ABSTRACT

Title of Dissertation: THE COMPARISON OF L1 AND L2 CASE PROCESSING: ERP EVIDENCE FROM TURKISH

Nur Basak Karatas, Doctor of Philosophy, 2019

Dissertation directed by: Professor Kira Gor
Second Language Acquisition

This dissertation investigates the morphological and morphosyntactic processing of case-marking by native and nonnative speakers of Turkish, through behavioral and electrophysiological responses. The study explores the locus of case processing costs during first (L1) and second language (L2) word recognition both in isolation and in sentences. It identifies the factors leading to persistent problems that late L2 learners face in attaining native-like processing of case assignment. To this end, the first experiment (a visual lexical decision task) examines whether different case forms generate differential processing costs, based on four main comparisons that reflect case properties and its status in the inflectional paradigm: 1) structural (genitive, accusative) vs. lexical (dative) case; 2) argument (accusative, dative) vs. non-argument (genitive); 3) higher (genitive) vs. lower type frequency (accusative, dative), and 4) citation form (nominative) vs. oblique cases (genitive, accusative, dative). The behavioral findings show significantly larger processing costs (i.e., longer reaction times and lower accuracy rates) for the genitive than the nominative case (citation form) across both subject groups, and than other oblique cases in L2 group only. ERP findings show significantly larger processing costs for the genitive than the accusative, and for the dative than the accusative only in L2 group. When the same case-inflected nouns were placed in a sentence context, larger N400 effects were found for the genitive, compared to the nominative and accusative in L1 group only. Together, these results suggest that different case forms generate differential processing costs in both subject groups, and L2 learners' difficulty with the non-argument genitive and lexical dative oblique cases are at the level of form rather than sentence structure. The second (sentence) experiment also examined the processing of case errors (i.e., substitution of the accusative for the dative or vice versa on the object). ERP findings show a qualitative difference between L1 and L2 morphosyntactic patterns: P600 was missing while early negativities (N400 and left anterior negativity, LAN) were present in L2 group. These results suggest that advanced L2 learners evaluate the verb argument structure (LAN) and semantic fit (N400), but do not attempt to reparse the sentence (P600), unlike native speakers.

THE COMPARISON OF L1 AND L2 CASE PROCESSING: ERP EVIDENCE FROM TURKISH

by

Nur Basak Karatas

Dissertation submitted to the Faculty of the Graduate School of
the University of Maryland, College Park, in partial fulfillment
of the requirements for the degree
of Doctor of Philosophy
2019

Advisory Committee:
Professor Kira Gor, Chair
Professor Ellen Lau
Professor Steven Ross
Doctor Scott Jackson
Professor David Bolger, Dean's Representative

Dedication

To my family—especially my father who has always been my role model with his character, life-style, and tenacity to hold on to life despite all the unexpected hardships that he had to face.

Acknowledgements

This dissertation has been long but exciting experience for me, and I would like to express my deepest gratitude and appreciation to those who helped me in completing it. First, I would like to thank the members of my dissertation committee, Dr. Kira Gor, Dr. Ellen Lau, Dr. Steven J. Ross, Dr. Scott Jackson and Dr. Donald Bolger for their insightful comments and suggestions.

My sincere thanks go to my advisor, Dr. Kira Gor for her meticulous guidance, constructive criticisms, and sound advice. She helped me conceptualize the theoretical framework of this study. I also would like to express my warmest thanks to my interdisciplinary mentor, Dr. Ellen Lau, for her continuous help with the research design and analysis. I feel very privileged of working with both these professors, especially for their initial encouragement and substantial directions to carry out research in a relatively unexplored field of case processing. Thanks to Kira and Ellen, I could achieve my only goal when I started my Ph.D., which was integrating EEG into my dissertation study.

I am also very grateful to Scott for the time he spent on my stats. His passion and interest in my data made me look for different ways of analyses to better explain the interesting patterns. Another person that I owe special thanks for his unforgettable help on my EEG stats is Eric Pelzl. He was always there whenever I encountered a difficulty in running a code (for planned comparisons). He is an amazing person and friend of mine!

During this hectic process, I feel so lucky to have my best friend, Filiz Rızaoğlu in my life. Despite the miles and the ocean between us, she was only a call away to cheer me up. Aakash Moni was another witness of all the painstaking stages of this dissertation. He always tried to motivate me to go on when I felt lost and frustrated. Thank you very much for your patience! I further extend my gratitude to my colleagues and friends from the program, Alia, Nick, Sunhee, Stephen, Hyojin and Jon, and from the Language Science Center, Nick, Chia-Hsuan, William, Paulina, Gesoel, and Zoe for their academic and moral support.

Above all, without the unconditional love, emotional support and trust of my beloved family, I would not have survived the last couple months. I feel very lucky to have such a caring mom, Naile Karataş, an altruistic dad, Metin Karataş, who has dedicated his life to his children's education, and a brilliant brother, my genius, Uğur Karataş. My mere expression of thanks does not suffice for the invaluable feeling of 'home' you have provided me and helped me carry it wherever I go. I am so proud of being my dad's princess, and my mom's "cadı" Basak, and in the rest of my life, I will try my best not to disappoint you.

In addition, my heartfelt thanks go to our collaborator from Istanbul University, Dr. Mehmet Aygunes, the founder of the electro-neurophysiology laboratory, Dr. Tamer Demiralp, who let me collect a huge amount of data in his lab, my colleagues from other departments there, Dr. Ali Bayram, Dr. Atilla Uslu, Talha, and Merve, who was my assistant for couple weeks, for all their support duing my data collection. They were very kind, patient, understanding and helpful to me. The biggest thanks should go to my participants, who did their best for my study. Without their participation, this dissertation would not have been possible. I would also like to acknowledge that this work was supported by the National Science Foundation under Grant No.1449815 and the Ann Wylie Dissertation Fellowship.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

1.1 Overview

Case-marking is a morphosyntactic feature that has frequently been shown to pose a major challenge to late second language (L2) learners even when they attain near-native proficiency. Yet, it has barely received attention even in first language (L1) processing literature, compared to a fairly well-studied phenomenon of gender agreement, probably because the inflectional paradigm for case is absent in many Indo-European languages spoken today. However, case morphology is a linguistic means of argument marking commonly found among head-final languages, which tend to allow free word order (e.g., Turkish, German, Japanese, and Basque). And indeed, processing case markers correctly is crucial to determine syntactic function and semantic roles of the arguments in a verb-final sentence.

To date, a few psycholinguistic studies have looked at L1 and L2 case marking processing in word recognition (Gor, Chrabaszcz, & Cook, 2017a, b, 2018) or syntactic reanalysis (e.g., case violations, see Hopp, 2010). Yet, the need for more research on case-marking processing is clear, especially using typologically different languages employing case markers in syntactic function assignment. To this end, the main goal of the current study is to gain more insight into the locus of case processing difficulties both at the lexical recognition level and sentence processing level through behavioral and electrophysiological responses. In a previous self-paced reading (SPR) study (Karatas, Gor, & Lau, in preparation) we observed significant differences only during L2 processing of accusative- vs. dative-inflected nominalized objects. These differences could have arisen from the processing costs involved in sentence parsing, the processing of case-inflected forms themselves, or both. To explore the source of differences in L2 case processing, the first experiment of the current study (Chapter 1) primarily set out to establish whether the processing costs will differ among different case markings, namely the nominative, accusative, dative and genitive, across native and nonnative single word recognition during a simple lexical decision task (LDT). If they do, the study will further examine whether these processing cost differences will reflect the internal features or the hierarchical structure of the nominal paradigm by testing the following comparisons:

1. *Structural case (genitive, accusative) vs. lexical case (dative)*
2. *Argument (accusative, dative) vs. non-argument (genitive)*
3. *Higher type frequency (genitive) vs. lower type frequency (accusative, dative)*
4. *Citation form (nominative) vs. oblique cases (genitive, accusative, dative)*

Based on the same comparisons above, Experiment 2 also investigates the L1 and L2 processing costs associated with neural responses from the same case-inflected nouns placed in a sentence (Chapter 3). To our knowledge, there is no prior work on case processing using event-related brain potentials (ERPs) within both single word and sentential contexts (see Gor, Chrabaszcz, & Cook, 2017b for phrase-level case processing). Furthermore, Experiment 2 investigates the morphosyntactic processing of structural and lexical case violations across native speakers and advanced L2 learners through behavioral (accuracy rates) and ERP responses. Even though the processing of case assignments by the matrix verb is an essential facet of correct sentence comprehension, its neural underpinnings are not well-understood. In this respect, by employing ERPs, which are known to be highly sensitive to immediate, unconscious online detection and processing of linguistic anomalies

(Osterhout & Holcomb, 1992), the present grammaticality judgment task (GJT) compares native and nonnative morphosyntactic processing patterns. It focuses on the amplitude differences of three ERP components (i.e., N400, LAN, P600) between L1 and L2 verb processing of case anomalies in order to understand how native-like L2 processing of case is, given that similar electrophysiological responses correlate with similar underlying neural and cognitive processing mechanisms (Mueller, Hirotani, & Friederici, 2007). Thus, the sentence-processing part of the study looks into how and when native and nonnative speakers access and process structural-grammatical information such as case markers as morphosyntactic cues, and whether L2 learners are sensitive to incorrect cue-usage, as in case violations (i.e., substitution errors). It seeks to find out whether nonnative speakers undergo syntactic repair during real-time language comprehension, which has been proven difficult to master by previous behavioral research (see Karatas, Gor, & Lau, in preparation). Last but not least, based on the previous SPR findings (i.e., relatively slower reading times for the structural case violations, that is, the substitution of the accusative for the dative), Experiment 2 compares the magnitudes of the neural correlates between the same two types of substitution errors (i.e., structural: substitution of the dative, a lexical case, for the accusative, a structural case vs. lexical: substitution of the accusative, a structural case, for the dative, a lexical case).

In Chapter 4 we discuss the findings of both experiments and consider how the four guiding comparisons, postulated in line with the distinctive case properties (i.e., structural vs. lexical case, argumenthood, type frequency and citation form vs. oblique cases) help us to interpret the results of L1 and L2 morphological processing of case markings during word recognition in isolation and in sentential contexts. Furthermore, we discuss the results of L1 and L2 morphosyntactic processing of structural vs. lexical case errors within central theoretical accounts of native vs. nonnative incremental sentence representations. Finally, it is important to highlight that the rich case system of Turkish, which has not yet been subjected to extensive neurocognitive research, provides an ideal testing ground for such an exploratory study that seeks to unveil the relative impact of case properties on L1 and L2 morphological (word-level) and morphosyntactic (sentence-level) processing.

1.2 Case-marking in word processing

1.2.1 The role of morphology in L1 lexical access

Understanding how words are represented in the mind and how their meaning is accessed from printed word forms are two primary goals of visual word recognition research. The speed and apparent ease with which an individual word can be identified amongst many other candidates in less than half a second have presented a continuous challenge for theorists trying to understand the architecture of the word recognition system. Yet, there is still not much agreement on how inflected words are stored in the mental lexicon and retrieved during lexical access.

Experimental studies have produced conflicting answers to the above questions. Two broad views can be distinguished: full-listing (Butterworth, 1983) and decomposition (Taft & Forster, 1975). The former model predicts no morphological parsing during word recognition, whereas the latter model does. In other words, the firts model assumes that the morphological structure of words plays no role in the way they are accessed and that words are listed as full forms in memory. On the other hand, the second model claims that the mental lexicon encodes morphological structure and that this information plays a role in lexical access, specifically of those which are morphologically complex (see Marslen-Wilson, Lorraine, Rachelle, & Lianne, 1994 for review). More recent data support a dual-route model, which holds that the processing of multimorphemic words in a language is tuned by its morphological characteristics. As a result, this third alternative model suggests that the representation of complex words may involve both constituent morpheme activation and full listing, depending on factors such as morpho-phonological/semantic transparency of stem-affix combinations or their frequencies (root, suffix, whole-word/surface frequency) (Baayen, Dijkstra & Schreduer, 1997; Schreduer & Baayen, 1995).

With respect to the first factor, the decompositional view in the Full Decomposition model maintains that all morphologically complex and transparent words are decomposed in lexical access (Taft, 2004). Since inflections have a clear grammatical meaning and thus inflected words are structurally transparent, fully transparent inflected words do not have whole-word representations. However, as evidenced by Lehtonen and Laine (2003), token (lemma) frequencies can further play a role in decomposition. For example, they report that low- and medium-frequency polymorphemic Finnish words matched on surface frequency and other lexical parameters with monomorphemic words induce additional processing costs only in native speakers, whereas high-frequency words do not, which signals full-form representations for highly frequent words. In a similar vein, Gürel’s (1999) unprimed lexical decision task results show affix-frequency effects in native speakers’ lexical access, such that words with the ablative suffix (the case marker with the lowest frequency) are accessed faster than the length- and frequency-matched monomorphemic words, while other multimorphemic words with a more frequent case marker (e.g., locative) are not.

Morphologically complex words have been a subject of intensive experimental research for the past 40 years (for a review, see Amenita & Crepaldi, 2012), with a focus on the idea that decomposition is a fundamental property of their lexical storage and access. Consequently, this line of psycholingusitics research has claimed that decomposition proceeds in several stages: first, word decomposition into stem and inflection (also referred to as affix stripping), followed by lexical access of the stem or processing of the inflection, and finally, recombination of the stem and inflection and checking the whole word for morphosyntactic information (Taft, 2004; Gor et al., 2017a). It is the last stage of recombination and checking that is expected to be responsible for any processing costs, as an indication of the processing effort, which will vary for different forms in the inflectional paradigm (Gor et al., 2017a)

In pursuit of the question of how the mind/brain represents and processes an inflected word's morphosyntactic features, most studies have used behavioral measures, specifically response latencies in lexical decision or naming tasks. More recently, morphological processing has been investigated in neurocognitive studies exploring the various underlying perceptual and cognitive processes involved in word recognition through electrophysiological and hemodynamic techniques (see Lehtonen, Vorobyev, Hugdahl, Tuokkola, & Laine, 2006; Lehtonen, Cunillera, Rodríguez-Fornells, Hultén, Tuomainen, & Laine, 2007). Still not much is known about the temporal aspects of structural-grammatical feature processing of inflected words during online language comprehension.

Neurophysiological studies have contributed to this discussion by exploring how and at what point in time morphology plays a prominent role in visual word recognition. The majority used a masked primed LDT, where primes presented for very brief durations (40-50 ms) are sandwiched between forward and backward (target stimulus) mask, in order to look at both response times and high-temporal resolution recordings of ERPs in different time windows (see Lavric, Clapp, & Rastle, 2007). The ERP data across different studies indicate that in the early portion (~300–380 ms, following the onset of the target) of centro-parietal negativities (N400), morpho-semantic priming (e.g., hunter-HUNT) is equal to the orthographic priming in the semantically opaque condition (e.g., corner-CORN, see also Lavric, Elchlepp, & Rastle, 2012 for converging evidence from unprimed lexical decisions). Only in the later time frame (~380–450 ms following the onset of the target, that is ~600–650 ms after the prime) robust morphological priming effects, constrained by semantic information (i.e., reduction of the N400 attenuation in the opaque condition), can be found, especially with visible primes (Lavric, Rastle, & Clapp, 2011) or long prime-target SOAs (for the review of different prime presentations, see Morris, Frank, Grainger, & Holcomb, 2007). It is also possible that N400 effects may be smaller or even eliminated due to an insufficient amount of time for the prime to activate the morphological constituents of the targets. In short, prior ERP work on morphological processing reveals an early process of semantically blind, orthography-based morphological decomposition in native speakers.

1.2.2 The role of morphology in L2 lexical access

Some studies suggest that in native speakers, decomposition is automatic and does not incur any processing costs, especially during the initial stages. Yet, based on the pattern of the processing costs that may be present and reassociated with late stages of processing, native lexical access may still be sensitive to the properties of the inflectional paradigm of a particular word (see Baayen, Feldman, & Schreuder, 2006; Clahsen, Eisenbeiss, Hadler, & Sonnenstuhl, 2001; Milin, Filipović Đurđević, & Moscoso del Prado Martin, 2009). There is also sufficient evidence indicating that nonnative speakers are sensitive to morphological structure of inflected words and decompose them during word recognition, as established by a differential pattern of processing costs for different types of inflected words (Coughlin & Tremblay, 2015; Foote, 2015; Gor & Cook, 2010; Gor & Jackson, 2013). Given that part and parcel of word learning, which is the key component in foreign language learning, is the acquisition of the morphological structure of words, the processing of L2 morphology has received considerable attention in recent years. Most of the work on nonnative decomposition of inflected words has been done on verbal morphology, such as English past-tense inflection (Silva & Clahsen, 2008). Later, the research expanded to delve into the morphological decomposition of regular and irregular verbs in different languages, such as Russian (e.g., Gor & Cook, 2010; Gor & Jackson, 2013), Turkish (Kirkici & Clahsen, 2013) or German (Neubauer & Clahsen, 2009). Yet, the processing of nominal inflection and the status of the inflectional paradigm in the mental lexicon has remained largely unexplored.

The debate on how L2 learners of languages with a rich inflectional morphology deal with a challenging task of processing inflected noun forms organized in structured inflectional paradigms is still far from settled and more data are needed. Since most studies of inflectional phenomena have been conducted on the processing of verbal inflection either in English (e.g., Pinker & Ullman, 2002; Silva & Clahsen, 2008) or in German (e.g., Clahsen et al., 2001; Neubauer & Clahsen, 2009), there is less agreement regarding the morphological processing of nouns in nonnative speakers learning other languages with richer inflectional systems. First, the distinction between rule- and associative memory-based inflectional processes[1] can be less straightforward in morphologically rich languages, as the efficiency of nonnative decomposition is likely to be mitigated by morphological complexity and the properties of the allomorphy of inflected words (see Gor & Jackson, 2013). Second, in morphologically rich languages bilinguals may employ the morphological decomposition route more than monolinguals. For example, Lehtonen and Laine (2003)[2] found that Finnish-Swedish early bilinguals decomposed inflected words, regardless of their lexical frequency, which is supposed to be the leading factor determining the choice of the route.

