Interference and Repetition Both Impact Left Prefrontal Cortex During Recall

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Introduction

There has been substantial debate about what specific role is played by the left prefrontal cortex (PFC) in memory retrieval (e.g., Thompson-Schill et al., 1997). This study looks to shed some light on this debate by manipulating two factors that would have qualitatively different effects on retrieval difficulty: repetition, which increases memory strength, and fan, which increases interference. We have posited an integrated theory of cognition in which the left PFC plays a general role in the retrieval of declarative memories (ACT-R, Anderson, 2007). According to this theory, changes in both memory strength and interference should impact neural activity in the PFC during retrieval.

Method

Nineteen participants were scanned while they performed a recall paradigm. Stimuli were 16 unique phrases in the form Subject-Verb-Object. Participants were given Subject-Verb pairings and had to respond by clicking a finger corresponding to the appropriate object. The two major factors were fan and repetition. The Subject and Verb in each phrase were either both unique to that pair (low fan) or each appeared in another pair (high fan). In addition, each phrases was either repeated once per block (low repetition) or twice per block (high repetition).

Results and Modeling

Participants responded more quickly and accurately to low fan items compared to high fan items and to high repetition items compared to low repetition items (Figure 1).

Activity in a predefined left prefrontal region was found to be higher in the high fan compared to the low fan condition as well as in the low repetition compared to the high repetition condition (Figure 2). This suggests that the left PFC plays a general role in memory retrieval, with neural activity being highly correlated with response time.

The ACT-R theory makes predictions about retrieval time in this experiment based on the following equation:

$$T = Fe^{-(B+S-\ln(fan))},$$

where repetition would effect the base-level activation term, *B*, and fan would impact the spreading activation term, *ln(fan)*. These terms together determine the retrieval time, *T*. *F* is the only free parameter given the constraints of the ACT-R theory, and it was estimated to give the response time fits in Figure 1. Response times were predicted by the ACT-R theory to be *T*+*C* ms, where *C* is constrained to be 1080 ms in this task.

By convolving the predicted retrieval times in each condition with a gamma function, we get reasonable fits to the hemodynamic response in the left PFC (Figure 2). That is, a model of prefrontal cortex activity that is determined by retrieval time provides a good fit to the data.

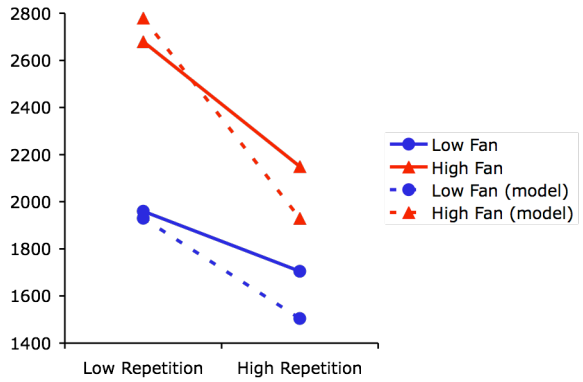

Figure 1. Response time data with model fits

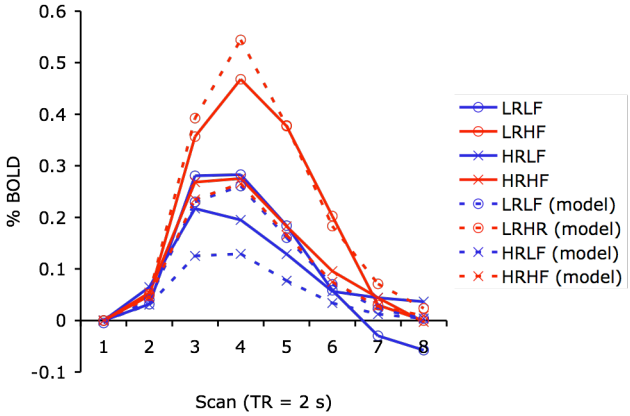

Figure 2. Activity in left PFC with model fits.

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References

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