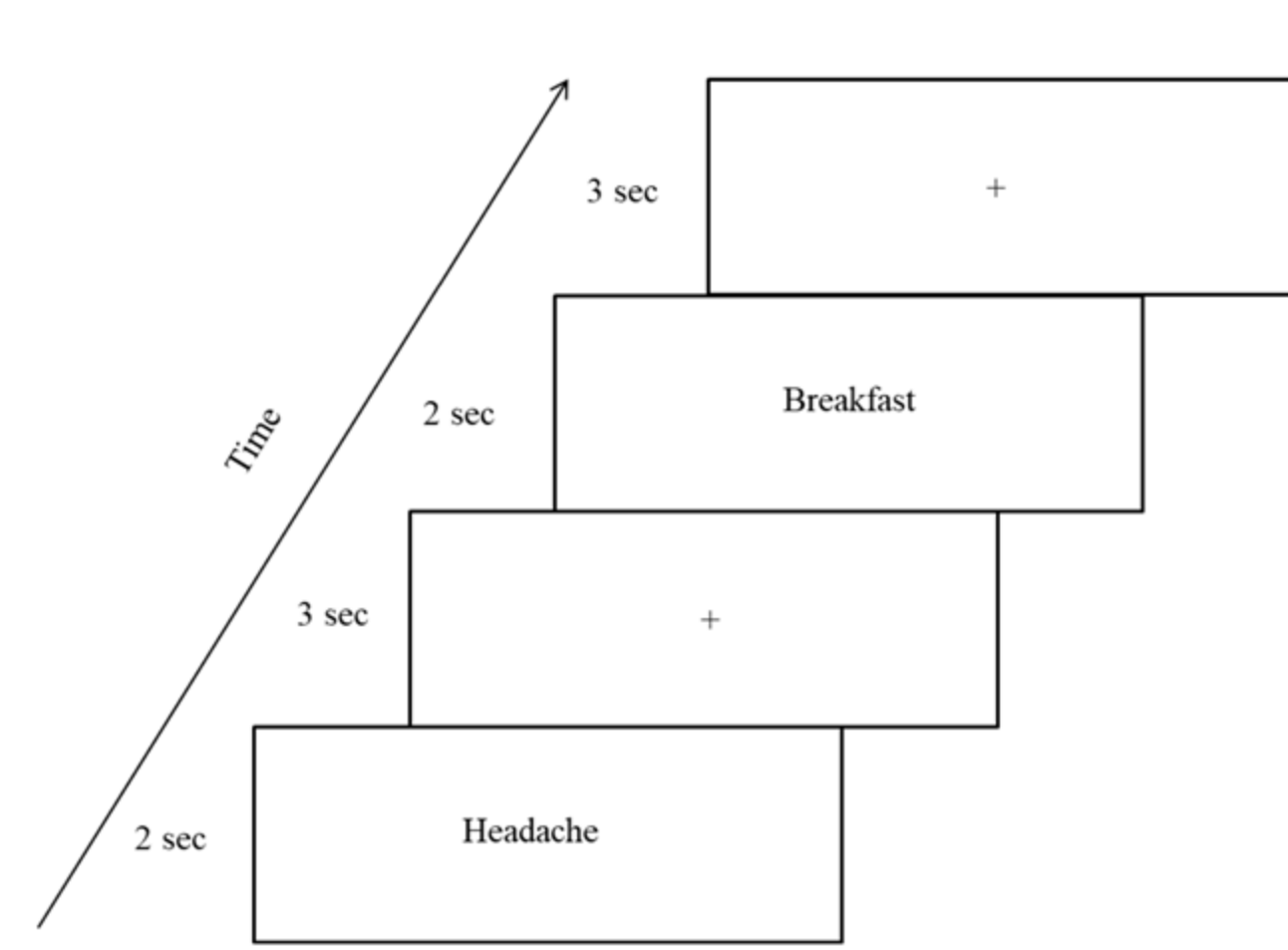
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Introduction

- Task-based functional magnetic resonance imaging (fMRI) detects a brain network that simultaneously engages Broca's and Wernicke's areas.
- This network is left-lateralized in language tasks, but it is also elicited by other task types [1,2].
- This study aims to further elucidate the function of this network by observing its activation over a range of cognitive fMRI tasks.

