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Putting things in new places: Linguistic experience modulates the predictive power of placement verb semantics

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ABSTRACT

A central question regarding predictive language processing concerns the extent to which linguistic experience modulates the process. We approached this question by investigating sentence processing in advanced second language (L2) users with different native language (L1) backgrounds. Using a visual world eye tracking paradigm, we investigated to what extent L1 and L2 participants showed anticipatory eye movements to objects while listening to Dutch placement event descriptions. L2 groups differed in the degree of similarity between Dutch and their L1 with respect to placement verb semantics: German, like Dutch, specifies object position in placement verbs (put.STAND vs. put.LIE), whereas English and French typically leave position underspecified (put). Results showed that German L2 listeners, like native Dutch listeners, anticipate objects that match the verbally encoded position immediately upon encountering the verb. French/English L2 participants, however, did not show any prediction effects, despite proper understanding of Dutch placement verbs. Our findings suggest that prior experience with a specific semantic contrast in one's L1 facilitates prediction in L2, and hence adds to the evidence that linguistic experience modulates predictive sentence processing.

Introduction

There is now broad agreement that incremental language understanding does not entail passive integration. Language comprehenders can use linguistic and non-linguistic cues to actively generate predictions about upcoming words and structures (for reviews, see e.g., Federmeier, 2007; Huettig, 2015; Kamide, 2008; Kuperberg & Jaeger, 2016; Kutas, Delong, & Smith, 2011; Pickering & Garrod, 2013; van Petten & Luka, 2012). Predictions can be reflected in, for instance, anticipatory eye movements to elements in a visual display while listening to speech (visual world eye-tracking, e.g., Altmann & Kamide, 1999; Tanenhaus, Spivey-Knowlton, Eberhard, & Sedivy, 1995; review in Huettig, Meyer, & Rommers, 2011), or in modulations of event-related potentials on sentence elements preceding a disambiguating content word during reading (EEG methodology, e.g., DeLong, Urbach, & Kutas, 2005; Federmeier & Kutas, 1999; van Berkum, Brown, Zwitserlood, Kooijman, & Hagoort, 2005). The cues used to generate such predictions range from linguistic (e.g., Hare, Jones, Thomson, Kelly, & McRae, 2009; Kaiser & Trueswell, 2004) and visual (e.g., Knoeferle, Crocker, Scheepers, & Pickering, 2005) context to morphosyntactic features (such as case and gender marking; e.g., Kamide, Altmann, & Haywood, 2003), prosody (e.g., Kurumada, Brown, Bibyk, Pontillo, & Tanenhaus, 2014), and semantic information encoded in verbs (e.g., Altmann & Kamide, 1999). As for the contents of the prediction, evidence points to a range of highly specific to slightly more abstract linguistic information, from specific lexical forms (e.g., Dahan & Tanenhaus, 2000; DeLong et al.,

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2005; van Berkum et al., 2005) to thematic role information (e.g., Kamide, Scheepers, & Altmann, 2003), and more general semantic properties of objects (such as edibility; Altmann & Kamide, 1999). There is also evidence that visual properties of an object are anticipated (e.g., shape; Rommers, Meyer, Praamstra, & Huettig, 2013). Generating predictions is considered crucial to the language processing system, leading to faster and more efficient mental operations (e.g., Farmer, Brown, & Tanenhaus, 2013; Fine, Jaeger, Farmer, & Qian, 2013; Hale, 2003; Levy, 2008). The language comprehension system is assumed to constantly keep track of the (in)coherence between anticipated and actual outcomes (e.g., Clark, 2013; MacDonald, 2013; van Berkum, 2010). On the basis of the resulting prediction error, expectations about future outcomes are adapted accordingly, hence minimizing the overall prediction error and maximizing communicative efficiency; this is considered the basic principle underlying (implicit) language learning (e.g., Chang, Dell, & Bock, 2006; Jaeger & Snider, 2013).