The way an L2 learner processes morphologically complex words may also emerge from the interplay among the internal morphological structure of both L1 (Portin et al., 2007a) and L2, word frequency, and some participant-related factors,

[1] The initial rule vs. rote distinction in psycholinguistic theories of lexical access was fiercely debated and replaced by the rule vs. associative memory by Pinker himself (1998). Several neuropsychological (Marslen-Wilson & Tyler, 1997) and brain imaging studies (Münte, Say, Clahsen, Schiltz, & Kutas, 1999) have produced the data in favor of a “dual-mechanism model”. This account posits that words can either be stored whole or computationally derived by simple combinatorial rules such as stem+affix, depending on the token frequencies, such that high-frequency regular inflected words may be coded into long-term memory as whole units (Pinker, 1999).

[2] Note that in another study, Lehtonen, Niska, Wande, Niemi and Laine. (2006) found early Finnish-Swedish bilinguals and Swedish monolinguals decomposing only low-frequency inflected words, which they attributed to the rather restricted morphological structure of the Swedish language, which may promote the development of full-form representations at lower frequencies.

such as age of acquisition and L2 proficiency (Coughlin & Tremblay, 2015). Even though there is some evidence on the role of these factors in early simultaneous bilinguals, the data on morphological processing in late learners of a foreign language are very scarce. Clearly, late learning leads to less language exposure (although relative L2 frequency of exposure to specific word forms still highly correlates with corpus frequencies) and less experience with L2 orthographic input, which makes them slower processors. This slowness can also be potentially exacerbated by the choice of experimental method (e.g., masked vs. visible priming paradigms, where the fast presentation in masked priming may disadvantage L2 learners in their ability to process the prime). In addition to this nonnative inefficiency and slowness exacerbated by masked priming, another important point to consider in an experimental design is the structure of nonwords and fillers, which can strengthen or weaken the effect of inflection on lexical access by late L2 learners (see Gor et al., 2017a, and Gor et al., 2017b for critical remarks).

Taken together, a large body of research has reported the absence of morphological priming effects, especially in late L2 learners, and this can be accounted for by other factors, rather than directly stipulating the non-decompositional account[3], which presumes whole-word storage and access in the L2 lexicon (e.g., Kirkici & Clahsen, 2013). However, such an account is at odds with the aforementioned fact that late L2 learners are exposed to reduced input. As a result, the claim that L2 learners store more inflected words than native speakers seem to be unwarranted (see also Gor et al., 2017a). There is also counterevidence showing that

[3] Alternatively, a developmental trajectory from whole-word storage to decomposition of inflected words with greater proficiency was postulated by some authors (e.g., Ullman, 2001).

even late exposure to a language can produce representations for inflected words that encode their morphological structure (see Portin, Lehtonen, & Laine, 2007b).

1.2.3 The role of case-marking in L1 and L2 lexical access

The debates surrounding the differences in the role of nominal morphology during L1 and L2 lexical access and retrieval have only recently focused on case inflection. Based on the idea that differences in response latencies in inflected word recognition compared to monomorphemic words reflect differences in morphological processing costs (Lehtonen & Laine, 2003), this line of research has compared the processsing patterns of different case forms during native and nonnative morphological decomposition (e.g., Gor et al., 2017a).

At this point, the question arises what actually drives longer response latencies in both native and nonnative case processing. Leminen and Clahsen (2014) argue that differences in RTs across L1 data stem from either differences in token frequencies, which can easily be ruled out in an experiment by controlling for surface frequencies[4], or parsing difficulty for complex morphological structures. A third possibility is the additional grammatical load that these suffixes carry, associated with type frequencies, which capture the number of different words inflected with a particular marker. In languages like German, type frequencies associated with a certain grammatical load, rather than token frequencies, are significant predictors of RTs during the processing of morphologically complex words, because as a predictive

[4] Surface frequency denotes the token frequency of a word form in a representative language corpus, whereas stem frequency is the combination of all the frequencies of a word's inflectional variants. Other relevant concepts used to predict RTs for lexical entries and lemmas of words are the family size frequency, which indicates the stem frequency + the number of derived words and the number of compounds, and the family frequency, which is the sum of frequencies of all the forms pertaining to the same morphological family (Schreuder & Baayen, 1997).

frequency measure, type frequency hinges upon the productivity of certain constructions in particular contexts, such as the strength of embedding into common or uncommon constructions (cf. Leminen & Clahsen, 2014). For example, in German, adjectives with -*e* or -*s* plural markings can optionally encode the nominative and accusative case. As a result of this increase in functional load, these different sets of morphosyntactic values elicit smaller processing costs than the -*m* plural form, which is restricted to just one case (dative) and thus displays lower type frequency. Based on different paradigmatic representations by these affixes, Leminen and Clahsen (2014) found a more pronounced left-anterior negativity (LAN) for prime-target pairs with -*m* than for the others, and a graded N400 pattern, based on frequency[5] (i.e., a larger N400 for -*m* than for others, as it is the least frequent affix in the inflectional system of German adjectives). In addition to N400, they also found a modulation of the early positivity (P300), which is nearly centrally distributed between 200 and 300 ms and is interpreted as difficulty of grammatical processing effort, lexical retrieval, stimulus evaluation or cognitive workload (see Yagoubi, Chiarelli, Mondini, Perrone, Danieli, & Semenza, 2008). Overall, even though this study could not tease apart the role of morphological decomposition and lexical-semantic effects in producing the attenuated N400 (see also Morris et al., 2007), they claimed that their results were consistent with structure-first models (i.e., early access to grammatical, rather than semantic information) of language processing.

[5] Crucially, however, frequency considerations provided only partial explanation for the priming results in this study, such that only -*m* forms, which are directly specified in a paradigm entry, reliably differed from -*s* forms because they are less common than the nominative and accusative contexts. Yet, there was no significant difference between -*e* and -*s* forms, though the former is the most common. This finding is also compatible with the previous behavioral results by Clahsen et al. (2001), where target lexical decision times on -*e* adjectives were facilitated more by -*s* than by -*m* prime words.

Based on this L1 data, Bosch, Krause and Leminen (2017) further examined how morphosyntactic and lexical-semantic information are represented in the L2 mental lexicon. They addressed this question in both a behavioral and an ERP priming experiment on German adjectives by testing late proficient Russian learners of German in comparison to L1 controls. Their behavioral cross-modal priming results replicated Clahsen et al.'s (2001) findings (i.e., slower target response latencies for *-m* than for *-e* and *-s* forms due to its lowest word-form frequency, as well as facilitation in the recognition of *-e* targets by *-s* primes) for native speakers of German[6]. The group-level differences were shown only by ERPs, which provided a direct millisecond scale evidence of inflected word parsing. The L2 group elicited a more pronounced negativity for the *-s* prime and the *-m* prime conditions than the L1 group in the 350–450 ms time-window, which can be interpreted as a prolonged and a more laborious evaluation of morphosyntactic feature information in the L2 group.

The locus of the processing effort has thus created a bottleneck in nonnative processing of inflection. To this end, Gor and colleagues (2017a) compared native and nonnative recognition of case-inflected nouns. Through two auditory LDTs, they examined the roles of case form (citation or oblique) and the type of inflection (overt or zero) in terms of the cost of checking or identifying the recomposed word within the inflectional paradigm and combining their lexical and morphosyntactic information[7]. Only with the manipulation to the nonwords (i.e., real stems were

[6] Behavioral L2 findings showed L1-like sensitivity to morphological processing and morphosyntactic feature access in the L2 group. However, as reported by Bosch and Clahsen (2016), these native-like modulations of repetition priming effects can vary under overt priming conditions as opposed to under masked priming conditions (i.e., no reliable facilitation effects).

[7] This study is a good successor of a Polish study (Szlachta, Bozic, Jelowicka, & Marslen-Wilson, 2012), where the case status and inflection type were confounded by not including zero-inflected oblique-case nouns. It had found that inflected Polish nouns engaged the left fronto-temporal system without any effect of inflection type.

illegally marked with real inflections, which emphasized the need for inflection processing), did they observe additional processing costs for oblique-case nouns, irrespective of inflection type in L2 learners. This finding implied that morphological processing can go beyond surface morphological decomposition as affix stripping by involving the covert structural level. L2 learners' sensitivity to case marking also increased with proficiency, suggesting that proficiency and task can mediate nonnative speakers' engagement with the morphological information. Following this study, Gor et al. (2017b) investigated whether this advantage for the citation form is present only in single-word presentation, or it is a fundamental property of lexical storage and retrieval. In a cross-modal morphosyntactic priming experiment, they compared the processing of the visual case-inflected noun targets preceded by auditory adjective primes with ambiguous oblique-case inflections (genitive or instrumental) between native speakers and early (heritage) and late learners of Russian. The results of case processing within adjective-noun dependencies were compatible with their previous study (Gor et al., 2017a), such that they again found a processing advantage for the citation form and that only native speakers and highly proficient late learners were influenced by the oblique-case type frequency-based hierarchy.

In conclusion, previous research has predominantly employed LDTs with and without priming in order to answer the questions of whether in accessing the representations of inflected words during recognition, morphological structure is required as a qualitatively distinct organizing substrate, and if yes, how these morphological features are represented and processed by native and nonnative language users. Against this background, which has largely focused on the presence of decomposition across L1 and L2 morphological processing, the current study compares the processing efforts associated with the distinct morphological features (e.g., structural vs. lexical case-marking) of different case-inflected variants of the same lexeme, which has previously been studied only from the perspective of the properties of the inflectional paradigm (i.e., type frequency) in behavioral (Gor et al., 2017a, 2017b) and neurophysiological priming experiments (Leminen & Clahsen, 2014; Bosch et al., 2017). In light of the decompositional view and several hybrid models mentioned above (Baayen et al., 1997; Gor, 2003, 2004; Marslen-Wilson & Tyler, 1997), the study presupposes that regularly case-inflected words will undergo decomposition during a simple visual LDT by both native and advanced late L2 learners of Turkish, a morphologically rich language. Based on certain properties of Turkish case inflection (i.e., the structural vs. lexical case dichotomy, case type frequency hierarchy, and argumenthood of a verb), the present research addresses the question of whether the processing demands of citation (i.e., nominative) and oblique-case forms (genitive, accusative, dative) differ from each other at behavioral and neural levels during native and nonnative word recognition.

1.3 Case-marking in sentence processing

1.3.1 Case-marking in L1 morphosyntactic processing

One of the biggest challenges in the study of human sentence processing mechanism is to understand how different kinds of information are used online. The relative ease of everyday language use belies the complex computational and neural infrastructure of the language faculty. Language users must apply certain rules to integrate word-elicited information into multiword representations, such as phrases or sentences. Understanding these processes and their implementation in the brain has traditionally been pivotal in neurobiological studies of language (Bornkessel-Schlesewsky & Schlesewsky, 2009). Yet, how first and second language users process case-related morphosyntactic information alongside other types of syntactic and semantic information in the brain, is yet unknown. To this end, the use of violation paradigms in case processing can help differentiate subprocesses engaged in the ongoing morphosyntactic analysis by native and nonnative speakers. To date, behavioral and neurocognitive research on case marking violations has concentrated on L1 and L2 processing of specific case markings, their thematic role functions, as well as their anticipatory effect on the way that the language system builds up at certain sentence positions (Hopp, 2015; Mueller, Hirotani, & Friederici, 2007). In this context, the current ERP research explores the morphosyntactic processing of two different object case markings, namely the accusative and dative, and the sensitivity of native speakers' and advanced L2 learners of Turkish to substitution errors in case marking on the object. It focuses on three main ERP components, namely N400, LAN and P600, each of which is described in detail below.

1.3.2 Benefits of ERPs and three main ERP components in case violation processing

Electroencephalography (EEG) records changes of voltage at the surface of the scalp over time for the purpose of measuring the exact temporal resolution of ongoing cognitive processes and thus disentangling these fast and sometimes hidden cognitive processes in the brain (Kutas & Federmeier, 2007). The phasic nature of cortical potential changes makes it well-suited to investigate linguistic processes that occur at different levels of cognitive processing in the brain. Studies using offline behavioral measures cannot provide access to this sort of evidence, which makes the interpretation of their results more difficult. Some online techniques such as eye tracking (Dussias, 2010) measure real-time language processing, but do not provide us with the qualitative evidence of potential brain functionality that ERPs can. In sum, it is not clear from behavioral or other types of real-time data alone at what point in time linguistic information of different kinds is at play.

Since Kutas and Hillyard's (1980) seminal discovery of the first language-related ERP component (N400), the notion that different subdomains of linguistic knowledge can be linked to distinct ERP signatures has been a major driving force behind many electrophysiological investigations of human language processing. This N400, a negative-going component peaking at around 400 ms (ranges from 250-600 ms) post-stimulus onset, is known to signal lexical-semantic processing at the word level as well as grammatical and thematic relations at the sentence level. Given that this component is sensitive to factors such as word frequency, cloze probability and semantic relatedness (semantic integration efforts), the more expected, familiar, or matching a word is, the less pronounced or reduced N400 should be expected (see Kutas & Federmeier, 2011). At the sentential level, it has also been reported as a response signaling reanalysis processes as in non-preferred disambiguation towards dative-initial interpretations (Hopf, Bayer, Bader, & Meng, 1998, for more information see below).

In some phrase structure violations, a negativity most prominent at central sites (N400) can shift into a broad positive wave (P600) with a maximum at parietal electrode positions (also dorsolateral regions contribute to P600 effects, especially during the processing of number agreement violations (see Indefrey, Hagoort, Herzog, Seitz, & Brown, 2001) in a time range of 600-1000 ms post-stimulus onset. In general, the P600 seems to be indicative of sensitivities to phrase-structure violations (Friederici, Hahne, & Mecklinger, 1996), subjacency violations (Neville, Nicol, Brass, Forster, & Garrett, 1991), verb tense or verb argument violations and case marking (see Friederici & Frisch, 2000). Morphosyntactic error detection in these linguistic structures may invoke repair or correction processes, to the extent that it is contingent on the knowledge of what the correct expression should be. Furthermore, the P600 amplitude modulations have also been shown to reflect the high degree of syntactic complexity in well-formed sentences (Kaan, Harris, Gibson, & Holcomb, 2000). In addition to these heterogeneous conditions indexed by the P600, the processes also seem to be independent of the core typological traits of the languages involved, such as alignment type (ergative vs. nominative-accusative), head parameter (SVO/SOV)[8], or agreement type. All in all, this lack of specificity defines the P600 as a general marker of syntactic difficulties as well as a general conflict monitoring mechanism[9] for language processing (cf. Díaz et al., 2011).

The P600 component was first observed by Osterhout and Holcomb (1992) as a response to a syntactic anomaly. It was classically interpreted as capturing syntactic

[8] Yet, recent processing studies argue for a deep impact of the basic word order on language processing, such that SVO and SOV languages can employ distinct processing strategies regarding the preeminence of different grammatical phenomena such as case-marking and word order, as a function of different neurocognitive substrata (for a detailed review, see Díaz, Sebastián-Gallés, Erdocia, Mueller, & Laka, 2011). Contrary to the general assumption that SOV word order should impose heavier processing demands on the cognitive system due to the scale of syntactic attachment, i.e., the interpretation and integration of displaced syntactic elements at verb position, it was found that in Basque SOV is the preferred and computationally less demanding word order (see Díaz et al., 2011). This finding can be ascribed to the usefulness of case morphology, which allows for the early determination of the thematic role and grammatical function of each nominal argument so that core grammatical information can be accessed before the verb (for further discussion, see the Extended Argument Dependency Model by Bornkessel & Schlesewsky, 2006).

[9] Similarly, some interpret the N400 as a domain-general correlate of semantic memory use (Kutas & Federmeier, 2000).

integration/repair (more fronto-central P600 distribution) and reanalysis (more centro-parietal distribution) processes following garden-path sentences as in filler-gap ambiguities (Osterhout, Holcomb, & Swinney, 1994) or following a mismatch between the analysis pursued by the parser and the upcoming input (Hagoort, Brown, & Groothusen, 1993). Unexpectedly, Hopf et al. (1998) found the N400, rather than the P600 to be characteristic of the garden-path effect created by case-ambiguous noun phrases (NPs) that may be assigned accusative or dative case in German. Sentences were disambiguated by the verb in sentence-final position. Their data show that sentences ending in a verb that assigns dative case to the ambiguous NP elicit a clear garden-path effect as indicated by a broad centro-posterior negative shift that occurred between 300 and 900 ms after the dative-assigning verb. It is claimed that the enhancement of a negative electrocortical sign with a classical N400 topography[10] corresponds to the difficulty of reanalysis and/or additional lexical activation/integration that is required for the release and reinterpretation of case-related information. More specifically, readers perceive a case mismatch when they encounter a dative-assigning verb because what they actually expect is an accusative-assigning verb. Therefore, they need to reaccess morpholexical information that lies outside the domain of their parsing module, by reentering the lexicon. As for the implications of their results with respect to parsing and its neuropsychological manifestations, a parser design is supported, such that the so-called structural case

[10] Hopf et al. (1998) tried to explain possible artifacts, such as different frequencies of occurrence of dative- vs. accusative-selecting verbs in that less frequent dative-assigning verbs were associated with larger N400s. However, this line of reasoning is not convincing, given the difference between the ambiguous and non-ambiguous dative sentences. Also note the study on the interaction between sentence context and word frequency by Van Petten and Kutas (1990), which found word frequency effect on the N400 component related to the processing of the initial, but not the final word of a sentence.

(nominative or accusative[11]) is assigned without any delay[12] in the absence of morpholexical counterevidence. Crucially, an early and fast commitment to a certain case marking shows that some morphologically or syntactically possible case options are not considered or assigned equal weight by the parser. In this case, the option to assign the dative to the ambiguous noun is neglected. Hopf et al. (1998) suggest that the reason why the accusative case assignment is treated as a privileged continuation is the parser's choice for the simplest structural assignment. Based on the linguistically defined distinction between the accusative and dative case, which labels the former as the structural and the latter as the lexical case, the parser may make minimal assumptions about the structure of the input (i.e., accusative object as it is the regular direct object case, in contrast to the idiosyncratic dative which needs a specific lexical licenser). Yet, these economy-driven principles in the choice of the accusative case during syntactic processing do not affect the phrase-structure representation of the sentence during the essential revision at the verb position. Hence, Hopf et al. (1998) suggest that this lack of phrase structure revisions may plausibly account for the absence of late positivities. In a nutshell, this study proves that syntactic reanalysis following a garden-path effect is not confined to late positive waves of the ERP but vary depending on the level of processing involved in reanalysis.