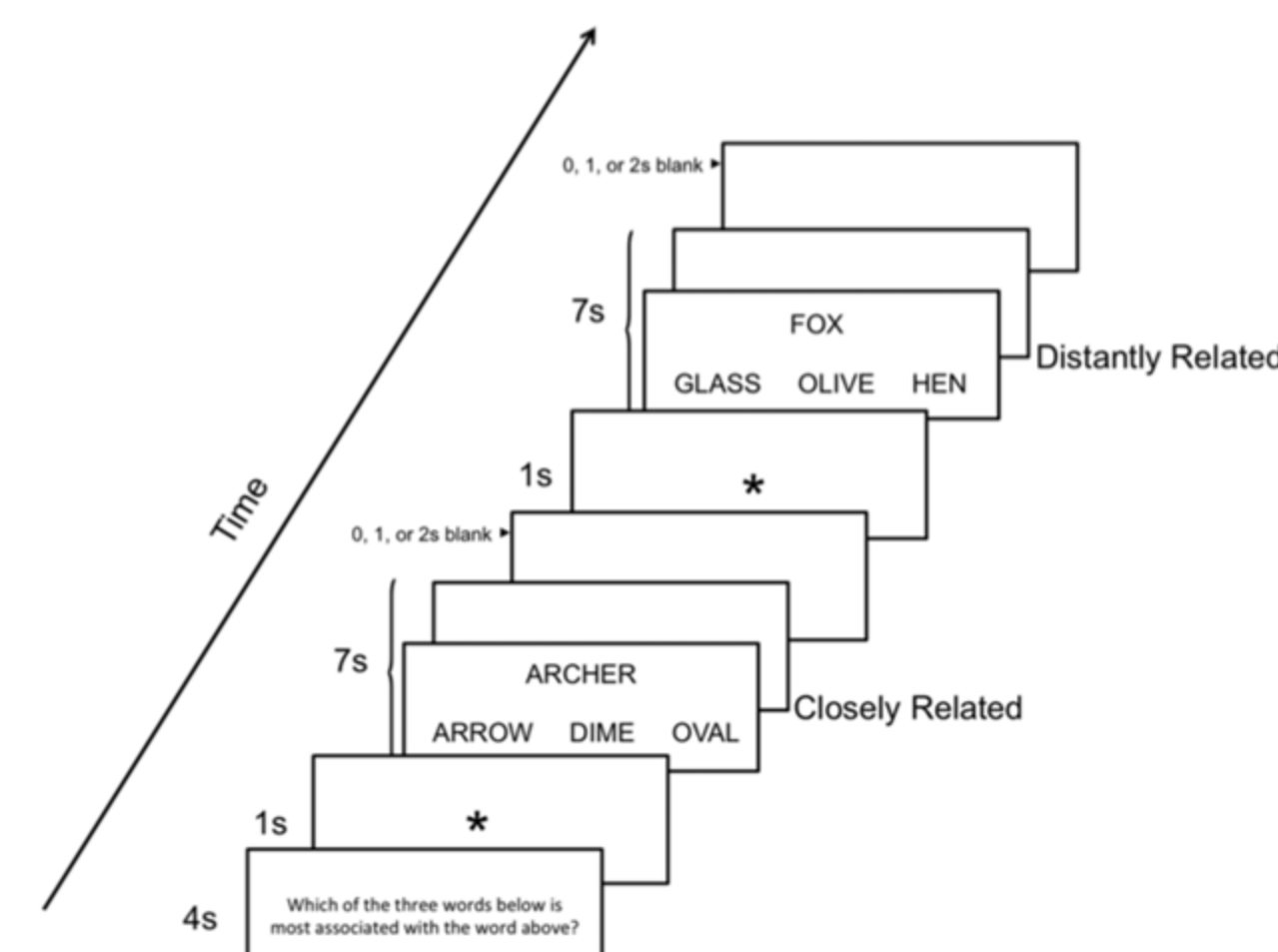
Methods

- Networks were extracted using constrained principal component analysis for fMRI (fMRI-CPCA).
- A MATLAB algorithm was used to classify these networks into 11 prototype templates [1].
- Four networks from five tasks with the highest correlation to the language network prototype were selected for this study.



