Bilinguals reading in their second language do not predict upcoming words as native readers do

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ABSTRACT

During reading, monolingual readers actively predict upcoming words from sentence context. Here we investigated whether bilingual readers predict sentence final words when they read in their second language. We recorded event-related potentials while English monolinguals (L1 comprehenders) and late Spanish–English bilinguals (L2 comprehenders) read sentences ending in an expected or unexpected noun. Lexical prediction was indexed by the amplitude of the N400 effect elicited by the article preceding the final noun, such that the more negative the N400, the less prediction as regards the final word. Contrary to L1 comprehenders, L2 comprehenders failed to show an N400 amplitude increase for unexpected articles. We interpret these results as evidence that L2 comprehenders do not actively predict upcoming words during sentence comprehension to the same extent as L1 comprehenders. This weaker capacity of lexical prediction in L2 might be one of the consequences of overall slower and less accurate linguistic processing stages in L2 relative to L1.

Introduction

Reading or listening to sentences in a second language (L2) usually proceeds slower and less accurately than in a first language (L1) (Cook, 1997; Green, 1998). Studies aiming at unravelling the cause of this difference have identified differences in L1 and L2 lexical (Soares & Grosjean, 1984), semantic (Hahne, 2001; Weber-Fox, Davis, & Cuadrado, 2003), and syntactic (Frenck-Mestre, 2002; Hahne & Friederici, 2001; Sanders & Neville, 2003; Weber-Fox & Neville, 1996) representations. Despite these

observations, the consequences of these differences between L1 and L2 processing remain to be explored. Based on the assumption that linguistic processing stages are overall slower and less accurate in L2 (Frenck-Mestre & Pynte, 1997), we will investigate here some potential implications for sentence comprehension. To do so, we will focus on semantic processing during highly constrained sentence comprehension, and more specifically on lexical prediction. We will explore the capacities of L2 comprehenders to process linguistic representations quickly enough during sentence comprehension to be able to form a message-level representation that influences lexical predictions of upcoming words in high-constraint sentences.

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Semantic processing during sentence reading

Semantic processing during sentence reading can be studied using event-related potentials (ERPs) by monitoring the amplitude of the N400, an ERP component more negative for semantically incorrect sentence endings as compared to semantically correct ones (Kutas & Federmeier, 2011; Kutas & Hillyard, 1980). Lower L2 proficiency in bilinguals has been shown to delay the N400 effect[1] (Elston-Güttler & Friederici, 2007; Hahne, 2001; Moreno & Kutas, 2005; Weber-Fox et al., 2003), suggesting that semantic processing is slower for reading in L2 than in L1 (for reviews, see Hernandez & Li, 2007; Kotz, 2009; Kotz & Elston-Guettler, 2007; Kutas, Moreno, & Wicha, 2009). However, recent accounts have suggested that this N400 component reflecting semantic processing is sensitive to lexical prediction (DeLong, Urbach, & Kutas, 2005; van Berkum, Brown, Zwitserlood, Kooijman, & Hagoort, 2005; Wicha, Moreno, & Kutas, 2004), orthographic/phonological analysis (Deacon, Dynowska, Ritter, & Grose-Fifer, 2004), semantic memory access (Kutas & Federmeier, 2000) and semantic/conceptual unification (Hagoort, Baggio, & Willems, 2009; for a review see Kutas & Federmeier, 2011). Until now, ERP experiments investigating semantic processing in L2 have not taken into account potential quantitative and/or qualitative differences between L1 and L2 regarding the way semantic processing – the N400 effect – is modulated by factors such as lexical prediction. Here, we set out to study lexical prediction during L2 sentence comprehension and how such expectation effects modulate semantic processing.