As mentioned above, in certain syntactic violations, late positivity is preceded by a strongly left-lateralized negativity around 400 ms after stimulus onset. This finding proves that the concept of N400 goes beyond the functional role of reflecting

[11] There is ample evidence in the literature on processing German or other related languages like Dutch that demonstrates that an ambiguous initial NP in a sentence is typically interpreted to be marked in the nominative case (see Frisch & Schlesewsky, 2005).
[12] The authors also argue that compared to more familiar types of ambiguities, such as phrase structure or filler-gap dependencies, case ambiguities are resolved immediately, as indicated by the lack of a pronounced ambiguity effect at the initial NP.

only semantic expectancy (Neville et al., 1991). Therefore, it has been proposed that this N400 effect as a result of syntactic agreement anomalies stems from non-syntactic information, such as difficulty in lexical access. Notably, there are also studies showing that N400 effects were elicited by manipulations that were not straightforwardly lexical-semantic in nature. For example, in a study on ergative case agreement in Basque, Zawiszewski, Gutiérrez, Fernández, & Laka (2011) found that the absence of the ergative case on a pronoun yielded a biphasic N400-P600 response, pointing to some problems with thematic hierarchizing. Likewise, Frisch and Schlesewsky (2001) observed an N400 for a case marking violation in German, where an animate nominative case-marked argument followed another nominative case-marked argument. They interpreted it as an effect revealed by a thematic interpretation problem (e.g., “who is acting on whom”). Conversely, they found only a P600 effect if the second argument was inanimate. In their follow-up study, Frisch and Schlesewsky (2005) examined the double nominative and double accusative constructions in German, and in both conditions, they found a biphasic N400-P600 ERP pattern time-locked to the second case-marked NP (N400 as the outcome of thematic integration problems again, and P600 as a response to syntactic ill-formedness). Interestingly, they further found a more pronounced N400 in the double accusative condition, which is more obvious during the course of sentence processing. This finding parallels the results of their previous behavioral study (speeded grammaticality judgment task), where double nominative conditions were judged as more grammatical (Schlesewsky, Fanselow, & Frisch, 2003). According to Frisch and Schlesewsky (2005), the reason behind this difference in the N400 amplitudes is that when the first NP appears as a nominative-marked agent, it fulfills the subject-first hypothesis and thus the second nominative NP is readily overlooked in double nominative violations. However, when the initial NP is marked with the accusative case, it is already in conflict with the same subject-first hypothesis. In sum, they concluded that the processing of these violations at the second NP is expectation-driven, and disconfirmed expectation of a certain case morphology acts as a source of N400 modulation, as both semantic and morphological expectations are rooted in a particular lexical choice.

Another variable component preceding the P600 in phrase structure violations is enhanced left anterior negativity (LAN) with a maximum between 300 and 500 ms after word onset. It occurs as a reaction to morphological and morphosyntactic violations, for instance verb-tense, verb argument, gender or case violations (see Coulson, King, & Kutas, 1998)[13]. Also, it has been discussed in conjunction with working memory processing load (Kluender & Kutas, 1993). It could be shown in numerous languages, but its occurrence depends on the degree to which a certain language utilizes morphological cues for encoding syntactic relations as in thematic role assignment (e.g., a scrambling negativity in response to object-initial arguments in German, which are supposed to be non-canonical, complex structures, see Schlesewsky, Bornkessel, & Frisch, 2003). As a consequence of the biphasic pattern of the LAN and P600, it is then assumed that after initial detection of syntactic errors

---

[13] Coulson et al. (1998) found a LAN/P600 pattern in adults processing case violations on pronouns in English (e.g., *the plane took *we to paradise and back*), in contrast to the biphasic N400/P600 pattern observed in case violations in German. Moreover, a LAN-N400-P600 pattern was further found for the combination of number and case violations while a LAN-P600 effect was found only for number agreement violation in German speakers (Roehm, Bornkessel, Haider, & Schlesewsky, 2005).

(LAN), the P600 reflects controlled processes of syntactic reanalysis and repair (Hahne & Friederici, 1999).

Within the traditional functional dichotomy in the cognitive neuroscience of language, transient LANs are often taken to index rule violations, whereas centro-parietal negativities (N400) are typically viewed as correlates of non-rule-based, lexically stored information (for an overview, see Kutas & Federmeier, 2000). As an illustration, the ERP study by Weyerts, Penke, Dohrn, Clahsen, and Münte (1997) observed LAN effects when an irregular noun stem was illegally combined with a regular plural suffix (-s) in German (e.g., *Bärs vs. Bären, 'bears'). By contrast, the combination of a regular stem with an irregular plural suffix (-en) produced an N400 (e.g., *Wracken vs. Wracks, 'wrecks'). To summarize, this overapplication of a morphological rule as in "regularized" irregular words correlates with the LAN effect, while the N400 in "irregularized" regulars can be interpreted as these words being treated like pseudowords that do not have any entry in the mental lexicon and thus are non-decomposable (see Choudhary, Schlesewsky, Roehma, & Bornkessel-Schlesewsky, 2009). This classical functional interpretation of LAN and N400 effects, which intertwines the notions of purely formal or rule-based, contrasting with non-rule-based or semantic aspects of linguistic knowledge, has been challenged by the findings of Choudhary et al. (2009). They found "rule-based" N400s" engendered by interpretatively relevant rule-based information (e.g., subject case marking in Hindi). Their results further provide a first indication that P600s are highly sensitive to rule exceptions and can only occur in response to principled incompatibilities between grammatical features such as case and aspect (i.e., in the ergative-imperfective condition, the negativity was accompanied by a broadly distributed positivity). On the basis of the finding that an N400 was observed in both types of subject case marking violations (i.e., the default rule, nominative case assignment, and the non-default rule, ergative case assignment), these authors argued that this dichotomy between rule-based or syntactic/morphological and lexical or semantic information needs to be revisited and refined. Thus, they supported the extension of the “rules vs. lexicon” distinction to a tripartite system in which rules are split up. In another study on ergative alignment by Díaz et al. (2011), N400 signature in Hindi could not be replicated in Basque. This difference between two studies can be attributed to Díaz et al.’s materials which did not induce any semantic difficulty in the NPs that were always correctly ergative case-marked. Nevertheless, their results resemble those of previous studies on double nominative markers (Frisch & Schlesewsky, 2001, 2005; Mueller, Hahne, Fujii, & Friederici, 2005; Mueller, Hirotani, & Friederici, 2007). From this perspective, the finding of equivalent ERP signatures and thereby neural computations engaged in the detection of case-marking violations, regardless of the alignment type of the language (i.e., nominative-accusative vs. ergative) highlights a common thematic structure across languages.

1.3.3 Case-marking in L2 morphosyntactic processing

So far, case marking has received little attention in ERP research on nonnative sentence processing. One good example comes from Mueller et al.’s (2007) study on a miniature version of Japanese (Mini-Nihongo), which examined word order variation, double nominative and double accusative violations. In their study, a biphasic N400-P600 distribution was elicited for double nominative case violation in native Japanese speakers, whereas N400 was missing in German learners trained to the highest proficiency level. These findings imply that native Japanese speakers use case for syntactic analysis (P600) and the thematic ranking of arguments (N400), whereas the non-natives resort to a shallower strategy of processing case markers according to their phonological salience. As a consequence, they seem to rely on the phonologically salient nominative case marker to a large degree, rather than the less saliently marked accusative form. Despite the similarity of N400 effect in timing between double nominatives and accusatives, Mueller et al. (2007) showed that the typographical distribution of the negativity was different in each subject group. It was broadly distributed in native Japanese speakers, while it was anteriorly focused in the learners, which resembles syntax-related negativities, i.e., LAN. Finally, it is worth noting that the comparable N400 effect in the L1 group evoked by both double nominative and accusative case violations in this study was in a conflict with the asymmetry in Frisch and Schlesewsky's (2005) study, where double accusatives led to an amplitude enhancement for N400, in comparison to double nominatives in German. Mueller et al. (2007) related enhanced N400 in Frisch and Schlesewsky's study to thematic markedness of accusatives and the word order, NP-V-NP, in German, rather than NP-NP-V in Japanese, as the prior presence of the verb may induce stronger thematic requirements for the upcoming arguments.

As shown by this ERP study on the comparison of L1 and L2 case processing, even very advanced L2 learners may fail to recruit case information in constructing an incremental representation of the sentence. In particular, when L2 acquisition starts later in life, the acquisition of inflectional morphology becomes even more difficult (Johnson & Newport, 1989). The most comprehensive evidence for this difficulty comes from behavioral research, though the findings are mixed. Some studies have reported native-like processing strategies, rather than dependence on linguistic awareness such as analytical thinking or reasoning, in L2 case processing, while others have shown that it is inherently different from the strategies of native speakers (e.g., Hopp, 2015). In respect to the major question of to what extent and under what circumstances late L2 speakers can show native-like patterns in case processing, a number of factors have been suggested to play a role: proficiency level (Jackson, 2008), the extent of overlap between L1 and L2 (Hopp, 2010), and case features in question (Hopp & León Arriaga, 2016).

For example, Hopp (2015) reported that L2 learners of German, regardless of their proficiency level, are not susceptible to case marking in an eye-tracking study in the visual world paradigm, where listeners are supposed to make anticipatory eye movements to upcoming referents (i.e., thematic patient or agent), based on the first nominative or accusative marked noun. Accordingly, this finding suggests that even highly proficient L2 learners, who are assumed to possess explicit knowledge of crucial grammatical features (e.g., the German case system flagging the word order), have difficulty in processing the functional role of case markers in sentences and accordingly may still rely on lexical-semantic information, rather than morphosyntax, during L2 sentence parsing (see Clahsen & Felser, 2006, 2017). Likewise, Jackson (2008) found that at lower proficiency levels (i.e., intermediate), learners of German adopt semantic-based strategies, in which all else being equal, they tend to interpret the first noun they encounter as the grammatical subject of the target sentences in a timed comprehension task. On the other hand, advanced L2 learners of German were found to rely more on structural cues (e.g., case markings) for determining the agent in a sentence, especially in sentences with a simple tense form, such as present tense rather than present perfect tense, where lexical semantic information of the verb is not accessed until the end of the sentences (e.g. Welche Ingenieurin hat der Chemiker gestern getroffen? ‘Which engineer has the chemist met?’). All in all, these studies indicate that target-like use of functional morphology across all sentence structure types stands as a tremendous challenge for adult L2 learners, despite their increasing proficiency.

In another study, Hopp (2010) pointed out the defining role of the availability of the target grammatical structure (i.e., case) in L1, such that L1 Russian learners of German whose L1 uses case marking for syntactic function assignment incorporated case in online processing already at advanced proficiency levels. There is growing evidence to indicate that late L2 learners whose L1 does not instantiate case marking or exhibit only vestiges of case marking do not process case in L2 in a native-like manner (e.g., over-reliance on word order by L1 English learners of German as reported in Kilborn, 1989). Yet, there is also evidence that near-native L2 learners are more attuned to the relative strength of case features even in their absence in their L1 grammar (Hopp, 2006). In a self-paced reading study with groups of advanced and near-native L1 English and L1 Dutch learners of German, Hopp (2006) noted that only at near-native proficiency levels, could both learner groups use case markings on determiners of nouns for syntactic function assignment. For thematic assignment in scrambled sentences with ditransitive constructions (e.g., accusative, dative or accusative-dative scrambling), Mitsugi and MacWhinney (2015) reported the use of surface cues, that is, case markers (i.e., cue-based strategy) by both Korean and English learners of Japanese, as well as no RT difference among the conditions, independently of the subjects’ linguistic background.

In pursuit of probing the conditions for the mastery of case marking in adult L2 sentence processing, intrinsic case features have also been found to be central moderators, such that structural case processing based on particular roles in a sentence, can be more target-like than non-structural (i.e., either inherent or lexical) case processing (Hopp & León Arriaga, 2016). In their eye-tracking study with German nonnative speakers of Spanish, Hopp and León Arriaga found that the nonnative speakers, unlike the native speakers, showed processing slowdowns only in response to violations of structural case marking with ditransitive verbs, but not to the erroneous realization (i.e., omission) of differential object marking (DOM) with transitive verbs (e.g., *a* in *Juan vio a la mujer*, “Juan saw the woman”), even though they could differentiate between grammatical and ungrammatical sentences in off-line acceptability judgments.

Taken together, previous findings on the L2 processing of case in ambiguous as well as ungrammatical sentences highlight the fact that target-like processing of case can rarely be observed even at the highest proficiency levels (Hopp, 2015), and can be moderated by L1 (Hopp, 2010), intrinsic features of case (e.g., salience and markedness associated with case type, see Mueller et al., 2007), violation type and task (Hopp & León Arriaga, 2016). In a similar vein, the previous self-paced reading (SPR) study (Karatas, Gor, & Lau, in preparation) also indicates that nonnative speakers do not react to morphosyntactic incongruence related to case marking during L2 comprehension. The study showed that even though L2 learners of Turkish were highly proficient and had large amounts of exposure to Turkish, they often did not recognize case violations (i.e., the substitution of the accusative or the dative on the nominalized object and the omission of the genitive on the embedded subject), across the accusative- and dative-assigning verb conditions. These results confirm that the problems with case marking processing are persistent and may not be affected so much by some of the explanatory factors listed above, demonstrating the difficulty of case acquisition by late L2 learners. In sum, our study proves that nonnative speakers' processing of case markers in online reading differs from native speakers' both quantitatively and qualitatively (for similar results, see Hopp, 2015).

Given that L2 learners may not have the computational capacity or attention to identify the case errors in an embedded structure with Turkish inflectional markings belonging to a complex paradigm (see Karatas, Gor & Lau, in preparation), the current study focuses solely on one type of error, that is, substitution of the accusative or the dative on the object for one another, in less complicated structures without any embedding or nominalization. Building on this previous SPR task, the present ERP research aims to examine whether those differences in behavioral outcomes of case violation processing across subject groups will also mirror deviant neural processes in the advanced L2 learner group. To our knowledge, this is the first study which examines the neural responses to L1 and L2 morphological processing of different case forms in a sentence (e.g., nominative, genitive, accusative and dative, based on specific comparisons, see Chapter 2). It further compares L1 and L2 sensitivity reflected in distinct neural responses[14], to the morphosyntactic processing of case violations (i.e., substitution of the accusative for the dative or vice versa) within a single ERP design.

[14] Based on the variable characteristics of the LAN and N400 components even in native sentence processing, we will consider the P600 to be the primary measure of native-like sensitivity to case violations, although we will report findings in the time window associated with the LAN/N400 (300-500 ms after critical verb presentation) as well.

1.4 Case-marking in Turkish

Turkish is a head-final language, in which the head always follows its complements, such that objects precede verbs, NP-complements precede their nominal heads, and so on. Given this typology, the basic constituent order in Turkish is subject-object-verb (SOV) (Erguvanlı, 1984). Yet, unlike English, where the syntactic function of a phrase is largely determined by the order of constituents, Turkish is a non-configurational language, where word order is relatively flexible, and accordingly, morphology is the core marker of grammatical relations.

Turkish is an agglutinating language where a single inflection corresponds to a single dimension and a multi-dimension paradigm can be built by combining inflections additively in a transparent way (i.e., the order of suffixes is fixed) in both verbal and nominal clauses (Lewis, 2000). In nouns, the category of case is identified with a certain set of suffixes which display several allomorphs, as conditioned by significant consonant assimilation and vowel harmony (i.e., the vowel of the suffix agrees with the stem in terms of frontness, and in some cases roundness as well, for detailed information on the grand vowel harmony in Turkish see Göksel & Kerslake, 2005). For an illustration of the six distinct case marking paradigms that Turkish distinguishes (Kornfilt, 1997; Göksel & Kerslake, 2005), along with their corresponding allomorphs, see below (the case markers of interest in the present study are marked in bold):

- **Nominative –∅,**
- **Accusative –(y)I → -(y)i, -(y)u, -(y)ı, -(y)ü,**[15]

[15] The consonants in parentheses, -/y/ in the accusative or the dative allomorphs, appear when the preceding stem ends in a vowel (e.g., *ayna+yı* "mirror+accusative" in the direct object position), as two

- **Dative –(y)A → -(y)a, -(y)e,**
- Locative –DA,
- Ablative –DAn,
- **Genitive –(n)I(n) → -(n)in, -(n)un, -(n)ın, -(n)ün**[16]

In Turkish, subjects of main clauses are assigned the nominative case, which is marked with the default null formative, whereas subjects of embedded nominalized clauses and possessors of nouns are marked in the genitive case. The case marking borne by the function of a direct object is typically expressed with the accusative. The dative, by contrast, is used with indirect objects, bene-/malefactives, and to express goals. In summary, the choice of the object case in Turkish is clearly governed by the verb. Based on the standard case distinction within the Generative orientation (Chomsky, 2000), Turkish nominatives, genitives and accusatives stand as structural cases, as they depend on structural configurations and relations for their licensing, and Turkish datives stand as a non-structural or lexical case, as they are semantically licensed by the idiosyncratic root of the verb. Unlike unmarked structural cases, lexical cases are unpredictable, as licensed by individual verbs, and semantically non-transparent, as they are not systematically linked to a thematic role (Neeleman & Weerman, 1999; Woolford, 2006).

---

vowels together are not allowed in Turkish, while the bare form of allomorphs including only the vowel appears when the preceding stem ends in a consonant (e.g., *defter+i* "notebook+accusative").

[16] In Turkish, possessive marking is fused with case marking (i.e., the accusative, dative and genitive case). In this sense, noun inflections are syncretic and polyfunctional. For example, in the genitive allomorphs, the consonant in parentheses, -/n/, also appears when the preceding stem ends in a vowel. However, it creates a homonymy at the same time, such that /-n/ can be interpreted as the second person possessive marker with its genitive-inflected pronoun, "your", dropped, and /-In/ as the genitive marker (see Chapter 2 to learn how this homonymy in the experimental items was ruled out). If the word ends with a consonant, then ambiguity arises, and /-In/ can be interpreted either as the possessive or the genitive case marker without any context.

