

When word category information encounters morphosyntax: An ERP study

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Abstract

The present study investigated the relationship between two different syntactic information types, namely word category and morphosyntax. The event-related brain potential (ERP) pattern of acoustically presented sentences containing two syntactic anomalies (word category and subject–verb agreement) was compared to the ERP response to sentences containing a single violation. The ERPs for the agreement violation revealed a left anterior negativity (LAN) indicating the detection of the morphosyntactic error, followed by a P600 reflecting processes of reanalysis. The ERPs for both the category and the combined violation showed an early negativity reflecting processes of phrase structure building, followed by a P600 indicating syntactic reanalysis. Additionally, a broadly distributed negativity following the early negativity and preceding the P600 was observed. This ERP component is suggested to reflect reference specification processes arising from the specific sentence structure used in the present study. The ERP pattern for the combined violation suggests no additivity or interaction between the two syntactic anomalies in the early time windows (early negativity, reference-related negativity, and LAN), whereas interactive effects are observed in a late time range (P600).

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The linguistic system consists of different components, which interact with each other according to certain principles. These different components include domains such as phonology, morphology, semantics, and syntax. The relationship between these different linguistic information types is a controversial issue in current research, especially with respect to the question of whether and when information from different domains interacts.

Psycholinguistic models of language comprehension differ with respect to how information from different linguistic domains is thought to interact. Serial or modular models [3,4] propose (at least initial) autonomous processing of different information types. Such models assume an autonomy and primacy of syntactic processing, independent of lexical–conceptual information. Interactive or parallel models [17], on the other hand, suggest that all information types

interact continuously as information becomes available. One recent neurocognitive model of sentence comprehension [5] proposes an initial autonomous processing of syntactic phrase structure preceding processing of semantic information (as in serial syntax-first models) but interaction of information from different domains in later stages.

An established method for analyzing the temporal dynamics of language processing is the recording of event-related brain potentials (ERPs). The investigation of different information types has made use of violation paradigms, in which a particular linguistic information type is anomalous in a given context. The interaction of various processing steps has been addressed using combination paradigms. In these studies sentences containing multiple violations from different linguistic domains are presented. The brain's response to such double violations is then compared to the response to single violation conditions. Combination paradigms have been used in recent years to investigate the interplay of syntactic and semantic processes [6,10,11,13,14,21]. However, the various

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ERP studies differ as to whether they combined semantic violations with phrase structure violations or with morphosyntactic agreement violations. While the former studies mostly report an independence of syntactic (phrase structure) processes from semantics [13,14], the latter studies either report independence [21] or interaction effects [11].

The present ERP study focuses on the relationship between two different types of syntactic processes, namely phrase structure building and morphosyntactic agreement.

Phrase structure violations typically elicit two ERP components: an early left anterior negativity (ELAN), reflecting initial phrase structure building processes, and a late centro-parietal positivity (P600), assumed to reflect syntactic reanalysis or repair [7,12–14]. Morphosyntactic agreement violations, on the other hand, usually elicit an LAN around 400 ms followed by a P600 [1,2,7,10,18,20]. The negativity has been interpreted to reflect the detection of the morphosyntactic congruence error and the P600 has been suggested to reflect syntactic reanalysis processes.

Primacy of phrase structure building over processing of semantic information is suggested on the basis of the ERP results using combination paradigms. Investigating outright word category violations combined with semantic violations resulted in an ELAN-P600 pattern in the absence of an N400, indicating that semantic integration reflected by the N400 was blocked, and therefore, no additive effect was present [13,14]. These findings encourage a syntax-first view, in which independent and autonomous syntactic processes occur in the first stage (ELAN) without any interaction in this time range. Because in these studies word category information was encoded in the prefix of the critical word one could assume that primacy of syntactic processes could be attributed to the primary occurrence of the syntactic anomaly before the semantic one. Friederici et al. [6] addressed this question and constructed German sentences, which encoded the word category information in the suffix, i.e. after the semantic error. For the pure syntactic violation condition they found a P600 preceded by an LAN that was later than those reported for sentences where the critical word category information was encoded in the prefix [7,12–14]. The same pattern was observed for the combined violation condition although with a larger amplitude of the P600. The absence of the N400 in this study suggests that even when semantic information precedes word category information, no semantic integration is initiated without prior syntactic licensing, indicating a functional primacy of phrase structure over semantic processes. The larger P600 in the combined violation points towards an interaction between syntax and semantics at a later stage. The processing of phrase structure has been shown to precede processing of other types of syntactic information as well. In an auditory sentence processing study [8] combining two syntactic violations (phrase structure violation and violation of argument structure) the same pattern as in the pure phrase structure violation, namely an ELAN and a P600, was found. This is of particular interest, as the neurocognitive model [5] not only assumes a primacy of phrase structure

Table 1

Experimental items (critical verb is italicized)

Correct sentence	Der Junge im Kindergarten <i>singt</i> ein Lied. (The boy in-the kindergarden <i>sings</i> a song.)
Category violation	Der Junge im <i>singt</i> ein Lied. (The boy in-the <i>sings</i> a song.)
Agreement violation	Der Junge im Kindergarten <i>singst</i> ein Lied. (The boy in-the kindergarden <i>sing</i> a song.)
Combined violation	Der Junge im <i>singst</i> ein Lied. (The boy in-the <i>sing</i> a song.)

building over semantic, but also over thematic processes. It predicts that initial phrase structure processes should be independent of lexical–semantic argument structure, and those morphosyntactic processes that are relevant for thematic role assignment. The model thus also predicts a primacy effect of initial phrase structure building over subject–verb agreement processes.

The present study thus investigated the relationship between a word category violation and a morphosyntactic subject–verb agreement violation. On the basis of previous ERP studies, we expected an LAN and a P600 for the morphosyntactic agreement violation and an early negativity and a P600 for the word category violation. If the combined violation gives rise to the same ERP pattern as the category violation, this would reflect not only a primacy of phrase structure processes over semantic processes, but would indicate that word category information, as a special syntactic feature, also has primacy over other syntactic features. For this purpose German sentences were constructed consisting of four experimental and three correct filler conditions. All sentences were realized as active constructions in indicative present tense in order to keep the critical word (verb) the same in all conditions, at least until the suffix in which the morphosyntactic agreement violation is encoded (Table 1).

The *category violation* violated the phrase structure by the absence of the noun in the prepositional phrase. The *agreement violation* was realized by an inflexion error on the verb induced by the second person singular instead of the correct third person singular. The *combined violation* contained both a category and an agreement error. Three correct filler conditions were included. Two of these comprised syntactically well-formed sentences of the same structure intended in the anomalous conditions. An additional third filler condition should balance the morphosyntactic error by using the second person singular in a correct sentence.

Each condition consisted of 60 sentences resulting in a total of 420 sentences. The sentences were spoken by a female native speaker of German in a soundproof booth and recorded digitally with 16 bit at a sampling rate of 44,000 Hz. The category and combined violation were spoken as complete correct sentences including a noun of the prepositional phrase (Der Junge im “Singraum” *singt* ein Lied.) in order to avoid possible phonological influences (cf. [12]). This additional noun was afterwards excised from the acoustic file. To prevent learning effects the 420 sentences were pseudorandomized

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