Influence of lexical prediction on semantic processing during sentence reading

The influence of sentence context on word processing has traditionally been studied using lexical decision tasks (LDT: word/non-word decision), classically showing faster responses when a word fits the sentence context as compared to when it does not (Fischler & Bloom, 1979; Kleiman, 1980; Stanovich & West, 1979). For instance, when reading "She has a nice voice and always wanted to be a...", a lexical decision on "singer" is made faster than on "lawyer". Using ERPs, it has been shown that the N400 component induced by a word is reduced when the word is embedded in a supportive context (Hagoort, Hald, Bastiaansen, & Petersson, 2004; Kutas & Federmeier, 2000, 2011; Kutas & Hillyard, 1980). Importantly, N400 mean amplitude is also reduced for the most highly expected noun in the sentence, compared to any unexpected noun (even if the unexpected noun is semantically congruent with the sentence context; e.g., "She has a nice voice and always wanted to be a *singer*" *versus* "She has a nice voice and always wanted to be an *artist*"; DeLong et al., 2005; Federmeier & Kutas, 1999; Federmeier, McLennan, De Ochoa, & Kutas, 2002).

Unfortunately, N400 amplitude modulations elicited by the critical noun of a sentence do not distinguish between active lexical prediction mechanisms and passive integra-

tion. In fact, semantic processing of the critical noun is assumed to be modulated by these two kinds of processes: (a) On the one hand, words are processed and integrated when they are read. Comprehenders incrementally build up message-level representations of meaning as the sentence unfolds, and words embedded in the sentence are integrated based on such representations. The more the meaning of a critical word fits message-level representations, the easier its semantic integration (as reflected by N400 amplitude reduction). Alternatively, according to the passive resonance hypothesis, words embedded in a sentence context activate a semantic relatedness network so that semantic processing of a critical word is facilitated when it is part of this semantic network (see Gerrig & McKoon, 1998; Myers & O'Brien, 1998; Paczynski & Kuperberg, 2012). According to these accounts, context effects appear when the critical word is presented and integrated based on the message-level representation and/or passive resonance with the pre-activated semantic relatedness network; see Kuperberg et al., 2011). (b) On the other hand, comprehenders can use sentence context information to generate predictions regarding upcoming words (active lexical prediction mechanisms; DeLong et al., 2005; Lau, Holcomb, & Kuperberg, 2013; Neely, 1977). According to this assumption, context effects can appear before the critical word is actually presented (see Lau et al., 2013, for extensive discussion on passive resonance *versus* active lexical prediction).

Predictions from the two accounts (passive lexical integration *versus* active lexical prediction) have been tested by studying ERPs elicited by the article preceding the final noun of a sentence. For instance, taking advantage of the grammatical properties of Spanish, which requires the article preceding the target noun to be marked and to agree with the gender of the following noun ("un" for masculine nouns *versus* "una" for feminine nouns), Wicha et al. (2004) observed ERP modulations between articles with expected and unexpected gender, based on prior sentence context. The authors concluded that readers generate predictions for specific nouns and their articles (Wicha, Bates, Moreno, & Kutas, 2003; Wicha, Moreno, & Kutas, 2003; Wicha et al., 2004). Using the phonological properties of English, where the indefinite article 'a' changes to 'an' if the following noun begins with a vowel, DeLong et al. (2005) also showed that expectation effects are already observable on the article, with the N400 more negative for the article 'an' when the best completion noun starts with a consonant, and inversely for the article 'a' when the best completion noun starts with a vowel. For instance, reading "She has a nice voice and always wanted to be..." leads to lexical prediction of the final noun "singer". Because of this lexical prediction, the N400 response to the article is greater in amplitude when the article encountered before the noun is "an" as compared to "a", since "an" is incompatible with "singer". Thus, readers actively predict words when processing a sentence with a constraining context. This active role of the comprehender during sentence processing probably speeds up language comprehension (Lau et al., 2013; van Berkum et al., 2005; Wicha et al., 2004).

In addition to the classical N400 effect elicited by unexpected lexical items, another important ERP

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[1] The N400 effect is classically defined as the magnitude of the difference in amplitude between the N400 elicited by a semantic violation and that elicited by a semantically correct word in the same position.