Flexible prediction: Global Context and Speaker Reliability Affect Sentence Processing

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Anticipatory processes affect language comprehenders' responses to sentence constituents in a variety of ways. (Altmann & Kamide, 1999; Brothers & Traxler, 2016; Brothers, Swaab, & Traxler, 2015; Dave, Brothers, Traxler, Ferreira, Henderson, & Swaab, 2018; Kuperberg & Wlotko, 2018). The mechanisms and processes that produce anticipatory effects are depicted in a variety of modeling approaches (e.g., Elman,2004; Gibson et al., 2013; Hale, 2001; Levy, 2008; McRae, Hare, Elman, & Ferretti, 2005). Research continues into the nature and extent of such anticipatory effects (e.g., Delong, Kutas, & Urbach, 2005; Nieuwland, Politzer-Ahles, Heyselaar, Segaert, et al., 2018). Some of this research effort has focused on the extent to which recent and long-term experience can affect anticipatory processes. For example, some studies indicate that exposure to a rare syntactic structure within and across experimental sessions can affect the processing load imposed by those structures (Fine et al., 2013; but see Stack, James & Watson, 2018; Tooley & Traxler, 2018; Wells et al., 2009). Other work shows that instructions to participants can affect the neurophysiological response to predictable words in sentences (Brothers, et al., 2017).

We report evidence from self-paced reading and ERP experiments showing how comprehenders respond to predictable words in sentences. The experiments tested how readers and listeners react when locally predictable information is embedded in a broader, experiment-wide context in which predictions are frequently confirmed versus disconfirmed. We hypothesized that comprehenders react differently to predictable information that is encountered in a global context where predictions were frequently confirmed compared to a global context where predictions were frequently disconfirmed.

In the self-paced reading experiment (N = 252), participants read predictable (*My pen has just run out of **ink***) and unpredictable sentence continuations (*Tim Barnes has just run out of **ink***), and the overall validity of predictive cues was manipulated across groups using a separate set of filler sentences. There was a linear relationship between the benefits of a constraining sentence context and the global validity of predictive cues. The difference in reading time between predictable and unpredictable words increased as global validity increased. Critically, no reading time benefits were observed as *prediction validity* approached zero (see Figure 1). These results indicate that within-sentence factors contribute to anticipatory effects more when the global processing environment indicates that predictable words are likely to appear.

In the ERP experiment (N=40), we tested participants' response to predictable and unpredictable words embedded in sentences. The test sentences were spoken by one male and one female speaker. Sentence context was manipulated so that all of the test sentences contained a predictable critical word (*Eric sued the taxi driver and took him to **court***) or an unpredictable critical word (*Eric picked up his friend and took him to **court***). In the filler sentences, one of the speakers always completed the sentences with a predictable completion (*The dairy cow produced a lot of **milk***). The other speaker would always produce an unpredictable completion (*...a lot of **noise***). The ERPs for the test sentences showed that the reliable speaker produced larger and earlier N400s (predictable compared to unpredictable critical words) than the unreliable speaker. I.e., n400s for test sentences (*Eric sued the driver and took him to **court***) differed based on whether the speaker was reliable in the filler sentences (see Figure 2). These results rule out a class of account under which prediction is a static process that operates solely on sentence-level cues. Instead, comprehenders dynamically adjust to aspects of the wider information processing context.