1.4.1 Case-marking in L1 and L2 Turkish

Despite this rich and complex case system in Turkish, they are acquired very early by monolingual Turkish children (Aksu-Koç & Slobin, 1985). In their longitudinal data on the emergence of the nominal case morphology, Topbaş, Maviş and Başal (1996) showed that the genitive case is used very frequently at early ages and the dative, along with the accusative case, emerge at around 15 months, followed by the locative and the ablative case (see also Sofu, 1989). Thus, by the age 23 months, monolingual Turkish children were able to produce all case markers. In contrast to this relatively easy and rapid L1 acquisition of Turkish case morphology, L2 learners show variability in the use of case marking in speech. To our knowledge, the acquisition of case by L2 learners of Turkish has been examined only in a few studies (Altunkol & Balci, 2013; Gürel, 2000; Haznedar, 2006; Aydin et al., 2016; Papadopoulou, Varlokosta, Spyropoulos, Kaili, Prokou & Revithiadou, 2011).

Most of these studies have focused on the problems encountered and errors made in the usage of case morphemes by L2 learners of Turkish. For example, Gürel (2000) found that L2 learners at different proficiency levels (i.e., beginner, intermediate, advanced) committed more omission errors than substitution errors in a picture description task (see Papadopoulou et al.'s study for similar results in a cloze task). She also found that these learners did not accept the ungrammatical non-specific non-adjacent objects[17] at a high rate, pointing to their sensitivity to word order constraints. In line with these findings, Haznedar (2006) reported that an English-speaking learner of Turkish was aware of word order restrictions, as he

[17] Non-specific direct objects and subjects with "dropped" structural case in Turkish are confined to the position at the immediate left of verbs.

correctly assigned case markers to scrambled objects. Her spontaneous production data (6 recordings) from an individual learner during his five-month stay in Turkey also showed that the use of verbal suffixes (e.g., Tense and S-V Agreement) could be intact and correct, albeit a very low performance in case markings other than the nominative case was observed, which implies a deficit at the syntax-morphology interface rather than the syntactic module per se. Another evidence for L2 difficulty in the Turkish case system comes from a recent work by Aydin et al. (2016) on the neural correlates of subject case and subject-verb agreement processing. Their study revealed different ERP components for case violations, whereas native-like brain processing mechanisms in the L2 group with a high-intermediate proficiency were observed for agreement violations in non-finite clauses. The finding of qualitative differences between native and nonnative case processing was also attributed to the distance or divergence between L1 of L2 learners and Turkish (e.g., they did not have genitive subjects in their L1).

The current study goes beyond the distribution of case errors in L1 and L2 Turkish sentence production or the effects of proficiency and L1-L2 distance on case violation processing and tries to explore how these case markings are first processed in single words and then in sentences. Building on the previous self-paced reading (SPR) task results, it tries to understand whether the case type (i.e., structural vs. lexical or citation vs. oblique) and its use of frequency or status within the inflectional paradigm modulates their morphological processing cost during lexical access by native speakers and highly proficient L2 learners whose L1 does not present a rich case system. Then, it compares the morphological processing patterns of the same oblique-case forms (i.e., the accusative, dative and genitive), along with the nominative, in a sentence context. In addition, it examines broadly whether native and nonnative comprehenders process case errors in a similar or different way, and more specifically whether their sensitivity is modulated by the type of substitution errors across structural and lexical case markings. In what follows, we propose the first ERP study where the behavioral and neural bases of case processing at the morphological and morphosyntactic levels are compared between native speakers and advanced L2 learners of Turkish.

Chapter 2: L1 & L2 case processing in isolated words

2.1 Overview

The study set out to explore what challenges L2 learners face in mastering the L2 case system and using it in comprehension. Within the realm of the morphological processing of different case markings, the first ERP experiment examines the time course of visual word recognition using a lexical decision paradigm, which allows us to compare the processing difficulty associated with different case markings. As such, it capitalizes on the idea that differences in behavioral and ERP responses will reflect differences in morphological processing costs (see also Lehtonen & Laine, 2003; Portin et al., 2007b). By measuring both behavioral and ERP correlates, the study allows us to check whether lexical decision responses (RTs and ARs) parallel neural responses (N400 amplitudes). Based on the previous self-paced reading (SPR) study (Karatas, Gor, & Lau, in preparation), it addresses four separate comparisons between case-marking, which attribute differential costs in case processing to a) structural (i.e., genitive, accusative) vs. lexical (i.e., dative) case dichotomy; b) argumenthood (i.e., argument: accusative, dative vs. non-argument: genitive); c) type frequency (i.e., high type frequency: genitive vs. low type frequency: accusative, dative), and finally the citation (nominative) vs. oblique-case form (genitive, accusative, dative) distinction. The relevant comparisons are discussed in the following subsections below.

2.1.1 Background and Motivation

The SPR task in the previous study had found a significant effect of case marking on the processing of the embedded nominalized object by advanced L2 learners, not native speakers, such that the dative case led to longer reading times than the accusative. This finding gave birth to the assumption that these differential patterns in morphological processing of these two case forms may be associated with the differences in their intrinsic features, such that the dative case is more marked and less frequent than the accusative (Neeleman & Weerman, 1999; Woolford, 2006). Yet, the complexity of the sentence structure (e.g., embedded clause with an inflectionally complex nominalized verb which used three different affixes) may have increased this difficulty in the learners' processing and judgments of the sentences with the dative case. Altogether, it is unclear whether L2 learners' difficulty with the dative case was at the level of form (i.e., which marker to use) or sentence structure and the syntactic role of case-inflected words within a sentence. Therefore, the first experiment in the present study, which is the simple lexical decision task (LDT), set out to disentangle the morphological processing costs associated with different case markings on isolated nouns, which fall into two distinct case types: structural (accusative and genitive) vs. lexical (dative) case.

Another interesting finding from the previous SPR study comes from the processing of the subject, such that the genitive case on the embedded subject led to much longer RTs (300-400 ms more) than the nominative case-marked subjects of the main clause. From the perspective of morphological processing, the reasons for this increased RTs on the genitive-inflected subject can be three-fold:

- Overt morphology: Compared to the nominative case (no overt morphology), the genitive case morpheme presents an additional processing cost.
- Argumenthood: Compared to the nominative case (subject of main clauses), the genitive signals that the noun is not an argument of the verb.

- Type frequency: Compared to the nominative case (citation form), the genitive case displays relatively lower type frequency within the inflectional paradigm.

In particular, the hypotheses that ascribe the processing cost of the genitive case to the presence of overt morphology and lower type frequency are likely to hold true even during the lexical access of isolated nouns without any sentence context. It should be noted that in the present study, the second hypothesis on "argumenthood" and the third one on "type frequency", along with the structural and lexical dichotomy, have been applied only to the oblique-case conditions, excluding the nominative case, which was used as a control or baseline condition to check for decomposition during word recognition[18]. The four main comparisons of interest for the morphological processing of different case forms in isolated nouns are as follows:

1. *Structural case (genitive, accusative) vs. lexical object case (dative)*
2. *Argument (accusative, dative) vs. non-argument (genitive)*
3. *Higher type frequency (genitive) vs. lower type frequency (accusative, dative)*
4. *Citation form (nominative) vs. oblique cases (genitive, accusative, dative)*

Importantly, Comparisons 1-3 are justified because the mean surface frequencies of these oblique-case inflected nouns are balanced (see Table 3). However, it is still worth mentioning that the genitive nouns in Turkish display a higher functional load, as they can be interpreted as encoding both possessive

[18] It is also crucial to note that a standard format of a LDT may bias readers' expectations towards the nominative, that is the citation form, which is used as a self-standing word in isolation, and may disfavor the use of an oblique case-inflected noun (e.g., a genitive-inflected possessor without the fortcoming possessed noun, or an accusative- or dative-inflected object without their following, corresponding verb). In order to mitigate this advantage of the nominative nouns in not generating any expectations for the upcoming word as well as its considerably high type frequency, the nominative condition in the current LDT consisted of low-frequency nouns with different stems than in the other critical case conditions (see the Materials section for more details on the inclusion of the nominative case as a baseline condition).

meaning and case (for the detailed description, see Materials section below). As an indicator of their functional load, they have the highest type frequency among other oblique-case markings in Turkish, which may bear an effect on the behavioral and ERP responses accordingly. As for Comparison 4, due to the high frequency of the nominative case in the inflectional paradigm and thus impossibility to balance the surface frequencies of the same noun form across the nominative and the oblique case conditions, low frequency nominative (bare) nouns with different stems were used to to create a control condition for word decomposition. As a result, the study remains agnostic to the claim about the distance of these oblique cases, especially the genitive case, from the citation form in terms of the processing load. Note, however, that this LDT is not designed to specifically test the existence of morphological decomposition. Rather, following the study by Gor and colleagues (2017a), it expects morphological decomposition in lexical access[19]. In other words, it assumes that if noun forms inflected in three oblique cases, which are matched for length and surface frequency, yield differential processing costs, they cannot be attributed to the lexical properties of these nouns, which were controlled, but rather to the processing costs of different case markings, which are available as a result of decomposition. Consequently, building on the findings and the methodology from two studies devoted to native and nonnative processing of case-inflected nouns (Gor et al., 2017a; 2017b), the present study uses the decompositional account as a framework[20] (for a

[19] One caveat is that the study does not a priori rule out the possibility of whole-word access, considering that especially in visual processing, when the entire word is available, it is conceivable that the processing begins with the stem and inflection at the same time. However, in this LDT experiment, non-inflected counterparts of the critical items have not been used; therefore, no strong argument can be made for whole-word storage of inflected words in the mental lexicon.

[20] As shown by Gor et al. (2017a), the efficiency of decomposition during L2 word processing is contingent on the proficiency level, such that low proficient L2 learners may not go beyond affix stripping, and this underuse of recombination and checking mechanisms can hinder their access to

discussion of models of morphological decomposition, also see Portin et al., 2007a). Yet, it is important to highlight that the study cannot include the nominative condition within Comparison 3, as it is the citation/bare form in Turkish, with the highest type frequency, which would make its comparison with other oblique cases confounded and hard to tease apart with Comparison 4.

To summarize, the purpose of the first experiment is to establish the level of difficulty in processing of different case markings in a single-word presentation. Based on the above comparisons, it is expected to shed light on the possible locus of differential processing costs across native and nonnative speakers. Below, the relevant research questions and hypotheses of this visual LDT are discussed through behavioral and electrophysiological correlates for these differential processing costs.

2.2 Experiment 1: Lexical decision for case-inflected words in isolation

2.2.1 Experiment 1: Research questions and hypotheses

Experiment 1 utilizes a visual LDT while recording EEG in order to address the following research questions regarding native speakers' and advanced L2 learners' behavioral and neural responses to Turkish words inflected with different case markers.

(1) *a. Are native speakers sensitive to the morphological structure of case-inflected nouns in isolation? b. If yes, are they also sensitive to the properties of the case form and its status in the inflectional paradigm?*

morphosyntactic information. However, the current study recruits only highly-advanced L2 learners, expecting them to access more than just the lexical meaning of the stem.

(2) *a. Are advanced L2 learners sensitive to the morphological structure of case-inflected nouns in isolation? b. If yes, are they also sensitive to the properties of the case form and its status in the inflectional paradigm?*

(3) *a. Does the sensitivity to the morphological structure of case-inflected nouns in isolation differ across native and nonnative speakers? b. If yes, does the difference concern the sensitivity to the properties of the case form and its status in the inflectional paradigm?*

Question (1) investigates whether native speakers of Turkish are engaged in differential processing costs during the online visual recognition of different types of case-inflected nouns, and if yes, whether their processing costs, as indexed by behavioral (i.e., RTs and ARs) and ERP (i.e., N400) measures, vary depending on the intrinsic properties of the case form, such as its type (structural: genitive, accusative vs. lexical: dative), its argumenthood (argument: accusative, dative vs. non-argument: genitive), its type frequency (higher type frequency: genitive vs. lower type frequency: accusative, dative) and the distinction between the citation and oblique-case forms within the inflectional paradigm (see Comparisons above). Based on previous research (Gor et al., 2017a), we predict that in native speakers the processing costs will differ between different case-inflected nouns; however, the actual pattern or direction of this case-processing difficulty can only be determined empirically and further explained by the relative relevance of the above parameters related to the case form features. At this point, it is important to highlight the fact that we are also exploring this new testing ground of morphological processing, as there is no prior research on the comparison of the processing costs across these three oblique-case markings, namely the genitive, accusative and dative, across native and nonnative speakers. On this note, based on the understanding of morphological processing as decomposition with subsequent recombination and checking of the inflected form (Gor et al., 2017a), specific predictions are tied to the four main comparisons of interest below.

If Comparison 1 holds true, native speakers will show decreased difficulty, associated with shorter RTs and higher ARs, for structural case markings, as they are less marked and more frequent. Parallel to these behavioral predictions, ERP responses are also expected to indicate a strong modulation of N400 amplitudes (Leminen & Clahsen, 2014) across these conditions, such that the structural genitive and accusative case markings should elicit a reduced negativity in late (300–450 ms) time windows, relative to their dative counterparts, because they are predictable case forms. If Comparison 2 holds true, the accusative and dative case markings will yield lower processing costs than the genitive, because the former two case types are marked on the objects, i.e., serve as verb arguments. If Comparison 3 holds true, the genitive will produce lower processing costs, because it has the highest type frequency among the oblique cases in the Turkish inflectional paradigm (see Bilgin, 2016). Comparison 4 can hold true, independent of the first two comparisons, and if it does, the nominative case form will yield the lowest processing cost, compared to the oblique-case forms, because the nominative case is the citation form of a Turkish noun. On the other hand, if none of these comparisons hold true, then there will not be any difference in behavioral (i.e, RTs, ARs) and ERP (N400 amplitudes) measures during the lexical access of these case-marked nouns.

Question 2 asks whether advanced L2 learners are engaged in differential processing difficulties during online recognition of case-inflected nouns belonging to the same lemma, and if yes, it examines whether their processing difficulty will change across the different case markings in accordance with the above comparisons. Question 3 asks whether these advanced L2 learners process the case-marked nouns in the same way as native speakers. If they do, they are expected to decompose them and show differential costs during their processing (see the data supporting a developmental trajectory in L2 learners of Russian, who show larger processing costs for oblique case forms at higher proficiency levels in Gor et al., 2017a). It is also possible that L2 learners of Turkish will not show any differential sensitivity to the case form features even though they engage in the initial stage of decomposition, aka affix stripping. This will be the case if they do not morphologically process recombined word forms for case as lower-proficiency L2 learners of Russian did (see Gor et al., 2017a). Or unlike native speakers, they may not be sensitive to the morphological structure of these case-marked nouns at all (see Kirkici & Clahsen, 2013). Under this "no decomposition" account, they are expected to show no difference in RTs, ARs, and N400 amplitudes between the processing of the nominative and oblique-case forms, which in return revokes Comparison 4. However, the current study will not be able to distinguish between the two accounts for L2 lack of sensitivity to overt case inflections through non-/decomposition due to the different stems in the nominative condition.

2.2.2 Experiment 1: Participants

72 participants (39 native speakers, 18 female; 33 nonnative speakers, 9 female) took part in the study (see Table 1). Prior written consent was obtained from all participants according to the established guidelines of the Institutional Review

Board of the University of Maryland. Only two nonnative speakers were left-handed, as assessed by the Edinburgh Handedness Inventory (Oldfield, 1971), but the rest of the participants were right-handed with normal or corrected-to-normal vision and without any neurological or language impairment. All participants were debriefed about the purpose of the study and received monetary compensation for their participation at the end of the study.

At the onset of the study, a demographic and language background questionnaire in Turkish (for native speakers) and in English (for nonnative speakers) was completed. Native speakers provided some demographic information (e.g., age, sex, education level, etc.) and stated their proficiency level in languages other than Turkish. Special attention was paid to select native speakers among college students majoring in non-language-related disciplines, such as Medicine, Engineering or Business, at local universities in Istanbul, where the medium of instruction is Turkish. Most of the native speakers were undergraduate students, and only four of them were graduate (Master) students. In addition to Turkish, they also knew some other languages, such as English, French, German, Italian, Spanish and Russian, but even though they were exposed to English, which is the most well-known foreign language, for an average of 11 years, most of the native speakers self-rated their English proficiency level either as beginner or intermediate across all four skills. Only seven of them rated it as advanced. These low self-ratings can be attributed to the fact that most of them sometimes or rarely used English in their daily lives and have never been to an English-speaking country. It is important to note that this study was their first experience of participating in an EEG experiment; therefore, they were all very highly motivated.

The current study was restricted to highly proficient L2 learners of Turkish whose L1 did not display a rich case system, specifically, L1 speakers of English, French, Spanish, Portuguese, Arabic, Farsi, or some African languages (i.e., Bambara, Hausa, Lugisu, Yoruba, Fula, Somali)[21]. At the time of testing, L2 participants were studying at public universities in Istanbul, where the medium of instruction is Turkish. The learners' average age of first exposure to Turkish was 19, and only five students started learning Turkish at the age of 15 in their high schools. In general, the students had been learning Turkish for an average of 6 years and were using it on a daily basis at home, work or at school with friends. Most of the L2 participants took the standardized Turkish proficiency test (STPT) administered at Istanbul University Language School or at TÖMER (Turkish Language Teaching, Application and Research Center) at the end of 9 months of preparatory year, which was solely based on Turkish learning, and they passed it with an average score of 85, out of a maximum score of 100 (for the overall distribution of these Turkish learning characteristics, see Table 2.1). Through this language background questionnaire, data were also gathered as to self-ratings of their Turkish proficiency across all skills. Except for two students, who rated their proficiency level in Turkish as near-native, most of the students rated their level as advanced. As for additional foreign languages, most of the L2 learners knew a second, third, fourth or even a fifth foreign language (i.e., Arabic, Chinese, English, Farsi, French, German, Spanish, Urdu) with proficiency levels ranging from beginner to near-native. It is again important to note that this study was their first experience of participating in an EEG experiment and

[21] These African languages listed above have been documented not to display a rich or an extensive case system as in Turkish, as retrieved from the large database, namely the World Atlas of Language Structures (WALS).

given that they were living in a foreign country, i.e., a less familiar environment, they were a little anxious about the procedure.

Table 2.1. Participant profile.

