

Does hierarchical predictive coding mediate language comprehension? Evidence from multimodal neuroimaging

Gina R. Kuperberg, MD PhD

One of the most fundamental questions in Cognitive Science is how the brain is able to extract meaning from streams of rapidly unfolding, noisy linguistic inputs. The process of language comprehension can be understood as *probabilistic inference* — the use of a hierarchy of linguistic and non-linguistic knowledge (a *generative model*) to infer the underlying representations that best explain the linguistic input. It has been proposed that the brain carries out this type of probabilistic inference using an algorithm known as *hierarchical predictive coding*. Although the term *predictive coding* has sometimes been used in a broad sense to describe any type of predictive processing by the brain, it actually refers to a specific computational architecture that was originally used to simulate extra-classical receptive-field effects in the visual system, and that has since been extended into a more general theory of cortical function. Predictive coding inherits many of the basic principles of parallel, interactive and constraint-based accounts, which have transformed our understanding of language processing over the past few decades. It also instantiates probabilistic prediction at multiple levels of linguistic representation, which is thought to play a major role in ensuring that real-time language comprehension is both fast and accurate. However, it is distinguished both from classic connectionist models and from more general predictive processing frameworks by committing to a particular arrangement of feedforward and feedback connections and flow of activity, both within and across different levels of the cortical hierarchy. In addition to its biological plausibility, this framework makes principled predictions that address some of the most fundamental questions in the neurobiology of language: When, where and how does incoming information interact with prior top-down contextual constraints as it becomes available to successive levels of the cortical hierarchy over time? Can contextual predictions pre-activate item-specific representations, and if so, at what levels of representation? And how is the brain able to rapidly shift away from prior predictions so that it can rapidly and flexibly respond to systematic changes in the underlying message? In this talk, I will address some of these questions, discussing the evidence we already have, and the evidence we still need to support the hypothesis that the brain carries out predictive coding during language comprehension.