A Double Dissociation between Alphabetic/Logographic Formats and Tasks (Reading Aloud/ Parity) as Revealed by Granger Analysis of fMRI data

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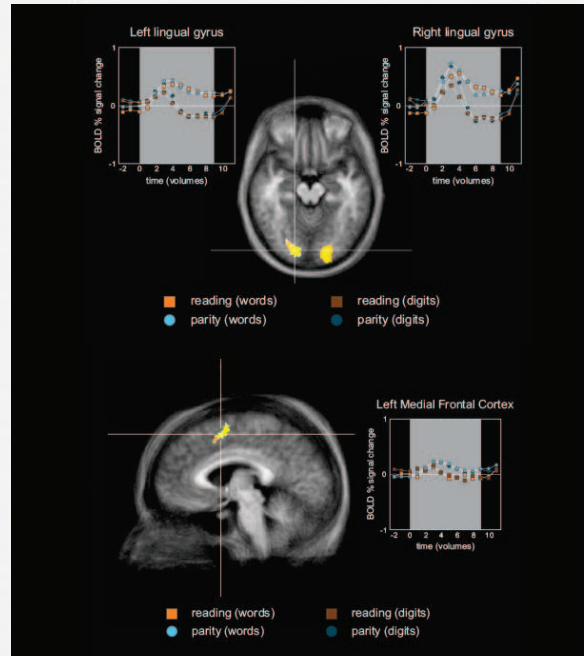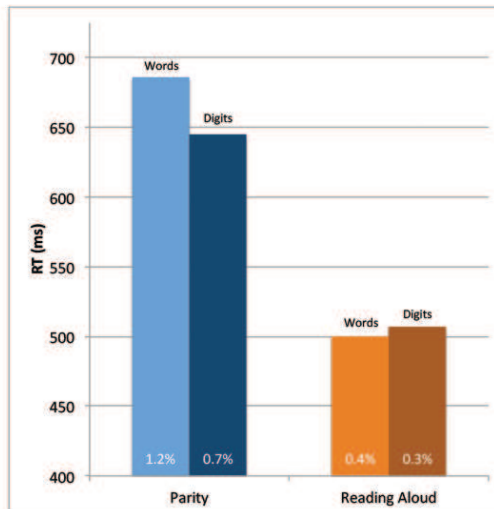UNIVERSITY OF WATERLOO

The Task Set Issue

Background

It is known that reading aloud is faster for words (e.g., two) than numerals (e.g., 2), whereas parity judgements are faster for numerals (Damian, 2004; Besner et al., 2011). This suggests that stimuli with the same meaning and phonology (e.g., two vs. 2) vary in terms of the strength of their connections with different tasks (parity vs. reading aloud). The strongest connection between stimuli and task can be thought of as the **default set**.
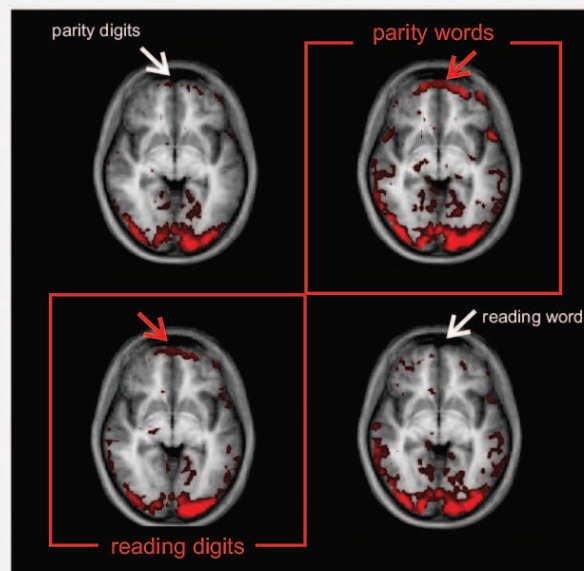
Hypothesis

The default set requires little or no goal maintenance, whereas when the stimulus-task combination competes with the default set, the **task set** becomes important. Here we sought evidence of such **goal maintenance** in terms of both slower RT and more frontal involvement when the current task competes with the default set.
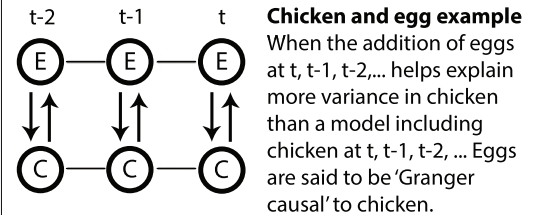
Study

Participants were shown blocks of words, or Arabic numerals, and were instructed at the beginning of each block to either read the stimuli, or perform parity judgement, silently in both cases.

What is granger causality analysis?

Chicken and egg example
When the addition of eggs at t, t-1, t-2,... helps explain more variance in chicken than a model including chicken at t, t-1, t-2, ... Eggs are said to be 'Granger causal' to chicken.

Role of BA10 in prefrontal cortex

BA10 (frontopolar cortex - FPC) is heavily involved in task-switching and task-prioritization. Specifically, activation in BA10 occurs when default processing needs to be halted so that another task (dictated by the instructions or situational context) can be engaged (Koechlin & Hyafil, 2007).

A double-dissociation in BA10 activation is consistent with the idea that certain stimuli-task combinations constitute default sets, and additional resources (BA10) are needed to override the default set and maintain the instructed one (reading digits, or performing parity judgements on words).

Instantaneous Granger Causality Map (bilateral occipital region as seed)

Conclusion

The double dissociation seen in the fMRI data provides compelling support for the idea that certain information processing routines (i.e., reading words aloud; making parity decisions about numerals) are so strong that they reflect the "default set". In contrast, when the subject must utilize processing routines which compete with the default set (i.e., name numerals; make parity decisions about printed words) they need to maintain a mental set which informs them what the task is. In the latter case (but not the former one), such maintenance involves BA10 in the frontopolar cortex.

References

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