Neural Correlates of Variability in Behavioral Performance

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Although fMRI contrast analyses can measure task-related neuronal activity, the measure does not account for individual variability in brain response to a task. Here, I will present the regression analysis from an experiment (Macedonia et al. 2010) we conducted in order to investigate areas of the brain whose activity was parametrically related with increasing levels of memory performance.

First, we acquired behavioral data on memory performance. In a within-subjects paradigm, participants learned 92 vocabulary items under two conditions: one condition paired novel words with iconic gestures and the other with meaningless gestures. Memory performance was assessed through single word translation tests. High performers consistently learned more items than low performers, regardless of the training condition, the time, and the difficulty of the task.

Thereafter, we acquired fMRI data. In the main contrast, i.e., words learned with iconic gestures versus words learned with meaningless gestures, we found that words learned with iconic gestures elicited greater signal intensity, bilaterally in the dorsal medial premotor cortex, during recognition/retrieval. These activations in the premotor cortices suggest motor simulation processes are occurring upon word presentation.

Brain activity in the main contrast was then parametrically related to the behavioral data. As a regressor (Neumann and Lohmann 2003), we used the behavioral data related to performance of the single subjects. We expected the results to parametrically mirror the brain patterns present in the main contrast: Because all words were encoded through motor activity, it would not have been surprising if the increase in subjects' performance correlated with an increase in activity in the premotor cortex. However, this was not the case. High performance correlated with activity in the left angular gyrus (Brodmann Area 39) and in the right extrastriate cortex (Brodmann Area 19). These cortical areas mediate integration of information across different modalities, as well as memory processes. Thus, high performance in vocabulary learning seems to depend on an individual's capacity to integrate and associate a word's semantics with sensorial stimuli.

In sum, this experiment shows that regression analyses can account for individual variability in brain responses to a particular task. Therefore, regression analyses can represent an excellent tool to investigate topics in NeuroIS where the connection between brain response and behaviour is crucial.

REFERENCES

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