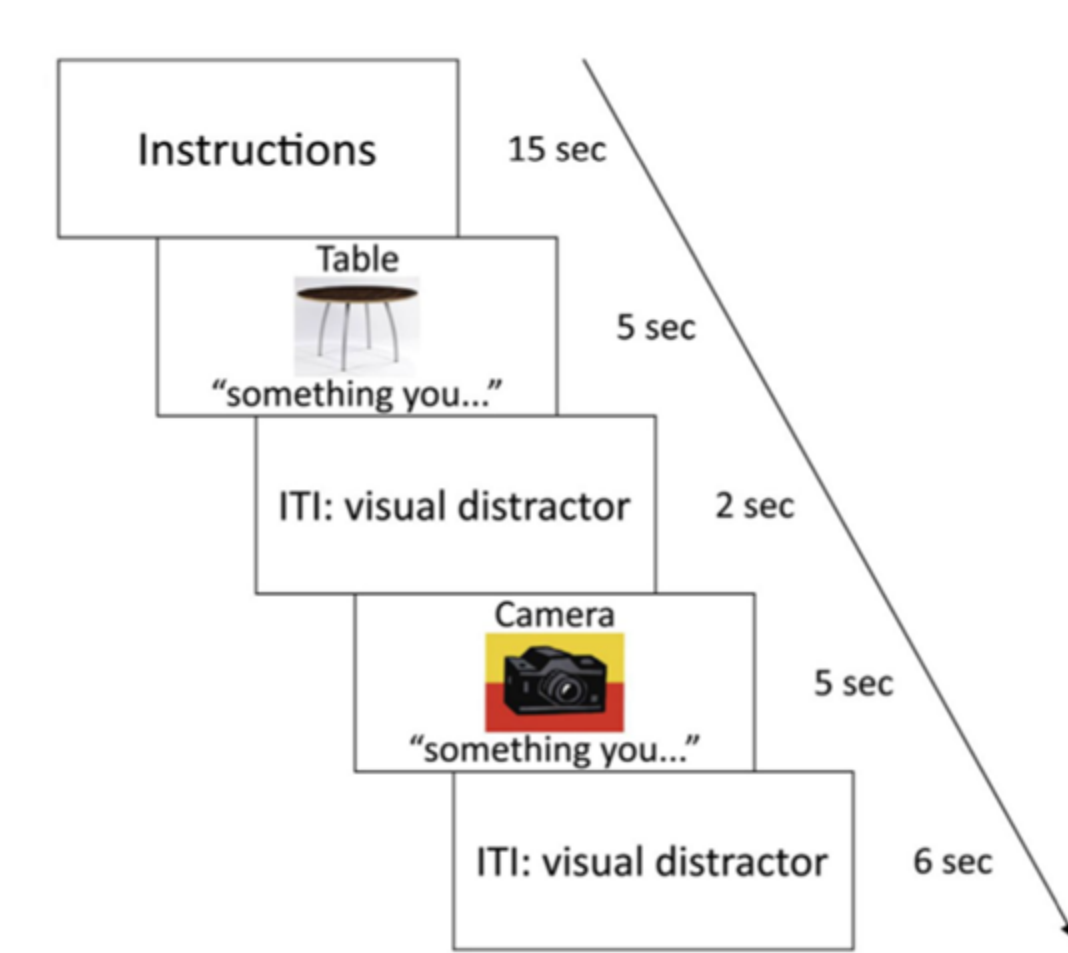
Metrical Stress (MS) Task:

Participants (n=79) were shown 2-syllable words and were asked about the word's syllable stress and connotation.



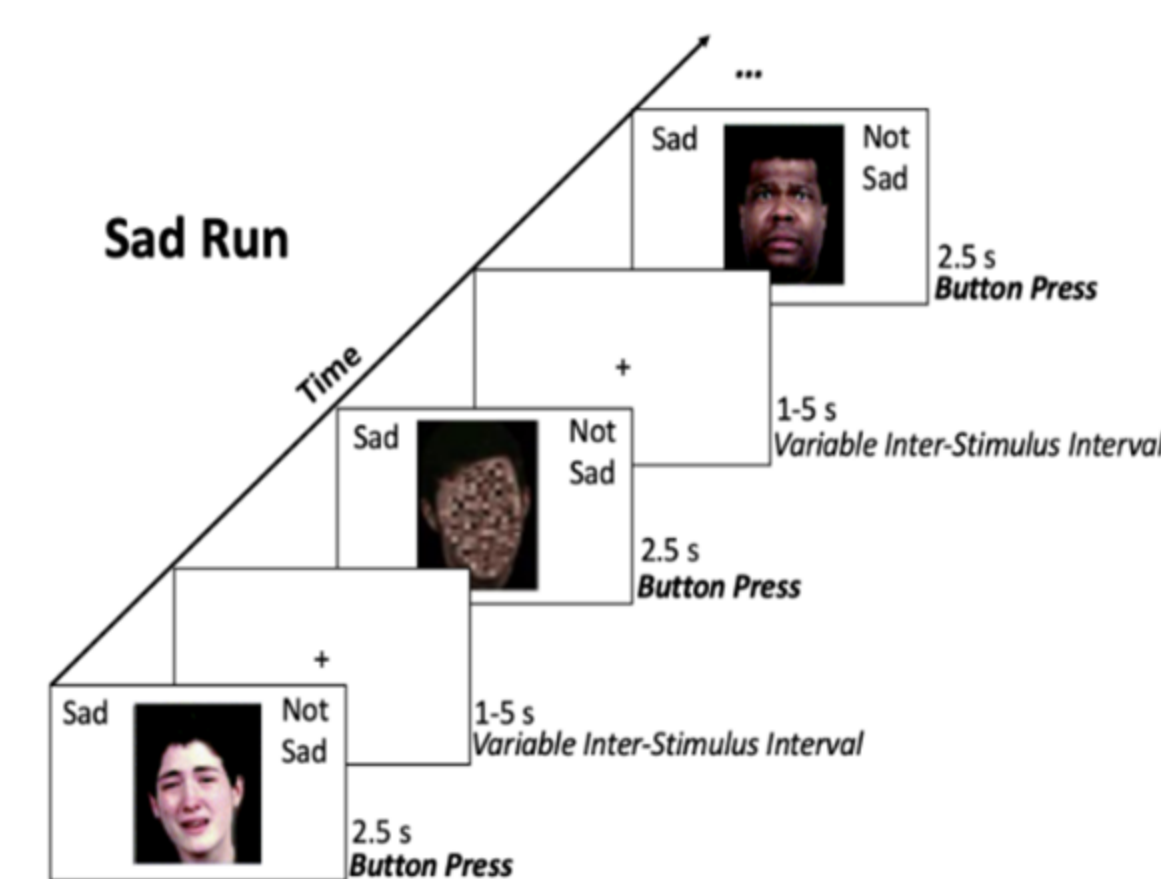
Semantic Association (SA) Task:

