PREDICTING THE FUTURE TO MAKE SENSE OF THE PRESENT: PREDICTIVE BRAIN MECHANISMS FOR SPEECH PERCEPTION

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Background: According to predictive processing theories, the brain is constantly predicting what is going to happen next and uses those predictions to fundamentally shape what is perceived (Rao and Ballard, 1999). For example, after hearing the speech sounds “l-a-v-i-”, it is proposed that listeners strongly predict “sh” because “lavish” is a rather more frequent word than “Lavis” (a region in northern Italy). This ability to form predictions is proposed to be fundamental for accurate speech comprehension (ensuring “lavish” is correctly identified even in a noisy room). Despite the popularity of the predictive processing theory, we still do not know how predictive processing is mechanistically realized in the brain (Aitchison and Lengyel, 2017). There are two main competing accounts of how predictions are combined with sensory input during perception. According to the Sharpening account, brain responses to sensory input are enhanced by predictions (Kok et al., 2012). The alternative Prediction Error account instead proposes that sensory responses are suppressed by predictions, allowing the brain to dedicate its resources to unpredictable (and therefore novel) information (Rao and Ballard, 1999).

Aims: In the current study, we aim to adjudicate between these theories using multivariate analysis of EEG during perception of a naturalistic speech stimulus (audiobook recording of Hound of the Baskervilles).

Method: High-density (128 channel) EEG data will be collected from over 50 participants as they listen to podcast speech. We will then implement Sharpening and Prediction Error accounts as computer models and directly test them against the EEG data using ‘Temporal Response Function’ analysis (Crosse et al., 2016). This project has the potential to provide the strongest evidence yet of how predictive speech processing is implemented in the human brain.

Preliminary results: Data have been collected from 30 participants. To ensure attention to the audiobook, listeners are being asked to detect occasional repetitions of audiobook segments. Our analysis of the behavioral data from this task suggests that all listeners can perform the task with high accuracy (>70% hit rates), confirming attention to the speech. Preliminary analysis of the EEG data also show that speech acoustics (speech envelope) can be decoded from neural responses, providing convergent evidence of successful speech processing.

Keywords: Predictive coding, Speech perception, EEG

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