Neurocognitive mechanisms of semantic ambiguity resolution

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Most words are semantically ambiguous, taking on different meanings in different contexts. Listeners use context and previous experience to make sense of – resolve – ambiguity. Resolution is particularly challenging when the disambiguating information is delayed until *after* the ambiguous word and supports a non-dominant (subordinate) meaning. Such sentence structures often require sentence reinterpretation for accurate comprehension. Previous brain imaging research on semantic ambiguity resolution has highlighted the importance of left inferior frontal gyrus, and left posterior temporal lobe regions. However, these fMRI[1,2] studies struggle to tease apart the time course of distinct cognitive operations: (i) the initial activation/selection of a meaning in response to the ambiguous word itself, and (ii) subsequent sentence reinterpretation. Here we used MEG to measure the neural responses associated with these cognitive processes.

Participants (N=20) listened to sentences presented in a 2X2 design that manipulated the presence of an ambiguous word and subsequent disambiguation (e.g., Sally worried that the *ball/pub* was going to be too *crowded/expensive*). An ambiguous word (*ball*) should require additional meaning selection processes relative to a matched control (*pub*). A disambiguating sentence-final word (*crowded*) resolved the ambiguity to a non-dominant meaning and should induce reinterpretation processes compared to a final word (*expensive*) that is consistent with both meanings. Listeners judged whether occasional visually-presented probe words were related to the preceding (filler) sentence. After MEG data collection, we assessed comprehension skill by asking participants to define the ambiguous words in sentences resolving to a non-dominant meaning, and administered tests of verbal and non-verbal IQ (Mill Hill Vocabulary; Cattell Culture-Fair Tests).

Analyses of evoked MEG responses (gradiometers, RMS transformed) time-locked to the ambiguous word revealed greater activation for ambiguous compared to control words (cluster corrected, $p<.05$) over left fronto-temporal sensors 392-800ms after word offset. This relatively late response likely reflects post-access processes involved in maintenance of alternative meanings/predictions, or suppression of the non-selected meaning. The amplitude of the MEG response correlated positively with individual differences in comprehension skill, suggesting an association with successful comprehension. Comprehension success was further predicted by participants' vocabulary scores, but not by non-verbal IQs. Source estimation localised maintenance or selection processes to right inferior frontal and anterior inferior temporal regions, somewhat consistent with fMRI evidence[1].

Reinterpretation was associated with marginally-increased neural activity (cluster, $p=.08$) over bilateral temporal sensors around sentence offset (-196-156ms). Behavioural analysis showed that sentences with more surprising (subordinate) disambiguating words were less well comprehended. However, we did not see a positive correlation between surprisal and MEG responses suggesting that reinterpretation processes may be less apparent in evoked MEG responses than in fMRI[2], perhaps due to variability in timing of the processes over participants and items. These findings inform our understanding of the neural and cognitive mechanisms of successful semantic ambiguity resolution.

[1]Rodd, J.M., Johnsrude, I.S. & Davis, M.H. (2012). Dissociating frontotemporal contributions to semantic ambiguity resolution in spoken sentences. *Cerebral Cortex,* 22 (8), 1761-1773.
[2]Vitello, S.**,** Warren, J. E.**,** Devlin, J. T., & Rodd, J. M. (2014). Roles of frontal and temporal regions in reinterpreting semantically ambiguous sentences. *Frontiers in Human Neuroscience, 8 (JULY), 1-14.*