Participants (n=57) were shown three match options for a word prompt and were asked to select an option that most resembles the prompt.



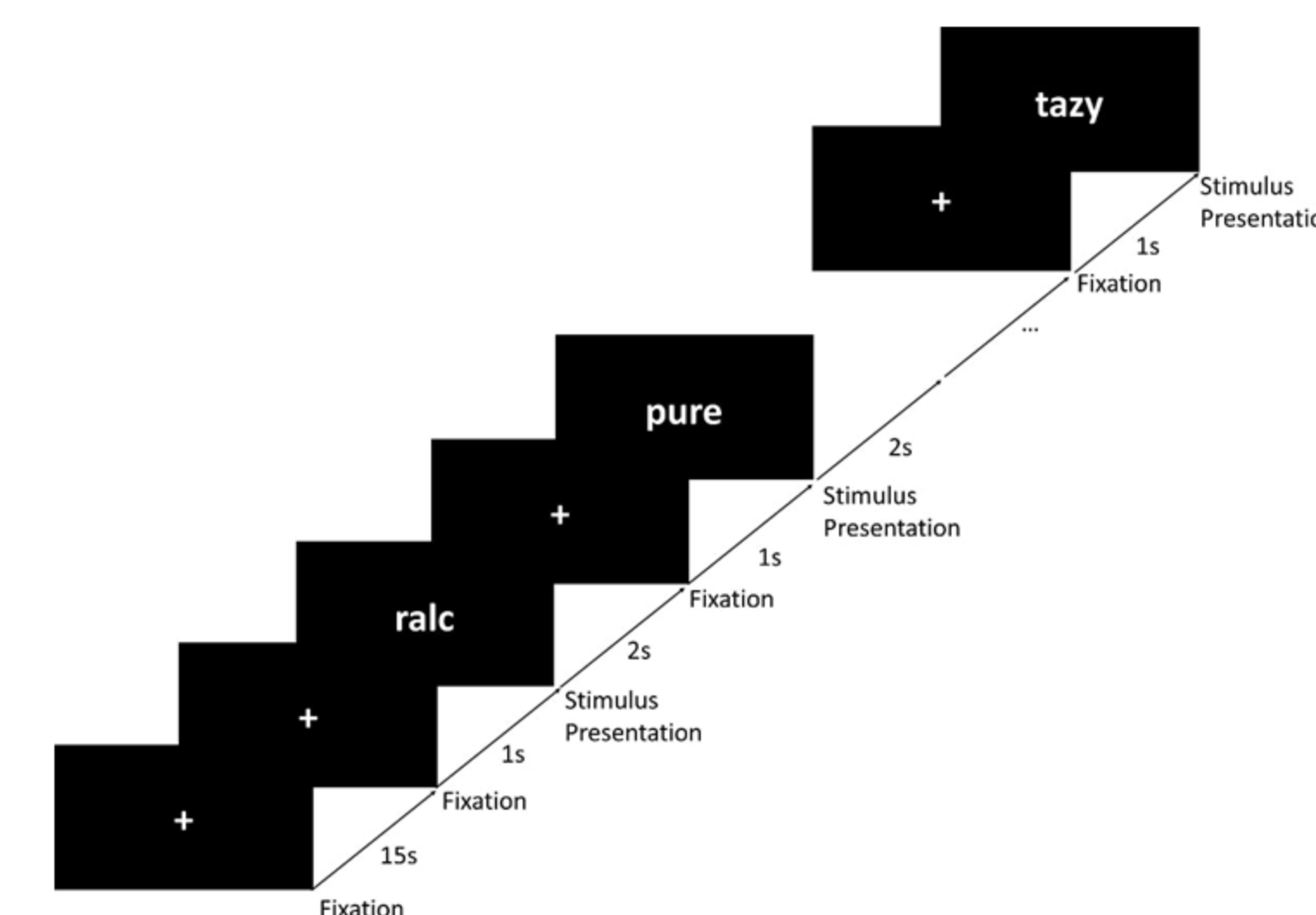
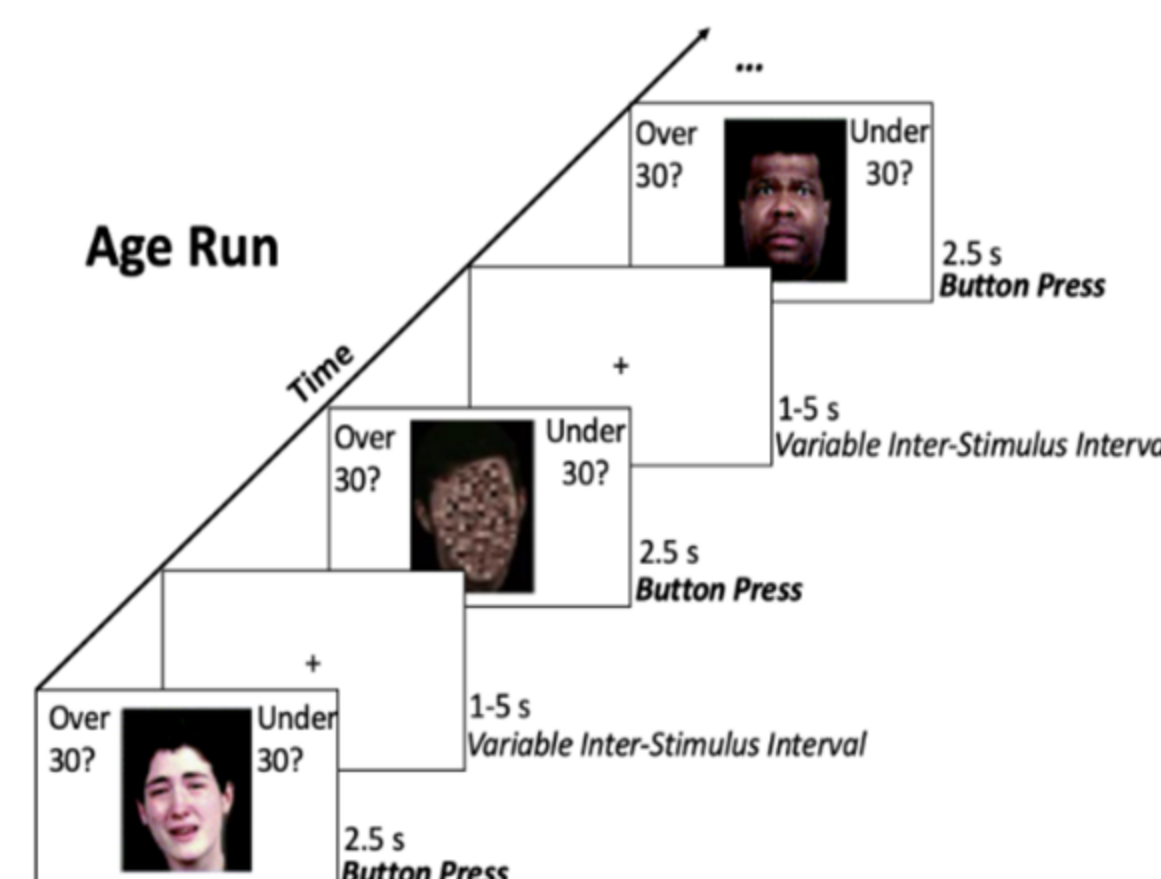
Thought Generation (TG) Task:

Participants (n=49) were presented with a word and its image, and were asked to either listen to, or generate, a definition for the word.



Emotion Discrimination (ED) Task:

