Neural correlates of implicit and explicit conceptual combination

Abstract: Conceptual combination is the process by which meanings are derived from combinations of words. We studied this process using 3T fMRI by comparing noun-noun phrases that form a meaningful combination (e.g., "the lake house") to their reversed forms, which do not ("the house lake"). One participant group (N = 23) performed a 1-back task in which they monitored for repetition of either word from the previous noun-noun phrase. Explicit semantic processing is not required for this task. A second group of participants (N = 19) explicitly judged whether each phrase was meaningful, not meaningful, or composed of nonwords. Stimuli were the same as for the first group but also included phrases comprised of nonwords. Phrases were chosen from a larger set normed for meaningfulness by a separate group of subjects. There were 200 phrases of each type. Several areas previously associated with semantic processing, including the left angular gyrus, posterior cingulate gyrus, and dorsomedial prefrontal cortex, were activated for meaningful compared to reverse phrases in the semantic judgment task but not the 1-back task. The single area activated for this condition across both tasks was the right
supramarginal gyrus, though this activation was larger and included the right angular gyrus in the explicit semantic task. Across both tasks, the left parahippocampal gyrus, an area previously implicated in lexical semantics, responded more to high than to low-frequency words. This area was also activated when the meaningful and reversed phrases were compared to nonwords. Overall the results confirm previous findings and extend them to include a role for left parahippocampal gyrus in lexical (single-word level) semantics as distinct from combinatorial processing. The finding of activation in this area for higher frequency words across both tasks suggests that it may reflect automatic activation within the semantic network. There was also a marked effect of task on phrase-level comparisons, with activation for meaningful greater than reversed phrases extending into the right angular gyrus and including left angular gyrus and posterior cingulate cortex only for the task that required semantic judgment. This finding suggests that the degree of explicit semantic processing affects the depth of conceptual combination. These findings are compatible with and provide additional neuroanatomical constraint to theories positing a disposition for lexical semantic processing in areas of the left hemisphere, and a disposition for more holistic, combinatorial semantics in areas of the right hemisphere.

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