Under the assumption that predictions are based on previous linguistic experience (cf. Chang et al., 2006; Jaeger & Snider, 2013; MacDonald, 2013; Wells, Christiansen, Race, Acheson, & MacDonald, 2009), differences in linguistic experience should affect predictive language processing. There is evidence that this is indeed the case: for instance, recent studies show that individual differences in written sentence processing, as measured by eye movements during reading, are best explained in terms of linguistic experience (Farmer, Fine, & Jaeger, 2011; Kuperman & van Dyke, 2011; each study using a different proxy for linguistic experience). Studies on literacy and dyslexia report a mediating role of language experience in spoken sentence processing. For instance, Mishra, Singh, Pandey, and Huettig (2012) compared Indian high and low literates' anticipatory eye movements to objects in a visual display while listening to constraining contexts; they found that people with higher reading skills anticipated target objects in the display, while people with lower reading skills only directed their eye gaze to target objects after encountering the critical word. Mani and Huettig (2014) found a similar correlation between reading skills and anticipatory eye gaze for children who are in the process of learning to read (see also Mani & Huettig, 2012). In Huettig and Brouwer (2015), dyslexic adults (people with reduced reading skills) participated in an eye-tracking experiment in which Dutch gender-marked articles served as predictive cues for the upcoming object (the article agreed in gender with only one of the objects in a display). Compared to non-dyslexic controls, dyslexics showed a delayed anticipation effect in their eye movements, indicating reduced ability to generate predictions about specific lexical forms. These findings together suggest that individual differences in linguistic experience account for variation in the ability to generate predictions during language processing.

A different way of investigating the role of linguistic experience in predictive language processing is by studying second language (L2) learners' predictive ability in their L2. The rationale here is that native and non-native/L2 speakers differ in their experience with the concepts and forms encoded in the second language, with native speakers being the 'experts' in processing the respective language: Speaker status (native (L1)/L2) is thus taken as a proxy for linguistic experience. The study of L2 users is a way of overcoming some of the difficulties associated with comparing high and low literates, for instance differences in formal education (cf. Mishra et al., 2012). Crucially, L2 research allows for cross-linguistic comparisons using identical linguistic materials, hence facilitating a direct comparison between populations. By controlling for the degree of similarity between the target language and the L2 users' native language in certain linguistic domains, we are able to look at linguistic experience in a more specific way. Participants with a native language background that overlaps with the target language on a specific predictive cue would have more experience in using this cue to generate predictions, compared to participants with a native language that differs from the target language with respect to that predictive cue.

Prediction in L2 sentence processing

The study of prediction in L2 users and bilinguals is emerging. Researchers have addressed to what extent L2 users and bilinguals predict specific lexical forms, as evidenced through event-related potential modulations on articles preceding nouns (Foucart, Martin, Moreno, & Costa, 2014; Martin et al., 2013), as well as their ability to use specific linguistic cues for the generation of anticipatory eye movements, such as grammatical gender, case marking, and semantic information encoded in verbs (Dussias, Valdes Kroff, Guzzardo Tamargo, & Gerfen, 2013; Hopp, 2013, 2015). Generally, studies targeting predictions based on semantic cues show that this process is effortless for L2 users, and that there are no critical differences between native and non-native speakers (e.g., Hopp, 2015; Trenkic, Mirkovic, & Altmann, 2014). However, multiple researchers have shown that L2 users do have trouble using (morpho)syntactic cues for prediction in L2 processing. For example, Martin et al. (2013) performed an EEG study of predictive processing in English monolinguals and Spanish–English bilinguals. Participants read constraining sentences in English in which the researchers systematically manipulated the final noun (expected vs. unexpected) and the preceding article (*a*/*an*), e.g., *the day was breezy so the boy went outside to fly a kite*/*an airplane*. If the form of the preceding article did not match with the expected noun, the researchers found an N400 modulation in monolinguals, but not in bilinguals. On the basis of this finding the authors conclude that bilinguals do not generate predictions about articles to the same extent as monolinguals do. Hopp (2013) used a visual world eye-tracking paradigm to investigate sentence processing in German by near-native English–German L2 users. The sentences in his experiment contained gender-marked articles that served as a cue for the upcoming noun. The L2 users did not use these cues to the same extent as German native speakers; this was interpreted as providing evidence for reduced predictive ability in L2 processing. In addition, Hopp (2013) found a correlation between consistency in gender assignment in a post-hoc production task and the