Group	Gender (n)	Mean Age (Range)	Mean Age of First Exposure (Range)	Mean Length of Exposure (Range)	Mean STPT Score (Range)
L1 Turkish (n=39)	Female (18) Male (21)	21.05 (19–25)	-	-	-
L2 Turkish (n=33)	Female (9) Male (22)	25.33 (20–34)	19.30 (15–25)	6.12 years (4–13)	88.45 (85–99)

2.2.3 Experiment 1: Stimuli

The experimental stimulus set consisted of 360 items (120 critical case-inflected words, 60 fillers and 180 nonwords). 90 critical words shared the same noun stem inflected with three different types of case markings (i.e., genitive, accusative, dative, see Table 2.2), which were counterbalanced across three presentation lists (30 critical words per condition). Through this Latin-square design, the same stem-item appeared only once. 30 other critical nouns were in the nominative (non-overt case) form, which consisted of different lemmas than the ones in the other critical oblique-case conditions in order to match the mean surface frequencies of all four conditions. Fillers and nonwords were kept constant across lists. Thus, the number of words and nonwords added up to 360 items in each list.

Table 2.2. Stimulus examples for each experimental condition.

Genitive	Accusative	Dative	Nominative
ayna–nın	ayna–yı	ayna–ya	battaniye
mirror–GEN	*mirror–ACC*	*mirror–DAT*	*blanket*

Filler items were included in order to make the critical comparisons less obvious to test-takers. The fillers were composed of the following word categories: adjectives, adverbs and verbs. They were mostly marked with either derivational (e.g., *şeker–siz* "sugar-without") or inflectional (e.g., *götürdü* "(he) brought") morphemes. 120 nonwords had nonce stems that were produced by manually changing the three letters of the stem onset while adhering to the phonotactic rules of Turkish (see Rugg & Nagy, 1987). On the other hand, 60 nonwords had real-word noun or verb stems illegally combined with real-word inflections (e.g., **yarın–Iyor* "tomorrow–progressive marker"). Such a manipulation was expected to draw L2 learners' attention on stem-inflection mappings. Accordingly, processing costs for oblique-case inflected nouns were expected to emerge even more clearly (Taft, 2004; Gor et al., 2017a; 2017b).

Four experimental conditions (i.e., nominative, genitive, accusative, dative) were carefully matched for all major lexical factors that are assumed to influence the speed of word recognition. First and foremost, they were matched for their mean surface frequency[22] so that any observed differences between their processing costs would be solely attributed to the differences in the effort involved in the analysis of their morphological structure, which is referred to as the morphological processing cost. In addition, their average length in letters (ranging from 6-10 letters per word) and in syllables (ranging from 3-4 syllables per word) were balanced across all the

[22] Surface frequency is the occurance of a particular inflected form, whereas the stem/lemma frequency is the summed frequency of all the inflected variants of a word. There is no corpus displaying stem frequencies in Turkish. Therefore, only surface frequencies were measured as occurrences per million, as indexed by the Turkish National Corpus (TNC), which consists of almost 50 million words compiled from 4438 written databases, 9 domains and 34 genres between 1990 and 2009 (Aksan & Aksan, 2009).

cases (see Table 2.3). Statistical analyses of the surface log frequencies were conducted to ensure that differences between conditions did not approach significance. There was a statistically significant difference between conditions as determined by one-way ANOVA, ($F(3,296) = 4.12$, $p = .007$). The post-hoc tests using the Bonferroni correction as the p-value adjustment method to control for the family-wise Type I error rate across the multiple comparisons revealed the only statistically significant difference between the surface log frequencies of the nominative (1.91 ± 0.65) and accusative (1.09 ± 1.23) conditions. Lastly, the fillers and nonwords were matched to the critical words to the greatest extent in terms of their mean length in letters and syllables. Neither of these comparisons revealed any significant differences in letter-length (p>.05).

Table 2.3. Properties of critical nouns. Standard deviations are presented in parentheses.

	Conditions			
	Genitive	Accusative	Dative	Nominative
Mean surface frequency	11.47 (21.66)	7.03 (14.31)	8.30 (12.27)	8.16 (4.88)
Mean length (letters)	8.02 (0.94)	7.02 (0.94)	7.02 (0.94)	7.43 (0.63)
Mean length (syllables)	3.29 (0.46)	3.29 (0.46)	3.29 (0.46)	3.07 (0.25)

It is important to note that each case is characterized by its type frequency, or the frequency of occurrence of this particular case within the whole inflectional paradigm. As revealed by Bilgin (2016), the genitive case is the most frequent of the oblique cases in Turkish[23], followed by the accusative and dative case, but it is heavily functionally loaded, similar to the accusative case. The present study has tried to avoid the form ambiguity in the accusative condition by including only the words ending in a vowel[24]. Yet, it could not be avoided in the genitive condition, such that the first /-n/ in the genitive case marking *–nIn* can be interpreted as the second person possessive marker. At this point, Bilgin's (2016) disambiguated frequency analysis of the Turkish inflected nouns provides useful data, such that the genitive case remains the most frequent of the three oblique-case markings, probably due to the fact that homonymy increases the cumulative frequency, which should thereby reduce their processing costs. As a result, prior to finalizing the materials, a norming task in the form of Turkish-English translation with the genitive-inflected critical items was given to 15 native speakers of Turkish (all college students, similar to the target subject group) in order to ensure that they were preferably parsed as the forms including the genitive case only. To this end, 90 genitive nouns were distributed across five lists (18 genitive nouns per list), along with 18 other nouns in nominative, locative, ablative and instrumental case forms as well as 18 other words from different word categories, such as adjectives, adverbs, and verbs. Overall, the task results showed that all critical genitive-marked nouns were translated as a possessor noun, rather than a second person possessor noun.

[23] Bilgin (2016) listed the most frequent suffixes of Turkish, based on BOUN (Bogazici University) Corpus, which is a "web-corpus" including 491 million tokens from the web sources.
[24] When the word stems ending in a consonant are inflected with *–I*, it can be interpreted as either the third person possessive marker or the accusative case. However, since the former has a higher type frequency, *–I* is more likely to be understood as a possessive marker rather than a case marker. This form ambiguity in the accusative condition has been avoided by including only the word stems ending in a vowel in the experiment so that the accusative case morpheme will be *–yI* with the buffer /-y/ to separate the two vowel pairings.

Two weeks after the study, all 120 critical nouns with different case markings were given to L2 participants in an offline task, where they could mark the noun stem whose meaning they did not know. Through this computerized task interfaced with Google survey tool, L2 learners' explicit knowledge of the critical noun stems was obtained so that those unknown items could be detected and excluded from further LDT analyses.

2.2.4 Experiment 1: Procedure

Participants were tested individually in a faraday cage in the electro-neurophysiology laboratory, at Istanbul University, Faculty of Medicine (Capa). They were seated approximately 15" from the presentation screen on which stimuli were visually presented as white Arial letters in font size 50 against a grey background. Each trial began with a fixation cross appearing in the center of the screen to alert participants of the forthcoming item. After 1000 ms, a string of letters replaced the fixation cross, and participants then had to decide as quickly and as accurately as possible whether the string was a real Turkish word or not. They were explicitly told that words from different categories (e.g., nouns, adjectives, adverbs, verbs) and in different forms could be part of the stimulus set. They were instructed to press the right button on the response box with the right index finger (dominant hand) when the string was a word in Turkish, and to press the left button with the left index finger (non-dominant hand) when it was not a word in Turkish. The response hand was reversed for the two left-handed nonnative speakers. The stimulus remained on the screen until participants' response or timeout (4000 ms). Trials were separated by an inter-trial interval of 500 ms, which was followed by the fixation cross. In the meantime, participants were told that they could freely blink but throughout the word presentation, they were again asked not to blink (for an example trial, see Figure 2.1). The experiment was run by using the E-Prime 2.0 program (Psychology Software Tools, Pittsburgh, PA) that recorded participants' RTs (miliseconds) and the accuracy of their responses. The RTs were measured from the letter string onset to the pressing of the response key. The presentation of the experimental items in each list was pseudo-randomized, such that not more than three items from the same condition were presented consecutively. Each participant was randomly assigned to one of the three trial lists so that the lists were equally distributed across participants.

Prior to the experiment, a short practice session consisting of 12 trials (6 words and 6 nonwords) was presented, and oral feedback was provided by the experimenter to familiarize participants with the task more easily. The stimuli of the practice session were from different word categories and included some affixes, such as noun-derivational, locative case or tense markers, and they were not used in the main experiment. Including three brief breaks given after every 90 items, the stimulus presentation portion of the experiment took 20–25 minutes. All communication during the experiment both with native and nonnative speakers was in Turkish. At the end of the experiment, participants were given the language background questionnaire and served some (caffeine-free) snacks.

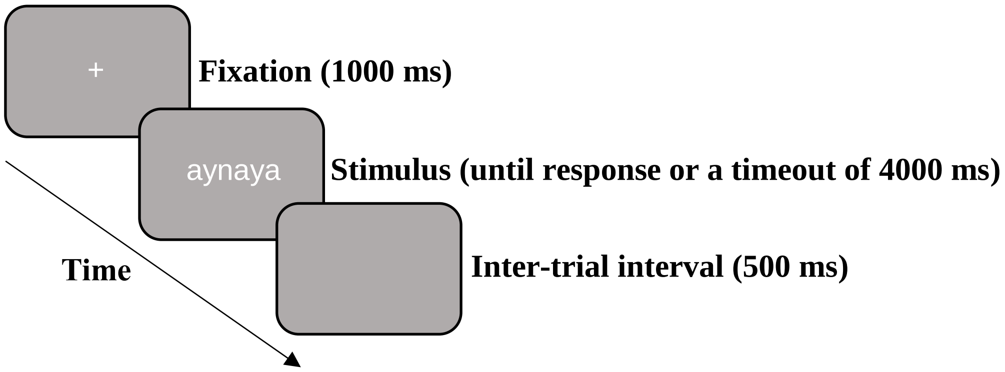


Figure 2.1. Illustration of the stimulus presentation sequence in a single trial.

2.2.5 Experiment 1: Electrophysiological recording

Thirty Ag/AgCl electrodes were held in place on the scalp by an elastic cap (EASYCAP, Brain Products GmbH) in a 10–20 configuration (O1, Oz, O2, P7, P3, Pz, P4, P8, TP7, Cp3, CPz, CP4, TP8, T7, C3, Cz, C4, T8, FT7, FC3, FCz, FC4, FT8, F7, F3, Fz, F4, F8, FP1, FP2). Vertical and horizontal eye movements were monitored from electrodes situated above the right eye and at the outer cantus of the right eye. All scalp electrodes were referenced to the average potentials of two earlobes. The ground electrode was also positioned on the right earlobe above the reference site (see Figure 2.2). Impedances were maintained at less than 10 kΩ for all scalp and ocular electrode sites and less than 5 kΩ for ground and reference sites. The EEG signal was amplified by the BrainAmp data acquisition system (Brain Products GmbH, Germany) with a bandpass of 0.1–250 Hz and was continuously sampled at 500 Hz by an analog-to-digital converter.

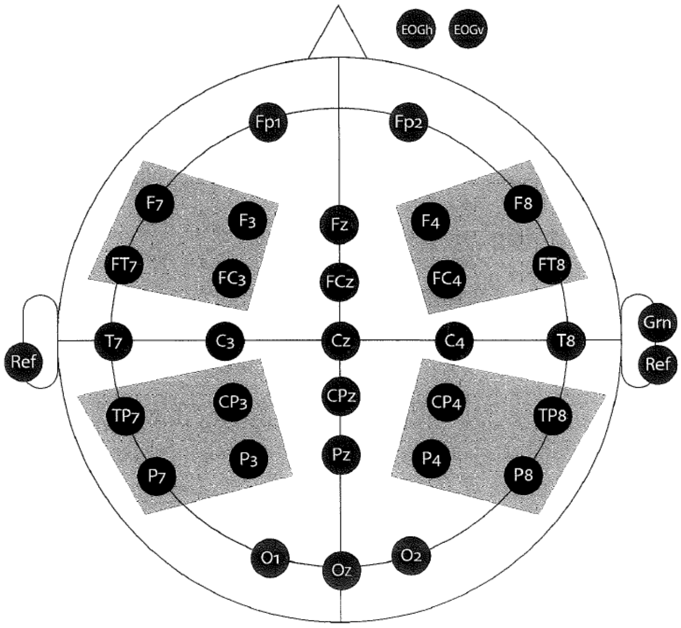


Figure 2.2. Electrode montage used in the study.
From "Non-native Syntactic Processing of Case and Agreement," by O. Aydin, M. Aygunes, and T. Demiralp, in A. Gurel (Eds.), *Second Language Acquisition of Turkish* (p. 63), 2016, Amsterdam/Philadelphia: Jessica Kingsley. Copyright 2016 by John Benjamins B.V. Reprinted with permission.

2.2.6 Experiment 1: EEG data processing

The EEG data were segmented into 600-ms-long epochs time-locked to the onset of the critical words (plus a 100 ms pre-word baseline). After baseline correction (-100 to 0 ms) and epoch formation, all trials were visually inspected and evaluated individually for artifacts using EEGLAB v14.1.2 (Delorme & Makeig, 2004) and ERPLAB v7.0.0 (Lopez-Calderon & Luck, 2014) running under MATLAB R2018a (MathWorks, 2018). Data from two L1 participants were excluded due to having more than 50% artifacts on experimental trials and some technical issues. Data from one L2 participant was also excluded due to a low accuracy rate (less than 80%). After excluding these participants, artifact rejection affected 5.30% of experimental trials (L1:3.90%; L2:6.92%).

Based on the clean data free of ocular and muscular artifacts and lexical decision errors, event-related potentials were obtained by averaging these epochs and applying a low-pass filter of 40Hz. Thus, single-subject ERPs were formed and filtered offline in order to be used to calculate the grand-average ERPs across all subjects. According to the visual inspection of grand average waveforms across all scalp electrodes, specific time window of interest associated with N400 was specified as 300-450 ms for both L1 and L2 data analysis.

Subject-level data for each condition baselined to the mean of the 100 ms baseline preceding the onset of the critical visual stimulus was exported for further processing in *R* (R Core Team, 2019). A single average amplitude was obtained for each critical condition for each electrode for each subject in a visual N400 window (300-450 ms). As suggested by the grand average waveforms, 450 ms was a reasonable end point to capture N400 effects, and sufficiently generous, such that it did not underestimate potentially slower L2 responses. Statistical analyses were performed on mean amplitude values on four regions of interest (ROI), each of which had four representative electrodes: left frontal (F3, F7, FC3, FT7), right frontal (F4, F8, FC4, FT8), left parietal (CP3, TP7, P3, P7), right parietal (CP4, TP8, P4, P8) (see Figure 2.2).

Finally, only trials that elicited a correct behavioral response (correct acceptance or correct rejection) were retained for final analysis. After all these steps, the final dataset contained 88,222 data points (94.71% out of total 93,153 data points: L1=96.1%; L2=93.08%).

2.2.7 Experiment 1: Behavioral results and statistical analyses

Reliability for the LDT accuracy data was high in general (α=.84). The following accuracy analyses included the data from participants with an accuracy rate (AR) above 80% in the whole item set. As a result, one L2 participant's data were excluded. In addition, three nominative nouns (i.e., *kiremit* "roof tile", *kurdele* "ribbon", *mıknatıs* "magnet") and three oblique-case marked forms of a critical noun (i.e., *ninenin, nineyi, nineye* of the bare form *nine* "nanny"), which showed less than 50% ARs in L2 group, were excluded from the entire L2 data set. Lastly, based on the unknown words detected through the offline task, fifteen trials were removed from the relevant subjects' data so that the data could be cleared of any accidental correct button presses. All of these exclusions comprised 2.99% of the critical trials. Descriptive results (Table 2.4) of mean accuracy suggest a very strong performance for both native speakers and L2 learners across different case-marked noun forms. For native speakers, ARs were almost at ceiling for the nominative and accusative case-inflected nouns (*means*=99%), whereas for L2 learners, dative case-inflected nouns yielded the highest AR (*mean*=96%). Figure 2.3 further visualizes these results across subject groups and conditions in box plots.

Table 2.4. Descriptive statistics for mean AR (%) and RT (ms) results of LDT (Experiment 1)

Subject Group	Condition	Mean AR % (SD)	Mean RT ms (SD)
L1 (n=39)	Nominative	99.32 (9)	645.50(156)
	Accusative	98.80 (11)	659.47(168)
	Dative	98.21 (13)	662.47(185)
	Genitive	98.29 (13)	688.12(195)
L2 (n=32)	Nominative	94.99 (22)	1014.11 (357)
	Accusative	93.98 (24)	1071.03 (407)
	Dative	95.57 (21)	1053.95 (392)
	Genitive	93.78 (25)	1185.62 (452)

A statistical analysis of these proportions of correct responses in the experimental trials was carried out using a logistic mixed-effects model (glm function, Jaeger, 2008), with *condition* (nominative, genitive, accusative, dative), *subject group* (L1 vs. L2) and their interactions as fixed effects. The within-subjects effect, *condition*, was dummy-coded so that different comparisons between these four case forms can be made by changing the reference level in *condition*. Based on the forward selection, item frequency and length were also added to the model as covariates, given the differences in surface frequencies and number of letters across words. These two continuous variables were first centered by subtracting the mean score from each data-point and scaled/standardized for possible model convergence problems or multicollinearity, and then entered into the model. At the end, the simple model with the random slopes of by-subjects and by-items intercepts only was the best-fitting model, as determined by model comparisons conducted through analyses of variance (ANOVAs). The maximal model with crossed random effects for subjects and items caused a singular fit, which suggests that the model is overfit and random slopes should be removed. In fact, participants were overall extremely accurate in this experiment, which makes estimating variance of a logistic effect across subjects harder or even unlikely. Therefore, fitting any of the random slopes of conditions, subject group or their interactions by subject and item leads to a singular fit, where the variance of one or more of those random slopes is estimated to be (nearly) zero.

Statistical analyses and data plotting were conducted using *R* (version 3.5.3, R Core Team, 2019), and in particular, the *lme4* package for mixed effects models (version 1.1-21) with the *bobyqa* optimizer (Bates, Mächler, Bolker, & Walker, 2019) and *ggplot2* (Wickham & Chang, 2012).

