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Neural Basis of Semantic and Syntactic Interference Resolution in Sentence Comprehension

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Introduction

During sentence comprehension, it is often necessary to retrieve earlier information across potentially interfering intervening material in order to link it with later information. For example, for the sentence “The client who had implied that the visitor was important was complaining,” “client” has to be retrieved as the subject of “was complaining” across the embedded clause including the noun “visitor.” Interference occurs when the intervening material partially matches the retrieval cues generated by the verb based on either semantic and/or syntactic features (Van Dyke, 2007). Using event-related fMRI, we examined the brain regions involved in resolving interference in sentence comprehension. Previous findings suggest a role for the left inferior frontal gyrus (LIFG) in resolving semantic interference (Kan & Thompson-Schill, 2004) and we wished to determine if this region would be involved in resolving semantic and syntactic interference in sentence processing. As the LIFG is often damaged in aphasia, the findings would have implications for patients’ sentence comprehension difficulties.

Methods

Semantic and syntactic interference were manipulated in a 2 x 2 design (see examples below). In the high but not the low semantic interference conditions the intervening noun is a plausible agent of the verb. In the high syntactic interference conditions, the intervening noun is a subject whereas in the low syntactic interference conditions, it is a prepositional object.

LOW SEMANTIC and LOW SYNTACTIC interference:

The client who had arrived after the important meeting was complaining.

HIGH SEMANTIC and LOW SYNTACTIC interference:

The client who had arrived after the important visitor was complaining.

LOW SEMANTIC and HIGH SYNTACTIC interference:

The client who implied that the meeting was important was complaining.

HIGH SEMANTIC and HIGH SYNTACTIC interference:

The client who implied that the visitor was important was complaining.

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Neurally intact subjects were presented with the whole sentence visually for 5 sec and, following the sentence, were asked to press a button to choose the right answer to a comprehension question.

Results

Regions that showed a main effect of condition (among all 4 conditions) were selected as regions of interest based on voxel-wise ANOVA. As predicted, one region in the LIFG (BA 45) showed greater activation for the high than the low semantic interference conditions. The results for the syntactic interference manipulation revealed another region in posterior LIFG (BA 47) but the findings were less clear-cut, possibly due a confounding factor of local coherence – that is, adjacency of the interfering noun and main verb (e.g. “visitor was complaining”) in the high semantic and low syntactic condition. A follow-up study avoiding this confounding factor is in progress.

Conclusion

The results suggest a role for the LIFG in resolving interference during sentence comprehension, with somewhat different regions involved for semantic vs. syntactic interference.

References

Van Dyke, J. A. (2007). Interference effects from grammatically unavailable constituents during sentence processing. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 33, 407-430.

Kan, I. P., & Thompson-Schill, S. L. (2004). Effect of name agreement on prefrontal activity during overt and covert picture naming. *Cognitive, Affective & Behavioral Neuroscience*. 4, 43-57.