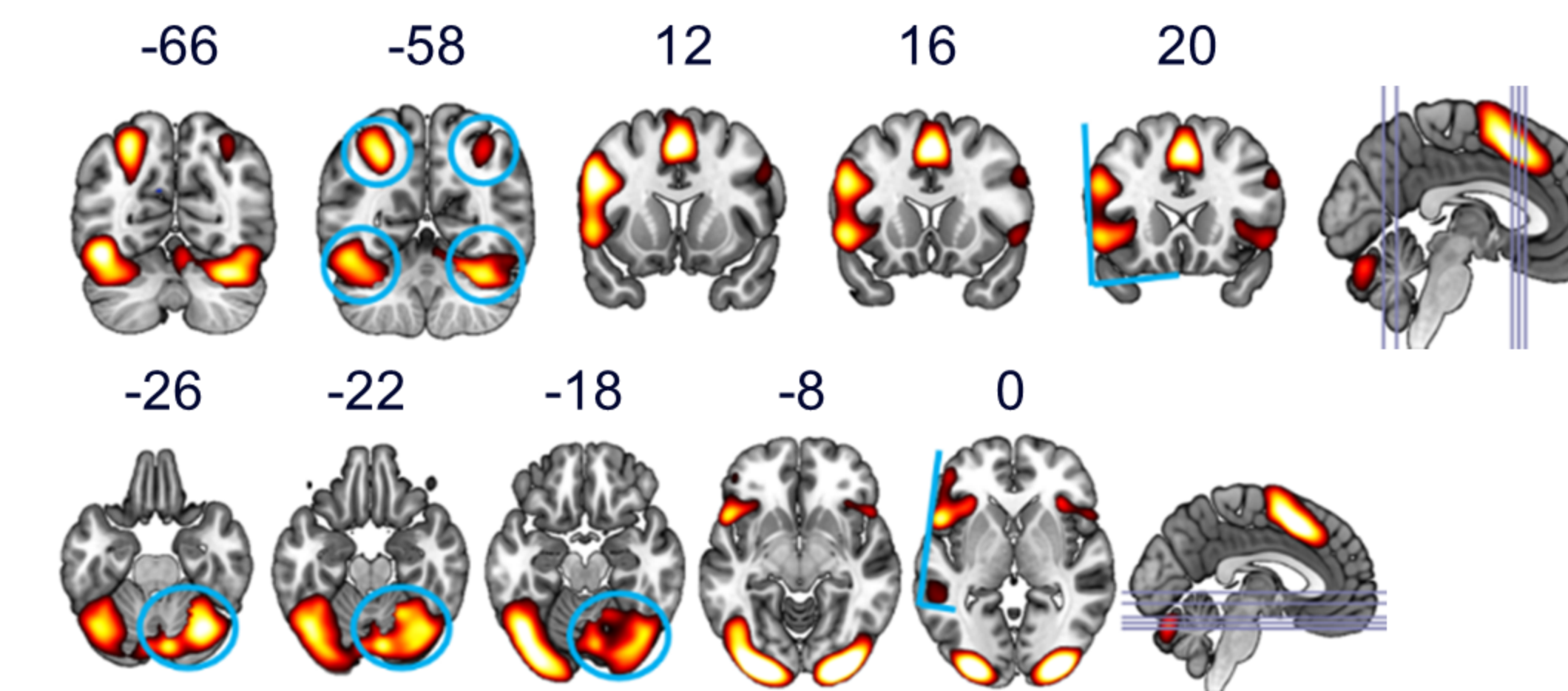
Participants (n=70) evaluated whether a face reflected a particular emotion or age.



Lexical Decision (LD) Task:

Participants (n=59) decided if visually presented letter strings represented a real word.