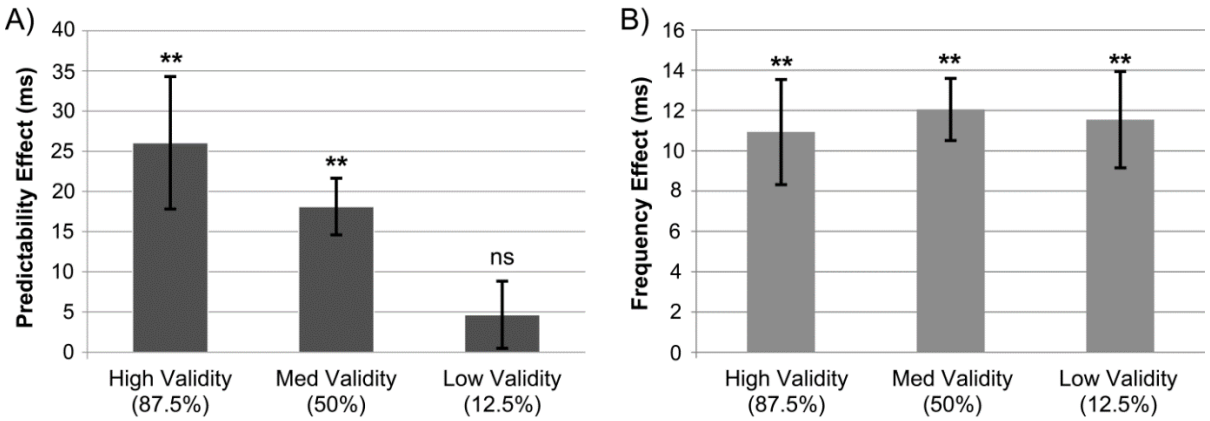

Figure 1. A) Differences in reading time between the Predictable and Unpredictable condition across the three Validity groups. The size of the predictability effect decreased monotonically as the validity of predictive cues decreased. B) In contrast, predictive validity had no influence on the reading time differences between high-frequency and low-frequency words. Error bars represent ±1 standard error of the mean. ** $p <$ 0.01, ns = not significant.

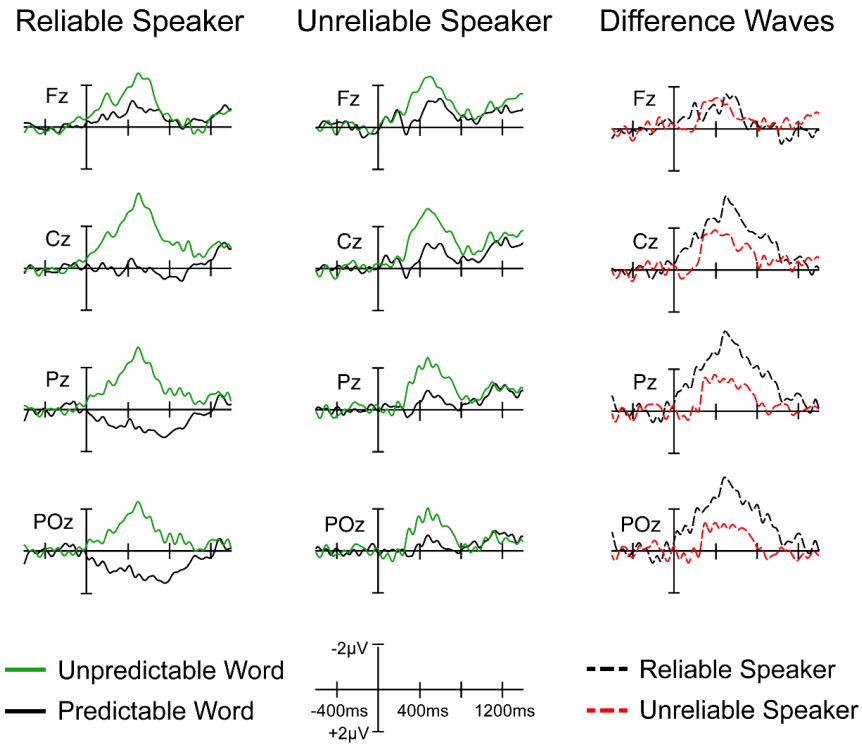

Figure 2. Grand-average event-related potentials, time-locked to the onset of the predictable or unpredictable critical word in the critical sentences (*Eric sued the taxi driver and took him to court*… vs. *Eric picked up his friend and took him to court*…). Waveforms are plotted separately for sentences spoken by the reliable and unreliable speaker. Predictability differences waves (Unpredictable minus Predictable) are also plotted for the two speaker conditions.