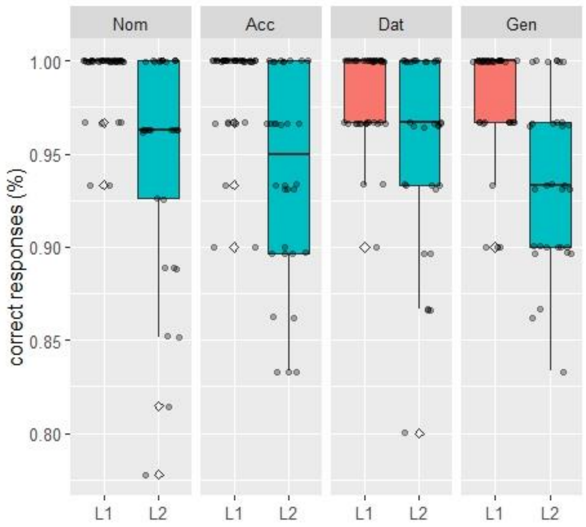


Figure 2.3. Boxplot of accuracy results for LDT (Experiment 1). Each circle indicates an individual participant's mean score. Diamonds indicate outliers.

As displayed in the model output Table 2.5, the analysis of the mixed-effects logistic regression revealed a main effect of subject group with significantly lower ARs for L2 learners, (β = -2.35, *SE* = 0.46, z = -5.08, *p* < .001). The model also showed significant main effects of item frequency, (β = 0.67, *SE* = 0.18, z = -3.65, *p* < .001), and item length, (β = 0.39, *SE* = 0.13, z = 2.99, *p* < .01). The first model with the nominative as the reference level revealed a significant decrease in AR for the genitive condition, as well as a marginally significant decrease for the dative condition in the native speaker group, (β = -1.34, *SE* = 0.50, z = -2.70, *p* < .01). On the other hand, L2 learners' ARs did not show any significant difference between these two condition and the nominative condition (*p* > .05). The second model with the accusative as the reference level revealed a significantly lower AR for the genitive condition across both native speakers, (β = -0.92, *SE* = 0.39, z = -2.38, *p* < .05) and L2 learners, (β = -0.57, *SE* = 0.25, z = -2.30, *p* < .05). Finally, the third model with the dative as the reference level also revealed a significantly lower AR in the genitive condition only by L2 learners, ($\beta = -0.89$, $SE = 0.26$, $z = -3.41$, $p < .001$).

Table 2.5. Logistic Mixed-Effects Model Table for LDT accuracy results (Experiment 1)

Fixed Effects	Estimate Std.	Std. Error	Z value	Pr >|z|
Group	-2.35	0.46	-5.08	<.001 ***
Item Freq	0.67	0.18	3.65	<.001 ***
Item Length	0.39	0.13	2.99	.003 **
Reference Condition: Nominative				
L1				
Dative	-0.91	0.49	-1.87	.062 .
Gen	-1.34	0.50	-2.70	.007 **
Dative × Group	1.31	0.50	2.63	.007 **
Genitive × Group	0.85	0.50	1.72	.086 .
L2				
Dative	0.41	0.32	1.25	.212
Genitive	-0.49	0.32	-1.53	.127
Reference Condition: Accusative				
L1				
Genitive	-0.92	0.39	-2.38	.017 *
Dative × Group	0.81	0.42	1.95	.051 .
L2				
Genitive	-0.57	0.25	-2.30	.021 *
Reference Condition: Dative				
L1				
Genitive	-0.43	0.35	-1.21	.226
Genitive × Group	-0.46	0.39	-1.19	.234
L2				
Genitive	-0.89	0.26	-3.41	<.001 ***

Signif. codes: *** <0.001; ** <0.01; * <0.05; . <0.1

Sample model formula: Item.ACC ~ 1 + (Acc + Dat + Gen)*SubjGroup + ItemFreq.s + ItemLength.s + (1 | Subject) + (1 | ItemNo)

Descriptive results of mean raw RTs (Table 2.4) suggest similar patterns for case processing across native speakers and L2 learners. For both subject groups, the nominative condition displays the shortest mean RT, while the genitive condition displays the longest mean RT. However, the middle part of this spectrum does not seem to change dramatically in either subject group, such that the accusative and dative condition displayed similar mean RTs. Figure 2.4 further illustrates results in box plots.

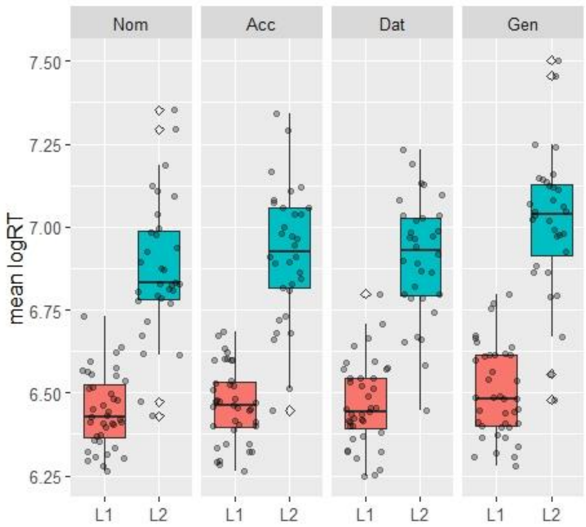


Figure 2.4 Boxplot of log-transformed RT results for LDT (Experiment 1). Each circle indicates an individual participant's mean logRT. Diamonds indicate outliers.

Reliability for the LDT RT data was quite high in general (α=.99). Based on the same cut-off rates for subject-level (above 80%) and item-level (above 50%) accuracy, the same L2 learner and critical items from AR analyses, including the fifteen trials with correct button presses for the unknown words as revealed by the offline task were excluded for RT analyses. In addition, all incorrect responses and potential outliers, such as RTs longer than 2000 ms in the native speaker group and 3000 ms in the learner group, were also removed prior to the analyses. The removal of the incorrect responses resulted in the exclusion of 4.27% of critical trials, while the removal of the RT outliers resulted in 3.28% exclusion.

Generalized linear mixed-effects models for the critical case-inflected nouns were developed with the log-transformed RTs in order to have a roughly normal distribution. The model included *condition* (nominative, genitive, accusative, dative), *subject group* (L1 vs. L2) and their interactions as fixed effects and crossed random effects for subjects and items. Following the forward selection procedure, item frequency and length were also added to the model after they were scaled and standardized for any possible convergence problems. The within-subjects effect, *condition*, was dummy-coded and the baseline/reference level was changed in every model so as to shed light on pairwise comparisons. The models had the maximal random effects structure with by-subject random slopes of the other conditions, apart from the baseline, and their by-item random slopes[25], along with the subject group. The random variance of the conditions by group interaction at the item level could not be included, due to the singular fit issue. Convergence difficulties were addressed by specifying uncorrelated random effects. At the end, the above models were the most complex and at the same time best-fitting models, based on the ANOVA results.

Table 2.6. Linear Mixed-Effects Model Table for LDT logRT results (Experiment 1)

Fixed Effects	**Estimate Std.**	**Std. Error**	**Z value**	**Pr >|z|**
Group	0.44	0.04	10.53	<.001 ***
Item Freq	-0.01	0.00	-2.52	.01 *
Item Length	-0.02	0.01	2.62	.009 **

[25] The nominative condition did not include the same noun stems as in the other conditions, so their item numbering is different. This difference causes singular fit when its effect is assumed to vary by item number. As a result, when the reference level of condition was not nominative, its by-item random slope was not included in the model.

Reference Condition: Nominative				
L1				
Accusative	0.03	0.01	1.96	.049 .
Dative	0.03	0.01	1.98	.047 .
Genitive	0.05	0.02	3.39	<.001 ***
Gen × Group	0.08	0.03	3.06	.002 **
L2				
Accusative	0.05	0.03	1.82	.071 .
Dative	0.03	0.03	1.24	.216
Genitive	0.13	0.03	4.84	<.001 ***
Reference Condition: Accusative				
L1				
Genitive	0.02	0.01	1.89	.059 .
Genitive × Group	0.06	0.02	3.55	<.001 ***
L2				
Genitive	0.08	0.01	5.88	<.001 ***
Reference Condition: Dative				
L1				
Genitive	0.02	0.01	1.80	.071 .
Genitive × Group	0.08	0.02	4.52	<.001 ***
L2				
Genitive	0.10	0.01	6.96	<.001 ***

Signif. codes: *** <0.001; ** <0.01; * <0.05; . <0.1
Sample model formula: Item.RT ~ 1 + (Acc + Dat + Gen)*SubjGroup + ItemFreq.s + ItemLength.s + (1 + Acc+Dat+Gen || Subject) + (1 + Acc+Dat+Gen+SubjGroup || ItemNo)

As shown in Table 2.6, the maximal model found significant main effects of subject group, (β = 0.44, *SE* = 0.04, |t| = 10.53, *p* < .001), item frequency, (β = -0.01, *SE* = 0.004, |t| = -2.52, *p* = .01) and item length, (β = 0.02, *SE* = 0.01, |t| = 2.62, *p* < .01). The initial model with the nominative as the reference level further revealed significantly longer RTs for the genitive condition, relative to the nominative condition, by native speakers (β = 0.05, *SE* = 0.02, |t| = 3.39, *p* < .001), and this RT difference between the two conditions was significantly larger in L2 group, (β = 0.13, *SE* = 0.03, |t| = 4.84, $p < .001$). On the other hand, compared to the nominative condition, longer RTs in the accusative, (β = 0.03, *SE* = 0.01, |t| = 1.96, $p = .049$), and dative conditions, (β = 0.03, *SE* = 0.01, |t| = 1.98, $p = .047$), could only reach a borderline significance in the native speaker group. Similarly, the RT difference between the nominative and accusative conditions was marginally significant in L2 group, (β = 0.05, *SE* = 0.03, |t| = 1.82, $p = .07$). The second model with the accusative as the reference level revealed that longer RTs for the genitive condition, relative to the accusative condition, were only marginally significant in the native speaker group, (β = 0.02, *SE* = 0.01, |t| = 1.89, $p = .06$), but the same RT difference was significant in the L2 learner group, (β = 0.08, *SE* = 0.01, |t| = 5.88, $p < .001$). Likewise, the last model with the dative as the reference level found that longer RTs for the genitive condition, relative to the dative condition, were only marginally significant (β = 0.02, *SE* = 0.01, |t| = 1.80, $p = .07$) in the native speaker group, whereas the same RT difference was significant in the L2 learner group, (β = 0.10, *SE* = 0.01, |t| = 6.96, $p < .001$). To sum up, the genitive case-inflected nouns elicited significantly longer RTs than all the other case-inflected nouns in L2 group, while they elicited significantly longer RTs, only relative to the nominative nouns in L1 group.

2.2.8 Experiment 1: ERP results and statistical analyses

N400 amplitudes for the correct trials are displayed visually as grand average waveforms in Figure 2.5. Across the fronto-central electrodes, L1 group appears to show largest N400 effects to nonwords. In contrast, L2 learners appear to show attenuated N400 effects overall to nonwords. Moreover, contrary to the gradual decline in N400 amplitudes from nonwords to the nominative nouns during L1 word processing, all conditions, except the accusative case, seem to be chunked together during L2 word processing. In fact, the accusative case condition appears to be producing the smallest N400 effects in L2 group.

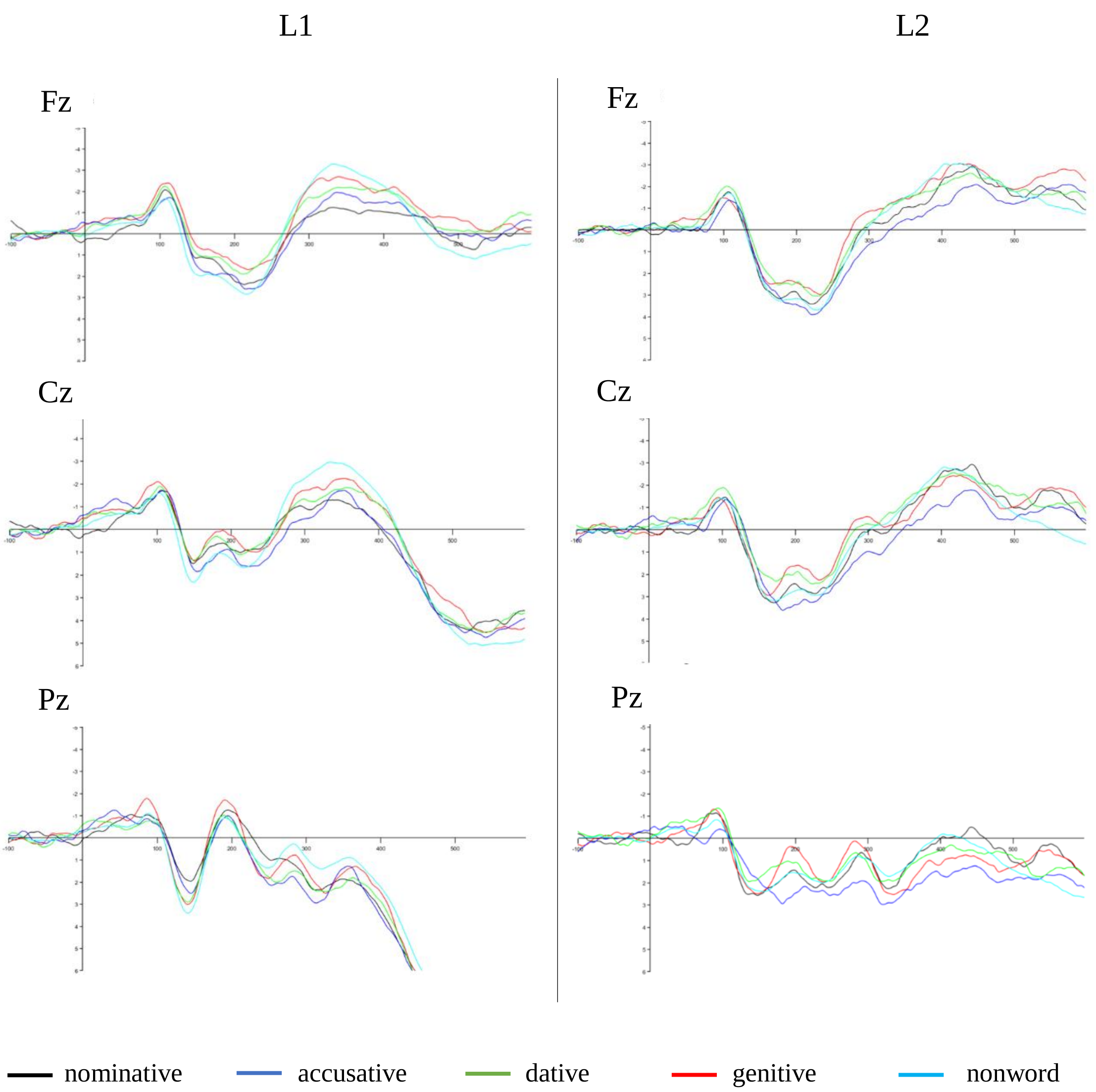


Figure 2.5. Grand average waveforms for LDT (Experiment 1), only correct trials are included (40 Hz low pass filter). The ordinate indicates the onset of the target word. Timing is given in milliseconds. Negative voltage is plotted upwards.

Based on the above display of N400 amplitudes, which show that nonword responses overlap with real word responses in L2 group, Figure 2.6 was further created. Across fronto-central electrodes, it depicts the grand average waveforms for real words vs. nonwords in order to compare their N400 effects across subject groups. L1 group appear to show a clear difference between the N400 effects of real words and nonwords. On the other hand, L2 group's nonword responses appear to diverge less strongly from their real word responses in terms of N400 amplitudes.

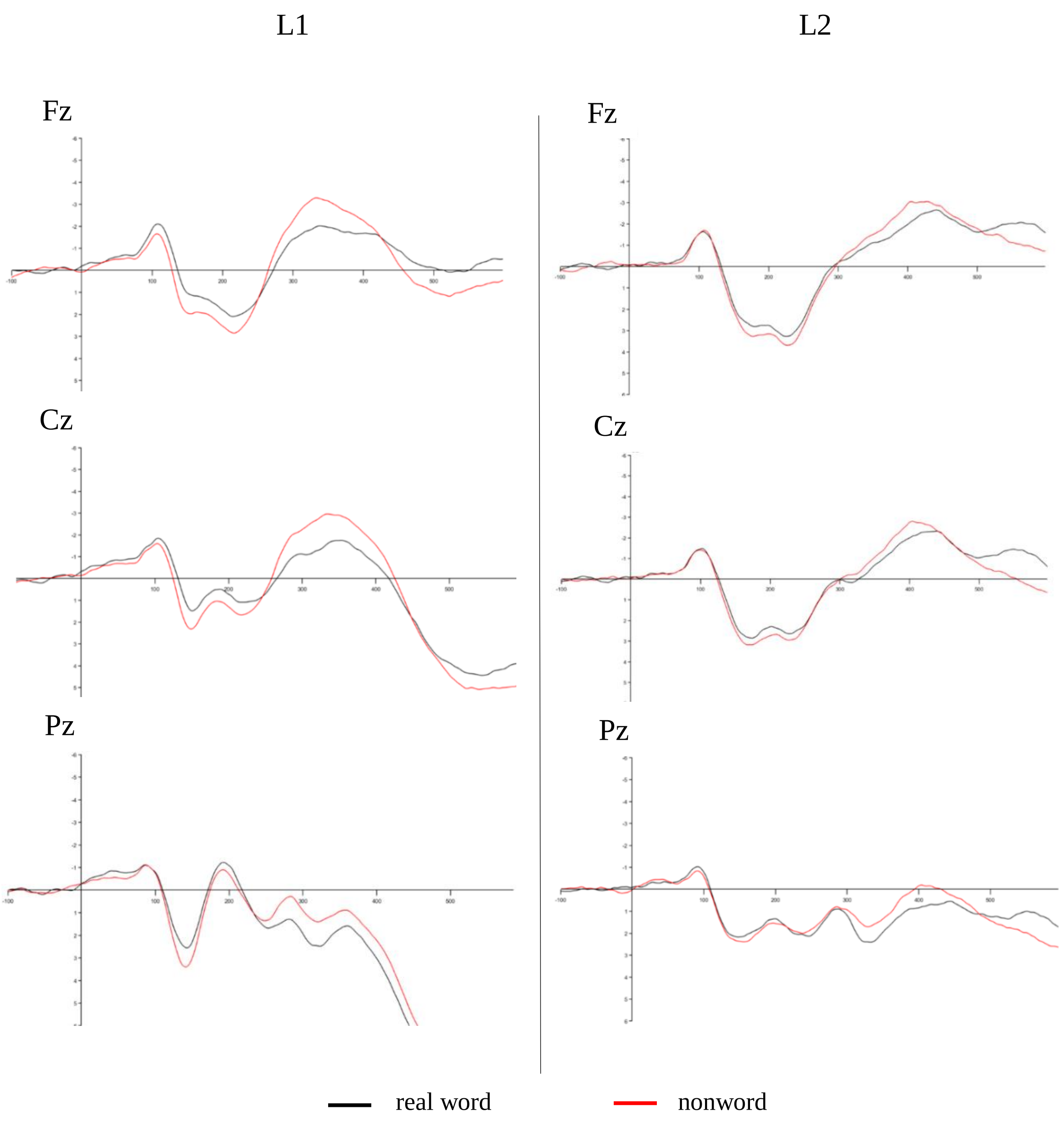


Figure 2.6. Grand average waveforms for real words vs. nonwords across L1 and L2 participants in LDT. Only correct trials included (40 Hz low pass filter). Negative voltage is plotted upwards.