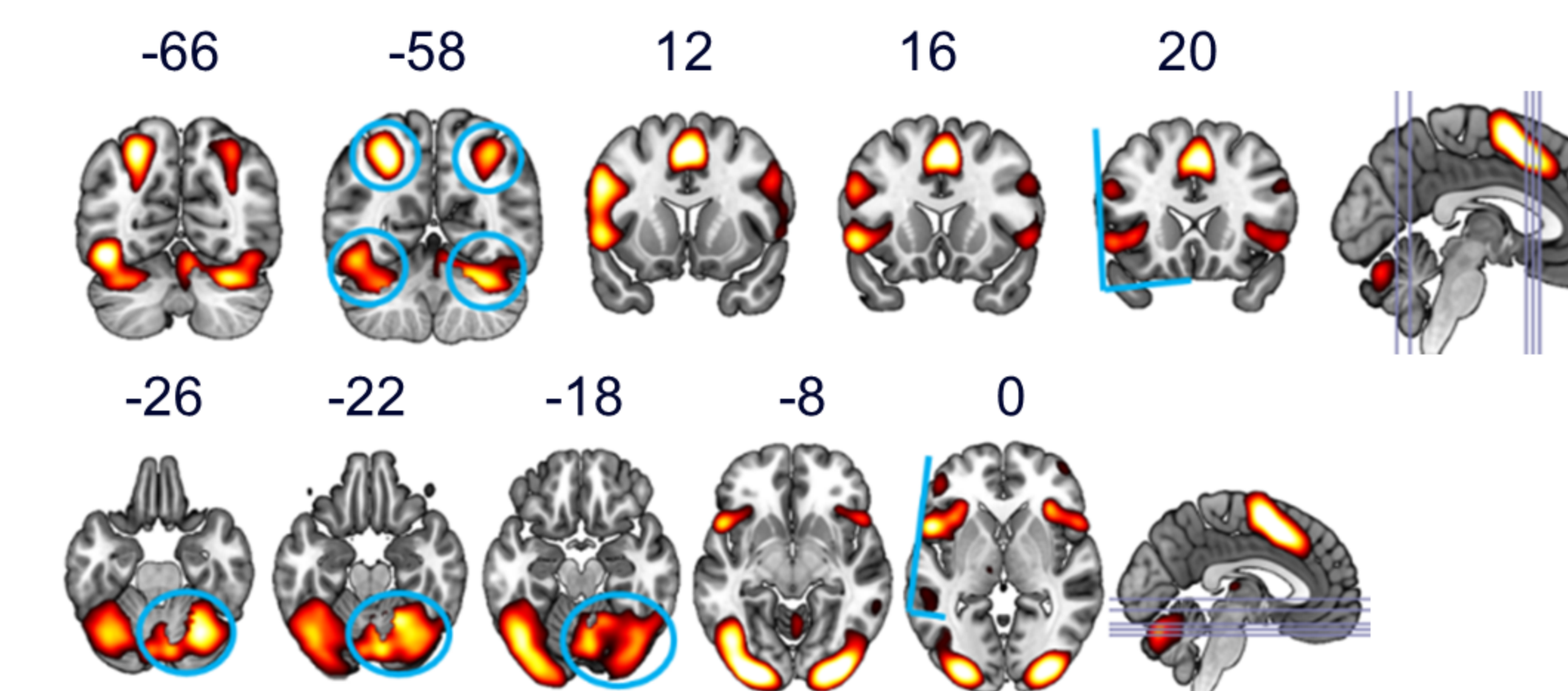
MS-TG-SA Merged Study



Hemodynamic Effects:

Increased activity with more linguistic demand. Equivalent activation for phonological and semantic processing. More activation for volitional vs. passive extraction of meaning.

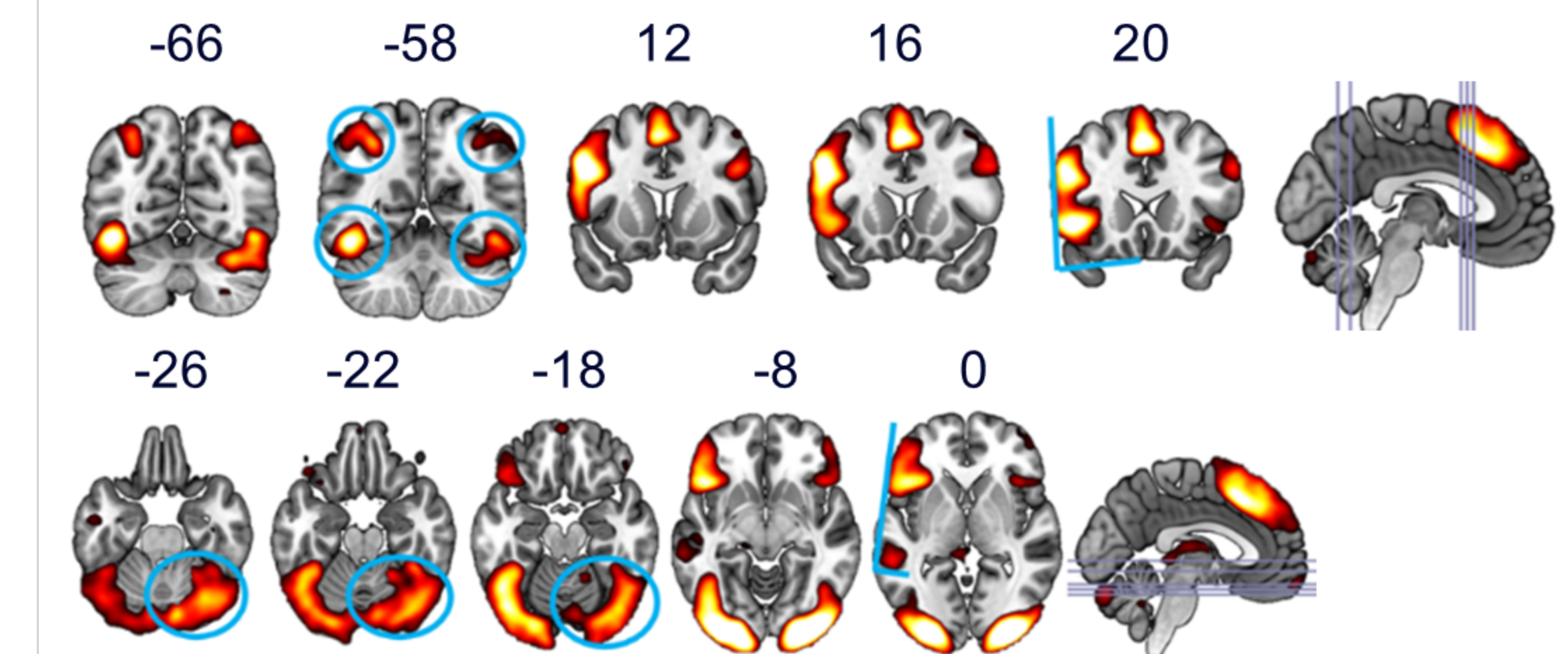
MS-TG Merged Study



Hemodynamic Effects:

More activation for phonological vs. semantic processing. More activation for volitional vs. passive extraction of meaning.

