Comprehenders Rationally Adapt Semantic Predictions to the Statistics of the Local Environment: a Bayesian Model of Trial-by-Trial N400 Amplitudes

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When semantic information is activated by a context prior to new bottom-up input (i.e. when a word is predicted), semantic processing of that incoming word is typically facilitated, attenuating the amplitude of the N400 event related potential (ERP) – a direct neural measure of semantic processing. This is observed even when the context is a single semantically related "prime" word. This "N400 semantic priming effect" is sensitive to the probability of seeing a related prime-target pair within experimental blocks, suggesting that participants may be adapting the strength of their predictions to match the environment. We formalize this adaptation using Bayesian updating, and link this model to N400 amplitude using an information-theoretic measure, surprisal. We found that this model explained N400 amplitudes (whether for related or unrelated words) as adaptation unfolded. These findings suggest that comprehenders rationally adapt their semantic predictions to the statistics of their environment.