First, averaged N400 amplitudes from the 300-450 ms time window were submitted to a 2 × 2 × 2 × 2 mixed-design ANOVA with Group (L1/L2) as a between-subject factor and Condition (real words/nonwords), Hemisphere (left/right) and Region (anterior/posterior) as within-subject factors. It is important to note that fifteen trials removed from the behavioral analyses due to correct button press for unknown words as detected through the offline task were not excluded from the following ERP analyses. Yet, the analyses were still restricted to only correct responses (correct acceptance or correct rejection). All analyses were once again conducted in *R* (version 3.5.3, R Core Team, 2019), using the *afex* package (version 0.23-0, Singmann et al., 2019). From 300-450 ms, the ANOVA across all 4 quadrant ROIs revealed significant main effects of all within-subject factors and their interactions (see Table 2.7). Based on the Group × Condition × Hemisphere interaction, $F(1,67)=7.19$, $p<.01$, post-hoc tests of N400 effects across hemispheres by subject groups revealed a significant effect of Condition over the right hemisphere only (collapsed across anterior and posterior ROIs), across both subject groups (see Figure 2.7). Overall, in both native speakers and L2 learners, nonwords evoked significantly more negative amplitudes, maximal at fronto-central electrodes in the right hemisphere.

Table 2.7. Mixed Model ANOVA Table for N400 (300-450 ms) amplitudes across real-words and nonwords in LDT (Type 3 tests) (Experiment 1)

Effect	Num Df	Den Df	F	Pr (>F)
Condition	1	67	8.00	.006 **
Hemisphere (Hem)	1	67	16.26	<.001 ***
Region	1	67	30.79	<.001 ***
Group × Region	1	67	5.33	.024 *
Condition × Hem	1	67	45.90	<.001 ***
Group × Condition × Hem	1	67	7.19	.009 **
Hem × Region	1	67	17.71	<.001 ***
Group × Hem × Region	1	67	5.76	.019 *

Group × Condition × Hem × Region	1	67	2.85	.096 .
Post-hoc Tests				
Left Hemisphere				
Group	1	67	0.01	.90
Condition	1	67	0.00	.97
Group × Condition	1	67	1.28	.26
Right Hemisphere				
Group	1	67	0.35	.55
Condition	1	67	25.67	<.001 ***
Group × Condition	1	67	0.84	.36
Signif. codes: *** <0.001; ** <0.01; * <0.05; . <0.1				

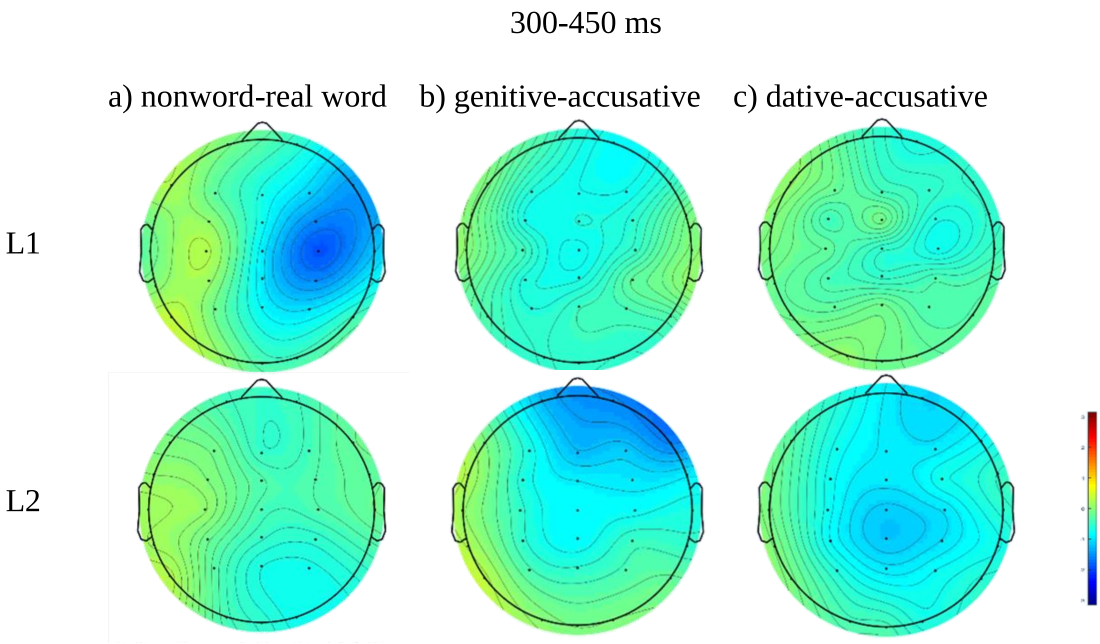


Figure 2.7. Scalp topographic maps showing the N400 distribution during the processing of a) nonwords vs. real words, b) genitive- vs. accusative- and c) dative- vs. accusative-case inflected nouns within the 300-450 ms post-noun onset.

The following analyses include the averaged ERPs from different case conditions in the same 300-450 ms time window. A 2 × 2 × 2 × 2 mixed-design ANOVA, with Group (L1/L2) as a between-subject factor and Case (nominative/accusative/dative/ genitive), Hemisphere (left/right) and Region (anterior/posterior) as within-subject factors, was conducted in *R* with the same *afex* package (version 0.23-0, Singmann et al., 2019). Greenhouse-Geisser correction (Greenhouse & Geisser, 1959) was applied to the repeated measures with more than one degree of freedom in the numerator.

Table 2.8. Mixed Model ANOVA Table for N400 (300-450 ms) amplitudes across case conditions in LDT (Type 3 tests) (Experiment 1)

Effect	Num Df	Den Df	F	Pr (>F)
Group	1	67	0.15	.699
Case	3	201	2.10	.107
Hemisphere (Hem)	1	67	29.29	<.001 ***
Region	1	67	27.83	<.001 ***
Group × Region	1	67	4.98	.029 *
Hem × Region	1	67	16.59	<.001 ***
Group × Case × Hem	3	201	2.83	.043 *
Group × Hem × Region	1	67	7.57	.008 **
Case × Hem × Region	3	201	3.54	.017 *
Post-hoc Tests on ROIs				
Left Anterior				
Group	1	67	3.30	.074 .
Case	3	201	0.66	.553
Group × Case	3	201	0.63	.572
Left Posterior				
Group	1	67	1.52	.221
Case	3	201	1.14	.332
Group × Case	3	201	2.01	.116
Right Anterior				
Group	1	67	0.07	.791
Case	3	201	5.10	.002 **
Group × Case	3	201	2.21	.091 .
Right Posterior				
Group	1	67	1.23	.271
Case	3	201	1.79	.152
Group × Case	3	201	3.16	.027 *
Post-hoc Test on Right Posterior ROI				
L1				
Case	3	108	1.22	.307
L2				
Case	3	93	3.55	.022 *

Signif. codes: *** <0.001; ** <0.01; * <0.05; . <0.1

As displayed in Table 2.8, the global ANOVA revealed the three-way interactions of Group × Case × Hemisphere, $F(3,201)=2.83$, $p<.05$, and Case × Hemisphere × Region, $F(3,201)=3.54$, $p<.05$. To understand these interactions and find out whether N400 effects change across different case markings depending on the Group and Hemisphere or Region, we performed additional post-hoc ANOVAs for each ROI separately, with factors Group and Case. This revealed a main effect of Case only over the right anterior ROI across both subject groups, $F(3,201)=5.10$, $p<.01$. In addition, these post-hoc tests revealed a significant interaction between Case and Group in right posterior ROI (see Figure 2.8), and the follow-up tests in this region found a significant effect of Case only in L2 learners, $F(3,93)=3.55$, $p<.05$. None of the other ROIs showed any significant effects of Case.

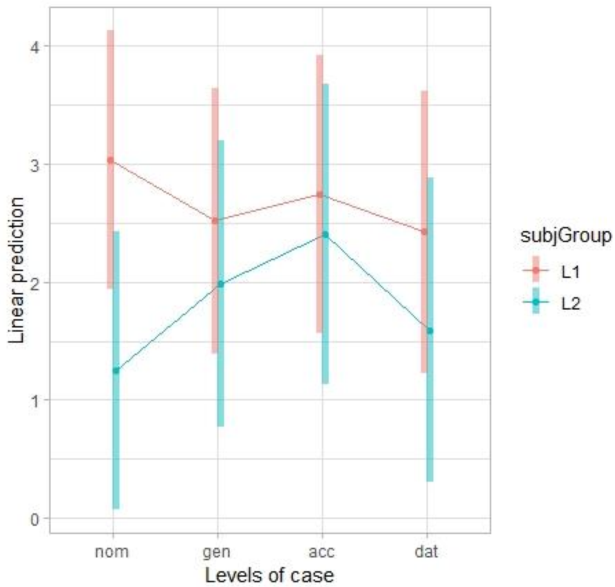


Figure 2.8. The interaction between Group and Case in N400 effects observed in right posterior ROI (Experiment 1).

Within the right anterior ROI, planned comparisons were further conducted (with Holm adjustments for p-values) by using effects coding for each case condition across subject groups. The only significant differences in N400 effects were found between the genitive and accusative conditions, (β = -1.66, SE = 0.45, |t| = -3.84, p < .01) and between the dative and accusative conditions, (β = -1.38, SE = 0.47, |t| = -2.93, p < .05) (see scalp topographic maps, Figure 2.7). Further comparisons of these main effects of case conditions for each subject group revealed that only L2 learners showed these significant differences between the genitive and the accusative, (β = -1.19, SE = 0.32, |t| = -3.76, p < .01) and between the accusative and the dative, (β = -1.13, SE = 0.35, |t| = -3.28, p < .05).

2.3 Experiment 1: Discussion

LDT results indicate that both native speakers and L2 learners are sensitive to the morphological structure of different case-inflected nouns and their sensitivity is further modulated by the case form features and its status within the inflectional paradigm. As already established by Gor and her colleagues (2017a), case-inflected nouns are segmented into 'stem+case marking' during online word recognition, and the degree of processing difficulty is determined by the case form at the stage of recombination of the stem with the case marking, following affix stripping. The results of the current experiment cannot lend strong support to the claims about the availability of decomposition, as the nominative nouns had different stems than the ones in the oblique-case conditions. Despite this stem difference, nominative nouns were processed the fastest by both native speakers and nonnative speakers, as revealed by RT data, in particular (for the contradictory, non-decompositional account for L2 morphological processing, see Kirkici & Clahsen, 2013). However, it produced significantly lower RTs only than the genitive condition across both subject groups, which is partly in line with Comparison 4. On the other hand, ERP results show that the case form with the lowest processing costs, as indexed by N400 amplitudes, was the accusative, specifically in L2 group. This discrepancy between the behavioral (RTs) and ERP (N400s) data in L2 group can be attributed to the stem differences and low lemma frequency in the nominative condition, given that L2 word processing is more sensitive to lemma frequencies than L1 word processing. In a similar vein, only ERP data found significant differences in processing costs of the accusative and dative case-inflected nouns in L2 group, which partly supports the effect of the structural vs. lexical dichotomy on case form processing without a sentential context, as postulated by Comparison 1 (for similar behavioral results, see Karatas, Gor, & Lau, in preparation). Overall, the processing disadvantage of the nominative condition composed of low-frequent stems different from the other cases, albeit citation forms in the Turkish case inflectional paradigm, and the processing advantage of the accusative (structural object/argument marking) over the genitive (nonargument) or the dative (lexical object/argument marking) were captured only by the time-sensitive electrophysiological measures such as ERPs.

Taken together, LDT results demonstrate that Comparison 2, which compares arguments (accusative, dative) to non-arguments (genitive) of a verb, holds true, in that the genitive yielded the lowest ARs, longest RTs and largest N400s among the other oblique-case forms across both subject groups. In addition to the "argumenthood" parameter, this finding might also be associated with the higher functional load of genitive nouns encoding both possession and case, although this functional load also leads to a high type frequency (Comparison 3). This possibility was ruled out by the results of the norming task that was given to native speakers at the beginning of the study (see the Materials section above), but it is still possible that certain items (e.g., family terms[26] such as *amcanın* "uncle's", which is more likely to be interpreted as "your uncle's" than an inanimate word *kapının* "door's") might have evoked the additional "possession" meaning in L2 learners. After all, L2 learners were the only ones who demonstrated significantly lower ARs or longer RTs, and thereby processing difficulty, for the genitive nouns, compared to the other oblique case forms or all other cases, respectively. In native speaker group, the genitive nouns led to a significantly higher processing cost mainly than the nominative condition, as revealed by both AR and RT data. As for the N400 effects, however, they were processed with a greater difficulty than the accusative nouns by L2 learners only. All these findings indicating the processing cost of the genitive case can further bear out another potential reason for this situation, which might concern the LDT design, such that readers' expectation for a possessed noun following a possessor (genitive) noun might be stronger than for a verb following an object with a structural case marking, in particular. Yet, such a tendency is also expected to fade away over the course of the experiment, after participants get used to the LDT format with a single-word presentation.

In conclusion, Experiment 1 shows that both native speakers and advanced L2 learners experience different processing costs during online word recognition, depending on the case type and its properties. This finding provides further evidence for the decomposition with recombination account for lexical access of inflected

[26] It is important to highlight that none of these family terms were translated as "your…", that is, no possession meaning was found in their Turkish-English translations in the norming task. It is mostly due to the fact that the use of these specific terms is not restricted to one's own family, and can refer to anybody outside (e.g., *amca* "uncle" can be used for any male person who is older than the speaker).

words by Gor et al. (2017a). On the other hand, it is in contrast with the alternative full-listing or whole-word storage account (Butterworth, 1983), which would predict no differences in any behavioral measures for nouns inflected in different cases, based on the fact that they are balanced on lexical properties, and crucially, on surface frequency, and these are the same stems (except for the nominative control condition). Analogous to previous SPR results (Karatas, Gor, & Lau, in preparation), the behavioral data show that both subject groups presented similar processing patterns, though L2 group, compared to L1 group, displayed more significant differences regarding the genitive and other oblique case forms. As shown by both subject groups' behavioral data, the nominative and the genitive were on two opposite ends of AR and RT scales, which partly provides support for Comparison 4. However, ERP data do not point to any significant differences between these two conditions in terms of their N400 amplitudes, and thus processing costs; instead they reveal this difference between the accusative and the genitive, based on "argumenthood" (Comparison 2) as well as between the accusative and the dative cases, based on the structural vs. lexical dichotomy (Comparison 1). As stated above, the significant difference between the accusative and genitive case markings with the second type yielding a greater processing cost, despite its highest type frequency among the oblique case forms in the inflectional paradigm (Comparison 3), was also established by the behavioral data (except RTs in L1 group) collected during this single-word processing.

Chapter 3: L1 and L2 case processing in a sentence context

3.1 Overview

The second experiment, a grammaticality judgment task (GJT), focuses on behavioral and neural responses while reading two segments of a sentence: a) the case-marked noun, to examine any additional difficulty in the morphological processing of the same oblique-case forms (i.e., genitive, accusative, dative) within a sentence context; b) the matrix verb, to examine the morphosyntactic processing of structural (the substitution of the dative for the accusative) vs. lexical case (i.e., the substitution of the accusative for the dative) violation on the preceding object that the verb commands and that becomes obvious at the verb site. Thus, the second experiment investigates L1 and L2 sensitivity to the properties of the case form and its status in the inflectional paradigm in a sentence, above and beyond what is observed in isolated words. It further tests L1 and L2 sensitivity to case violations, as indexed by behavioral (ARs) and electrophysiological markers such as N400, LAN and P600, and if they do, whether their sensitivity differs across the case substitution error types (for native-like L2 processing of structural, rather than lexical or inherent, case violations, see Hopp & León Arriaga, 2016). To the best of our knowledge, the present work is the first ERP study to compare L1 and L2 morphological (word-level) and morphosyntactic (sentence-level) processing patterns of different oblique-case markings in an agglutinating language such as Turkish.

3.1.1 Background and motivation

Based on the aforementioned findings of the previous SPR task, namely, remarkably increased reading times for the genitive subjects by both participant groups and different reading times of the accusative- and the dative-inflected nominalized objects by advanced L2 learners, the first region of interest in this second ERP experiment will be the nouns with different case markings (i.e., nominative, genitive, accusative, dative). In addition to the reasons listed in Chapter 2 for the processing difficulty of the genitive subjects, another possibility might be to ascribe this cost to their signaling the upcoming embedded sentence with a high level of morphosyntactic complexity (i.e., nominalization, possessive and case markers on the object). As a result of this complex sentence processing computation, the genitive might have induced such a big slowdown in reading times. However, in the current GJT, sentences will be composed of simple genitive-possessive constructions without any embedding; and therefore, a more direct comparison between the morphological processing costs of the nominative and genitive nouns can be made.

