Distinguishing two routes to silent meaning in the brain

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 cognitive neuroscience (Baggio, et al., 2010; Husband, Kelly, & Zhu, 2011; Kuperberg, et al., 2010; Pylkkänen & McElree, 2007) techniques. Sentence with silent meanings, like "*The reporter (1) began/(2) needed the article"*, assert an implicit meaning (e.g. "*reading/writing"*) 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*). Twenty-three 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 bilateral IFG and the anterior cingulate cortex (ACC). Syntactic enrichment (vs. control) sentences elicited increased activity in bilateral IFG and ACC, and, importantly, LATC. Syntactic enrichment also elicited increased activity in LAG, left middle temporal gyrus, and the precuneous. These results suggest that different neural circuits are recruited to process computationally different silent meanings. While semantic and syntactic enrichment both recruit bilateral IFG and ACC during their processing, syntactic enrichment recruits additional areas, including LATC which may support the specific syntactic computations required for this type of enrichment.

Selected References

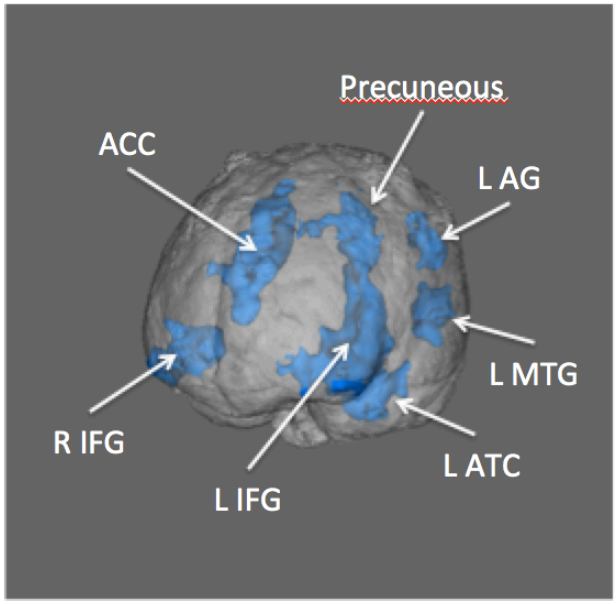
Delogu, F., Vespignani, F., & Sanford, A. J. (2010). Effects of intensionality on sentence and discourse processing: Evidence from eye-movements. *Journal of Memory and Language, 62*(4), 352-379.

Husband, E. M., Kelly, L. A., & Zhu, D. C. (2011). Using complement coercion to understand the neural basis of semantic composition: Evidence from an fMRI study. *Journal of Cognitive Neuroscience, 23*(11), 3254-3266.

McElree, B., Traxler, M. J., Pickering, M. J., Seely, R. E., & Jackendoff, R. (2001). Reading time evidence for enriched composition. *Cognition, 78*(1), B17-B25.

Pylkkänen, L. (2008). Mismatching meanings in brain and behavior. *Language and Linguistics Compass, 2*(4), 712-738.

Syntactic Enrichment



Semantic Enrichment