Distinguishing two routes to silent meaning in the brain
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Over the past decade, investigations of the processing of silent meaning have made inroads in our understanding of how sentence meanings are composed online using both behavioral (Delogu, Vespignani, & Sanford, 2010; McElree, et al., 2001; Traxler, Pickering, & McElree, 2002) and neuroimaging (Baggio, et al., 2010; Husband, Kelly, & Zhu, 2011; Kuperberg, et al., 2010; Pylkkänen & McElree, 2007) techniques. Native speaker intuitions suggest that sentences with silent meanings, like “The reporter (1) began/(2) needed the article”, assert an implicit meaning (e.g. “to read/to write/etc.”) which must be inferred and incorporated into the semantic representation of the sentence for successful comprehension. While these inferences appear to be similar, different computations are thought to derive them: (1) requires semantic enrichment, (2) requires syntactic enrichment (Pylkkänen, 2008). These computational differences may recruit different brain regions as semantic processing is thought to recruit left inferior frontal gyrus (LIFG) and left angular gyrus (LAG) while syntactic processing is thought to recruit LIFG and left anterior temporal cortex (LATC) (Lau, Phillips, & Poeppel, 2008).

To investigate this possibility, we conducted an event-related fMRI study contrasting sentences requiring semantic enrichment (1) or syntactic enrichment (2) with unenriched control sentences (The reporter wrote the article) and implausible sentences (The reporter annoyed the article). Thirteen adults read 336 sentences (84/condition) using word-by-word rapid serial visual presentation in four 8min 37sec blocks. Acceptability was judged after each sentence. fMRI data were acquired with echo planar imaging on a Siemens 3T scanner (8 channel head coil, 36 slices, 35msec TE, 2130msec TR, 90° flip angle, 208mm FOV, 64×64 matrix). fMRI preprocessing/analyses were conducted in FSL.

We report that semantic enrichment (vs. control) sentences elicited increased activity in LIFG (but not LAG). Syntactic enrichment (vs. control) sentences elicited increased activity in LIFG, LATC, and the anterior cingulate cortex (ACC). These results suggest that different neural circuits are required to process computationally different silent meanings. While semantic and syntactic enrichment both recruit LIFG, syntactic enrichment further recruits LATC, supporting syntactic computation, and ACC, which may aid in detection of syntactic requirements.

Figure 1. Differential activation for semantic and syntactic enrichment conditions minus control contrasts in the whole brain analysis. Z statistic images are thresholded using clusters determined by Z > 2.3 and a (corrected) cluster significance threshold of p = .05.

Selected References


