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Review

Second language syntactic processing revealed through event-related potentials: An empirical review

Sendy Caffarra [a,*], Nicola Molinaro [a,b], Doug Davidson [a], Manuel Carreiras [a,b]

[a] BCBL, Basque Center on Cognition, Brain and Language, Paseo Mikeletegi 69, 20009 Donostia-San Sebastian, Spain
[b] Ikerbasque, Basque Foundation for Science, Alameda Urquijo, 36-5, Plaza Bizkaia, 48011 Bilbao, Spain

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ABSTRACT

Learning a second language (L2) can be crucial in the present globalized society. However, reaching the level of L1 performance of native speakers is still a challenge for many. Distinct factors could account for the persistent gap observed between natives' and non-natives' syntactic abilities: L1–L2 differences, AoA, proficiency, L2 immersion duration, L2 training duration. Although different theoretical approaches described the role of these several factors, not all studies using on-line measures have investigated them comprehensively and consistently. The present work reviews available ERP studies on L2 syntactic analysis in order to establish the relative weight of each factor on the time course of L2 processing. Logistic regression analyses were performed on the presence or absence of ERP effects reported in response to L2 syntactic violations, including all the influential factors as categorical independent variables. The results showed that immersion duration has an influence on the ERP correlates linked to early mechanisms of syntactic processing, while the global proficiency level has an impact on the ERP correlates related to late, language-monitoring activity.

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* Corresponding author. Tel.: +34 943 309 300; fax: +34 943 309 052.
  E-mail addresses: s.caffarra@bcbl.eu (S. Caffarra), n.molinaro@bcbl.eu (N. Molinaro), d.davidson@bcbl.eu (D. Davidson), m.carreiras@bcbl.eu (M. Carreiras).

1. Introduction

Within the domain of a highly interconnected and globalized society, speaking a second language has become more and more important (Vassiliou and Šemeta, 2012). However, several researchers have pointed out that reaching a native-like L2 attainment still represents a challenge and that L2 speakers often show performance outside of the native range, for either monolingual or multilingual native speakers (Clahsen and Felser, 2006; Kroll and de Groot, 2005). Specifically, it has been observed that, when people have to learn a foreign language, they usually show more difficulties with syntactic processing (and also phonology) as compared to semantics and lexicon (Hahne, 2001; Hahne and Friederici, 2001; Weber-Fox and Neville, 1996). Different factors (*L2 factors*) have been identified in order to account for this difference between native and non-native speakers: cross-linguistic similarities between the mother tongue and the new language, starting point of L2 acquisition (AoA), global proficiency, and duration of immersion in the L2-speaking country. Theoretical models have put different emphasis on each of them and, for straightforward reasons, experimental research has mainly focused on a single factor independently from the others. As a consequence, it is still not clear what is the relative contribution of each factor on L2 syntactic processing.

The present work represents the first empirical review that takes into account the impact of *all* these factors on the time course of L2 syntactic processing, comparing the relative influence of each of them. Event-related potential (ERP) studies so far conducted on L2 syntactic violations in sentence comprehension will be reviewed in order to know whether distinct aspects of syntactic analysis (i.e., automatic or more controlled processes) would be differently influenced by the L2 factors described above. In the manuscript, for the sake of clarity, we will use the term "L2 speakers" to refer to relatively skilled bilinguals (who can be defined in terms of AoA and proficiency level) and, more specifically, we will use the term "L2 learners" to describe people who are involved in L2 grammar training.

L2 syntactic processing has been widely investigated in the last 20 years with different experimental designs (i.e. longitudinal or cross-sectional), languages (i.e. artificial or real languages), participants (i.e., L2 speakers with different characteristics, but also L2 learners), and techniques (i.e. off-line and on-line measures).

ERPs have been one of the techniques employed to investigate this topic since they provide on-line measures of brain activity. Specifically, ERPs represent a non-invasive measure of electrophysiological brain activity time-locked to the onset of an external event (e.g. a word appearing on a screen). This brain activity is measured at the scalp and it mainly reflects the sum of synchronized postsynaptic potentials across large groups of cortical pyramidal cells. This technique is particularly useful for studying fast brain responses to any linguistic stimulus and its high temporal resolution allows to examine brain responses specifically elicited by a single word embedded in a sentence. For these reasons, it has been widely employed in studying L1 and L2 sentence processing.

To study L1 syntactic processing, many ERP studies adopted violation paradigms where non-grammatical sentences, containing a violation of a specific syntactic rule or principle, are compared with the correct sentences, which are otherwise similar to the violation stimuli. This paradigm is based on the assumption that – given all the other linguistic variables held constant – the brain reaction to a syntactic violation, compared to the brain reaction to the control stimulus, reflects processes related to the use of the grammatical rule or principle in question (as well as further processes involved in understanding the sentence on the basis of ungrammatical input). The principle ERP effects reported in L1 sentence processing are summarized in Table 1, with their most-commonly accepted functional interpretations.

Studies of L1 violation ERP effects have been often considered as a reference for the L2 sentence processing literature. Specifically, several ERP studies on L2 sentence comprehension have used violation paradigms, presenting the same syntactic violations to natives and L2 speakers and comparing the ERP correlates between the two groups. This common experimental design has been adopted in order to: (1) examine how electrophysiological correlates of L2 sentence analysis differ from those observed in native speakers; (2) test whether distinct aspects of L2 syntactic processing can be influenced by the L2 factors. Although this approach allows researchers to better understand the temporal dynamics of L2 sentence processing, it should be noted that it has a fundamental and, for some controversial (Cook, 1992; Grosjean, 1989; Meisel, 2004), assumption: when people reach L2 final attainment, their syntactic processing should present characteristics similar to those of native speakers, which are considered to be the ideal standard for success in L2 learning. Given this assumption, many authors have