

Where and when do we predict in the brain during language comprehension? Insights from multimodal neuroimaging studies

Gina Kuperberg MD PhD

Language comprehension is challenging. This is because the linguistic input unfolds quickly, it is often ambiguous, and our environments are noisy. It therefore helps if we can use context to mobilize stored relevant linguistic (and non-linguistic) knowledge to probabilistically predict upcoming information, thereby facilitating the processing of bottom-up inputs that match these predictions. On the other hand, given that our communicative environments are constantly changing, we will inevitably encounter information that strongly violates our predictions. In such situations, we still need to recover the communicator's intended message.

I will discuss a series of multimodal neuroimaging studies (ERP, fMRI and MEG) providing evidence that spatiotemporally distinct neural signatures correspond to: (a) the top-down generation of semantic predictions, (b) the pre-activation of representationally specific lexico-semantic predictions, (c) the facilitation of bottom-up inputs that match these predictions, and (d) prolonged 'costs' when bottom-up input violates predictions at different levels of representation.

I will interpret these findings within a dynamic generative framework of language comprehension that conceptualizes comprehension as an incremental and dynamic process of prediction and hypothesis updating at multiple levels of representation, with the ultimate goal of inferring the latent cause that best explains the full set of inputs encountered — the message that the communicator intended to convey (Kuperberg & Jaeger, 2016; Kuperberg, Brothers & Wlotko, 2019). I will suggest that, rather than conceptualizing neural responses to prediction violations as 'costs' of prediction, they may play a crucial role in triggering us to rapidly adapt to the statistical structure of our ever-changing communicative environments so that we can predict more efficiently in the future.

Finally, if time, I will discuss how this type of generative probabilistic framework of language processing can provide insights into language and thought dysfunction in schizophrenia (Brown & Kuperberg, 2015).

Kuperberg, G. R., and Jaeger, T.F. (2016). What do we mean by prediction in language comprehension? *Language, Cognition and Neuroscience*, 31. 32-59.

Kuperberg, G.R., Brothers, T. & Wlotko, E. (2019). A tale of two positivities and the N400.

Brown, M., & Kuperberg, G. R. (2015). A Hierarchical Generative Framework of Language Processing: Linking language perception, interpretation, and production abnormalities in schizophrenia. *Front Hum Neurosci*, 9, 643.