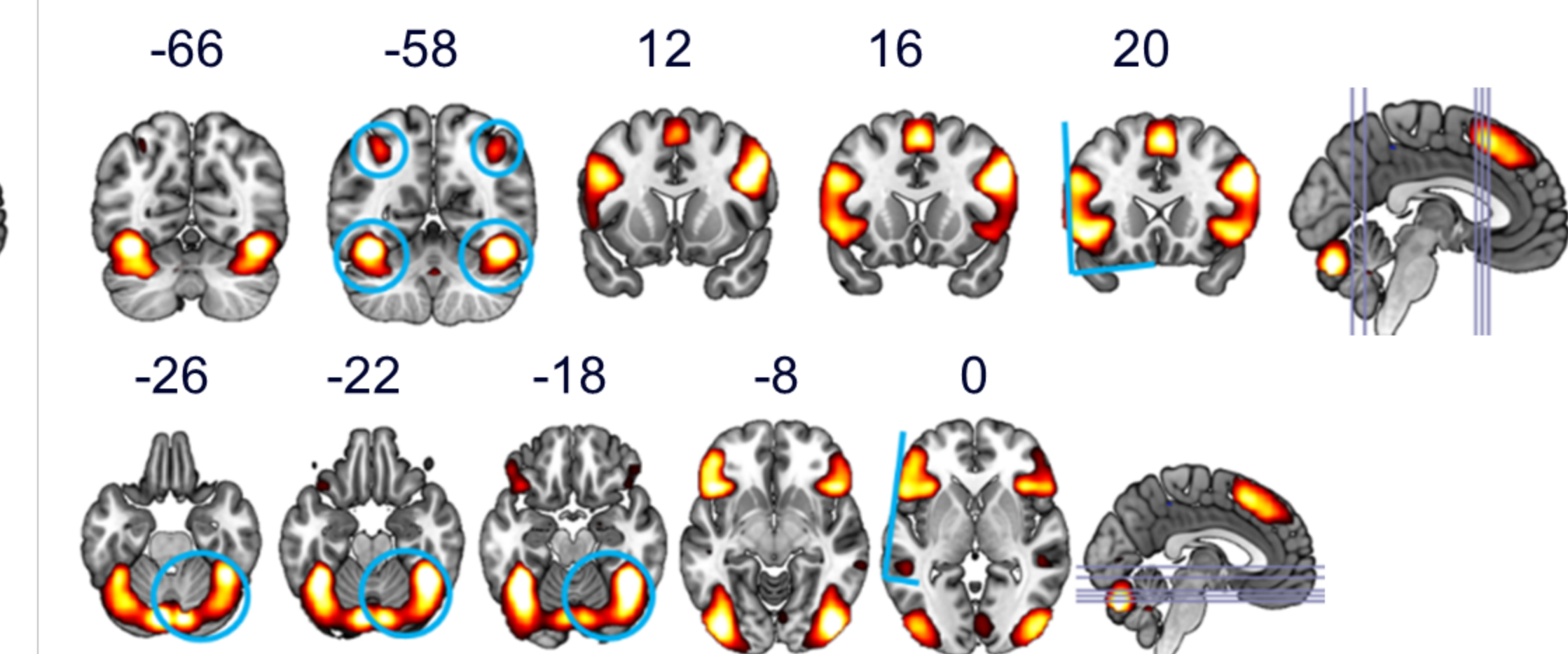
LD Task



Hemodynamic Effects:

Suppressed when linguistic information is required to be ignored.

ED Task



Hemodynamic Effects:

No activation when no face. More for target emotion than foil. Least activation for happy and most for fear.

Discussion

- A left-lateralized brain network that simultaneously engages Broca's and Wernicke's areas was observable during language tasks.
- However, the same network configuration with a bilateral representation was observed during emotion recognition [3].
- This network's function is thus related to the extraction of linguistic- and emotion-based meaning.
- Future work will allow us to determine a wider range of functions of this network.

References

[1] Percival, C. M., Zahid, H. B., & Woodward, T. S. (2020, November 15). CNoS-Lab/Woodward_Atlas. Zenodo. <https://doi.org/10.5281/zenodo.4274397>
 [2] 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.
 [3] Goghari, V. M., Sanford, N., Spilka, M. J., & Woodward, T. S. (2017). Task-related functional connectivity analysis of emotion discrimination in a family study of schizophrenia. *Schizophrenia Bulletin*, 43(6), 1348-1362.



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