Following the first word-level morphological processing experiment, this second experiment investigates the morphological processing of the same case-inflected noun forms in a sentential context. The first part of the present experiment thus examines whether the differences in morphological processing costs of different case markings are at the level of word or sentence. Regarding this sentence-level processing of four different case markings, the same type of comparisons as in LDT have been postulated:

1. *Structural object case (accusative) vs. lexical object case (dative)*
2. *Argument (accusative, dative) vs. non-argument (genitive)*
3 *Higher type frequency (genitive) vs. lower type frequency (accusative, dative)*
4. *Citation form (nominative) vs. oblique-case forms (genitive, accusative, dative)*

Comparison 1 includes only object case markings in order to delve into the previously observed difference in their L2 SPR reading times, but in simpler sentence structures this time (see Karatas, Gor, & Lau, in preparation). As in the first experiment, Comparison 2 and 3 include only oblique-case forms so that a direct comparison across experiments, that is word and sentence contexts, can be made if needed. Similar to the first experiment, the nominative condition is discussed separately under Comparison 4, which aims to establish the morphological processing costs for the nominative case used to denote the subject of a sentence, against the oblique-case forms during sentence comprehension. Because there will be no behavioral responses while reading these case-inflected nouns, only ERP responses (i.e., N400 amplitudes) will be evaluated as a straightforward measure of their morphological processing difficulties.

In our previous study (Karatas, Gor, & Lau, in preparation), behavioral results showed that even very advanced L2 learners of Turkish fail to recruit case marking during sentence comprehension. Therefore, the current study relies on ERPs to explore the processing of grammatical case, and establish whether different neural computations are engaged during the processing of different case markings and case violations across native and nonnative speakers of Turkish. Interestingly, in the same previous SPR task, the finding on L2 learners' different reading times for accusative vs. dative case-marked nominalized objects had further been supported by the marginally significant effect for the same cases on their offline judgments of case violations. In this offline judgment task, L2 learners were less sensitive to the substitution of the accusative for the dative on the embedded nominalized object, as disambiguated by the verb in Turkish[27], than the substitution of the dative for the accusative. Based on these results, the current study compares the morphosyntactic processing costs of structural vs. lexical case violations:

4. *Structurally-assigned (substitution of the dative for the accusative) vs. lexically-assigned (substitution of the accusative for the dative)*

The manipulation of the case type within the substitution error (i.e., misapplication of a structural/default (accusative) vs. a lexical/non-default (dative) object case marking) in less complex sentence structures will enable us to better examine the strength and nature of the behavioral and ERP responses across subject groups. Through these behavioral and electrophysiological responses to different case violations, it futher aims at contributing to our understanding of whether the previously found L2 processing differences between the two case markings in the SPR and offline tasks were driven by the lexical processes or sentence processes.

3.2 Experiment 2: Grammaticality judgment task

3.2.1 Experiment 2: Research questions and hypotheses

Questions (1-2) below address the morphological processing of the case-inflected nouns in a sentence context. More specifically, they ask whether native speakers and advanced L2 learners will be sensitive to the case form properties and thus show differential processing costs, as measured by the N400 amplitudes, for different case-inflected nouns in a sentence, above and beyond what is observed in isolated words. In other words, this first part of Experiment 2 probes into the question

[27] As described above, object case violations can only be realized during the processing of the matrix verb in an SOV head-final language like Turkish. As such, the L1 and L2 comprehenders in the current study must retrieve the case-marking on the object fast enough to establish case concord and notice the incongruent case morphology at the verb position.

of whether the potential processing differences across the case forms are due to sentence processing rather than word processing, that is, whether any additional difficulty will be experienced by native speakers or L2 learners for certain case forms in a sentence context. To this end, Experiment 2 aims to elucidate the following research questions:

(1) *Are native speakers sensitive to the properties of the case form and its status in the inflectional paradigm within a sentence context?*

(2) *Are advanced L2 learners sensitive to the properties of the case form and its status in the inflectional paradigm within a sentence context?*

(3) *Does the sensitivity to the properties of the case form and its status in the inflectional paradigm within a sentence differ across native and nonnative speakers?*

From the perspective of decompositional models of the neurocognition of morphology (Marslen-Wilson & Tyler, 1997), one would expect all the overt case-marked forms to be segmented into stem and affix. The difficulty then should arise during the recombination stage when the case information becomes available. Based on previous findings on the differential sensitivity to different case forms in an agreement phrase by Gor et al. (2017b), it is likely that native speakers' processing will be influenced by distinct case form features. Therefore, the same comparisons listed in Chapter 2 for the isolated noun processing should be discussed for the processing of the same nouns in a sentence context, along with the addition of the nominative forms. As for Comparison 1, parallel to our previous behavioral SPR findings, which indicated longer RTs for embedded nominalized dative objects by L2 learners, dative objects in the current GJT may yield larger N400 amplitudes than its accusative counterparts, especially in L2 subject group. However, the current task items are intentionally less difficult than the SPR study (i.e., no embedded clauses). As a result, it is not certain whether we will obtain such a differential processing cost pattern in L2 case processing, as indexed by RTs in that SPR study. With regard to Comparison 2, the genitive-inflected possessor nouns may result in the largest N400s across L1 and L2 participants, as they are not a direct argument of the verb. Thus, through follow-up pairwise comparisons, differences in the morphological processing costs of different oblique-case inflected nouns may be found, above and beyond what is observed in LDT. For example, if the hypotheses according to which the genitive cost reflects its interaction with general sentence processing computations, especially in the L2 group, hold true, then an augmented processing cost for the genitive-marked nouns will be observed in this sentence experiment. Contrary to Comparison 2 predictions, Comparison 3 anticipates the smallest N400s in the genitive condition, due to its highest type frequency among the oblique-case forms in Turkish. In contrast to these predictions, neither subject groups may show any differential sensitivity to different oblique-case forms, and the only difference in ERP responses may be found in Comparisons 4. Previous research on Russian nominal inflection reports a processing advantage for the nominative case, the citation form, in native and highly proficient nonnative speakers (Gor et al., 2017a). Therefore, the nominative-marked (subject) nouns are expected to generate the smallest N400 amplitudes in both subject groups, as they are the citation forms of Turkish nouns. Based on Question 2, an alternative hypothesis may further predict a differential sensitivity to different case forms only by native speakers. Consequently, L2 learners, like or unlike native speakers, may or may not show different ERP responses for different case-marked nouns during their sentence-level processing.

As shown in the previous work (Hopf et al., 1998), SOV languages like Turkish exploit processing strategies that rely more on case morphology, which allows for the early determination of the thematic role and syntactic function of each nominal argument even when word order is a valid cue, so that core grammatical information can be accessed before the matrix verb. In this regard, Questions (3-4) address the morphosyntactic processing of the accusative and dative case markings. Based on previous research, native speakers are expected to show sensitivity to case violations, as indexed by both behavioral (e.g., Hopp, 2010, 2015), and electrophysiological responses (e.g., Frisch & Schlesewsky, 2001, 2005). Here, we further examine if their sensitivity will differ across different case substitution error types. On the other hand, even advanced L2 learners may not show sensitivity to case violations, as indexed by both behavioral (Hopp, 2015) and electrophysiological responses (Mueller, Hirotani, & Friederici, 2007). Specifically, the following research questions are addressed:

(3) *Are native speakers sensitive to case violations? If yes, does their sensitivity differ across substitution error types (i.e., structurally-assigned vs. lexically-assigned)?*

(4) *Are advanced L2 learners sensitive to case violations? If yes, does their sensitivity differ across substitution error types (i.e., structurally-assigned vs. lexically-assigned)?*

Both types of case anomalies may engender a biphasic N400-P600 pattern during verb processing by both native and nonnative speakers. Yet, a strongly left-lateralized negative deflection (N400) may also not precede the centro-parietal pronounced positivity (P600), as there is no semantic import of a meaning change due to object case marking violation[28]. Given that the LAN is another inconsistent electrophysiological processing correlate preceding the late positivity in phrase structure violations (for previous reports on the LAN-P600 pattern, see Schlesewsky et al., 2003; Hahne & Friederici, 1999), a clear LAN effect may potentially be observed in both L1 and L2 data, but may also be missing. As for the differential sensitivity to the different case substitution error types, it is important to remember that such a distinction between the structural and lexical case processing was not observed in LDT. Yet, given that within a sentence context, some morphosyntactic features of inflected nouns are expected to be more readily activated, native speakers may show such a structural vs. lexical distinction in their behavioral (i.e., ARs) and ERP indices (i.e., P600, LAN and N400) for case violation processing. If they do, the predictions will be based on Comparison 4, such that they may be less sensitive to the substitution of the accusative for the dative case, as the accusative is the default/less marked/more frequent case for object marking. Accordingly, lower ARs for the sentences with the substitution of the accusative for the dative on the object and reduced P600, along with reduced LAN and N400 amplitudes, are expected during verb processing in such sentences.

On the L2 processing side, three possibilities may accrue: a) Differential sensitivity to case substitution error types (see Hopp & León Arriaga, 2016 and

[28] Also see Zawiszewski and Friederici (2009) for a larger N400 effect for subject-verb agreement violation than for object-verb agreement violation, while the reverse pattern was true for the amplitude of the P600 component. This finding proves that the brain's responses vary depending on the actual type of syntactic violation that is involved.

Karatas, Gor, & Lau, in preparation); b) no differential sensitivity; or c) no sensitivity to case violations at all (e.g., s*hallow structure hypothesis* by Clahsen & Felser, 2006, 2017). If L2 learners' processing patterns align with those of native speakers, then they will notice the grammatical case error while processing the verb, and a significant difference in the P600, LAN and N400 amplitudes between the processing of the verbs in the grammatical and ungrammatical sentences will be observed. However, it is also likely that no online sensitivity to ill-formed sentences (no P600, in particular, which typically occurs in response to syntactic anomalies, and is viewed as a measure of nativelikeness) will be found in the L2 group. If L2 learners rely more heavily on the lexical semantics of the object noun than morphosyntactic cues, such as its case marking, to anticipate the upcoming matrix verb (see Mitsugi & MacWhinney, 2015), then they will not realize the case error, as predicted by the *shallow structure hypothesis* (Clahsen & Felser, 2006, 2017). Consequently, they will not show any difference in the magnitudes of the aforementioned ERP components. Alternatively, similar to native speakers, they may realize the case error and their sensitivity may further be modulated by the object case type, in that the default and more frequent accusative case may mask the mismatch in the case assignment between the verb and its object. If they show this differential sensitivity across structurally- and lexically-assigned object case markings, the same ERP patterns as in the native speakers' data should be obtained. More specifically, the inspection of the waveforms triggered by the verb should point to an enhanced P600, LAN and N400 in the erroneous condition where the dative is substituted for the accusative, during the reanalysis process.

3.2.2 Experiment 2: Participants

Participants were the same as in Experiment 1 reported above.

3.2.3 Experiment 2: Stimuli

The stimuli comprised 180 critical sentences subdivided into six lists of 30 sentences in each condition. Due to the scarcity of the critical nouns, the same noun was used twice in the same list but in a different case form and a sentence with a different beginning and ending. As shown in Table 3.1, the experimental design crossed the factors of case marking on the nouns used in the visual LDT (nominative, genitive, accusative, dative) and case violation type (substitution of the accusative for the dative vs. substitution of the dative for the accusative). The design therefore introduced four sets of grammatical sentences and two sets of ungrammatical sentences. Based on the two grammatical conditions with either accusative- or dative-marked object, two ungrammatical conditions were derived. Case violations were created by replacing the case marking on the object argument with its wrong counterpart (i.e., substitution). Thus, grammatical and ungrammatical sentences were identical, except for the case morpheme attached to the object noun. The anomaly in the case assignment was revealed by the matrix verb; in other words, the reader was expected to anticipate a dative-assigning verb after seeing a dative-inflected object, and it was only when the accusative-assigning verb was displayed, the reader was expected to recognize the case violation and reanalyze the grammatical structure.

Table 3.1. Experimental stimulus examples. Bold words represent the critical word(s) for each condition, from which onset epochs were established.

a. Grammatical Nominative Sentence	Yarım saat boyunca banyodaki **ayna** konuşuldu. *Half an hour during in the bathroom* ***mirror*** *was discussed.*
b. Grammatical Genitive Sentence	… **ayna-nın** konumu konuşuldu. ... ***mirror-'s*** *location was talked.*
c. Grammatical Accusative Sentence	… **ayna-yı** **sildim**. ***mirror-ACC*** *wiped I.*
d. Grammatical Dative Sentence	… **ayna-ya** **baktım**. ***mirror-DAT*** *looked(at) I.*
e. Substitution of the Dative for the Accusative	*… **ayna-ya** **sildim**. ***mirror-DAT*** ***wiped I***.
f. Substitution of the Accusative for the Dative	*… **ayna-yı** **baktım**. ***mirror-ACC*** ***looked(at) I***.

As illustrated in Table 3.1, each critical sentence started with an adjunct, preferably an adverb of time or place, and ended with the matrix verb, which provided critical information as to whether a sentence involved a violation of object case marking or not. It is important to note that even though there was no other argument, such as an adverb, between the critical object and the verb and the verb was in the sentence-final position, no potential spill-over effects of the object noun processing or no wrap-up effects on the verb (see Stowe, Kaan, Sabourin, & Taylor, 2018) were expected due to the sufficiently large stimulus-onset asynchrony (SOA) time window for the separate and full processing of the object (850 ms) and the verb (1000 ms). Moreover, by placing the verb at the end of the sentence, scrambling, which might have led to extra processing demands particularly for L2 learners, was avoided. Importantly, the length and frequency of the matrix verbs in the conditions with the accusative or the dative-inflected objects have been matched (see Table 3.2) in order to attribute any observed difference solely to the reanalysis of the object-verb mismatch in terms of case assignment.

Table 3.2. Properties of matrix verbs. Standard deviations are presented in parentheses.

Matrix verb case assignment type	Mean surface frequency (per million)	Mean length (number of letters)	Mean length (number of syllables)
Accusative (n=30)	6.87 (15.11)	8.22 (1.90)	3.13 (0.79)
Dative (n=30)	6.67 (15.93)	8.60 (1.96)	3.22 (0.82)

Each list was combined with 180 filler sentences that had a similar structure with the same length of 6–7 words as in the critical sentences. To investigate the specificity of the neural processing consequences of case violation, 60 ungrammatical filler sentences with some sort of subject-verb agreement violation (e.g., number, person) were created as a morphosyntactic control. The agreement violation in number was introduced by the singular genitive constructions and plural verbs, while the one in person was introduced by singular nominative nouns and first-person plural verbs. Thus, the grammatical nominative and genitive noun forms in the critical conditions were matched with these ungrammatical counterparts. In addition, a mismatch between the number or quantifier and singularity of a noun was created in 60 filler sentences. Additionally, 60 filler sentences with another type of case marker, such as the locative, ablative, and instrumental, did not display any anomaly and were syntactically and semantically correct. Overall, each list consisted of 360 sentences (180 grammatical and 180 ungrammatical). Prior to testing, a naturalness task was given to three Turkish native speakers to ensure that the grammatical sentences sounded natural without any unintentional error, while the ungrammatical sentences sounded unnatural with only one type of error: case violation.

Last but not least, the offline task given to L2 learners at the end of the study, as mentioned in Chapter 2, also included all 180 critical verbs as questions and the accusative and dative case-inflected objects as options. Out of six lists, each participant was given a specific list with 120 critical verbs that they were exposed to during the online GJT. Thus, L2 learners' metalinguistic knowledge of correct case assignment in Turkish was obtained at their own pace. In addition, there were two other options under each verb in order to elicit whether or not they know the meaning of that critical verb and/or object noun (e.g., *arıza ne demek bilmiyorum* "I don't know what malfunctioning is"). They were instructed that after choosing the correct case-inflected object, they can also mark those options if they do not know their meanings. Consequently, those unknown verbs and objects could be detected, along with the unknown verb-object pairings so as to be excluded later from further GJT analyses.

3.2.4 Experiment 2: Procedure

Half an hour after the first experiment, the sentence experiment was conducted. Participants were again tested individually in the same faraday cage. As in a typical language comprehension ERP paradigm, sentences were visually presented one word at a time at the center of the computer screen. Words were displayed in white letters on a grey background. The setup of this sentence experiment was as follows: Each trial started with the presentation of a fixation cross for 1000 ms. Following a subsequent 200 ms blank screen, sentences were presented word by word with a word duration of 650 ms and SOA of 850 ms. After the verb, which was the sentence offset, a blank screen was presented with 350 ms and SOA of 1000 ms for the verb (650+350 ms). Then it was replaced by a question mark, as a cue for the grammaticality judgment, which was treated as an index of how accurately the sentence has been read and processed. Participants were instructed to push the right button on the response box with right index finger (dominant hand) when the sentence presented was grammatically correct and to push the left button with the left index finger (non-dominant hand) when the sentence was incorrect. The response hand was reversed for the two left-handed nonnative speakers. The question mark automatically disappeared after the participants' response or timeout of 5000 ms. The next trial started 1500 ms after participants' response (see Figure 3.1). During this interval, participants were told that they could freely blink. They were instructed to fixate on the middle of the screen during the fixation period and simply await the start of the next trial. In order to reduce ocular artifacts to a minimum, participants were asked not to blink throughout the presentation of the fixation cross. Instructions stressed the relevance of avoiding blinks and body and eye movements starting from the apparition of the fixation cross until the question mark appeared.

The experiment was run using the E-Prime 2.0. software (Psychology Software Tools, Pittsburgh, PA) which recorded participants' accuracy of their responses. The experiment started with eight practice trials (4 grammatical and 4 ungrammatical with the same type of violation as in the filler sentences). During this practice session, oral feedback was provided by the experimenter to better familiarize participants with the design. After the training phase, the 360 trials were presented in a random order with the constraint that no more than three consecutive trials were presented from the critical or filler conditions. Each participant was randomly assigned to one of the six trial lists so that the lists were equally distributed across participants. In order to avoid any potential fatigue effect, the experimental session was subdivided into 9 blocks of 40 sentences, between which participants could take short breaks. All in all, the stimulus presentation portion of the experiment lasted over an hour. The whole study took approximately 3 hours including electrode preparation.

Lastly, the offline task was given to L2 learners two weeks after the study. It was interfaced with the Google survey tool, and thanks to this computerized format, L2 participants could fill it out at their convenience, anywhere and anytime of the day. In addition, the presentation of all the critical verbs and their response options on a single page provided the flexibility of moving back and forth among sentences without any time constraint. This design was assumed to give our L2 participants more comfort and less stress. Altogether, this procedure was estimated to only 15-20 minutes.

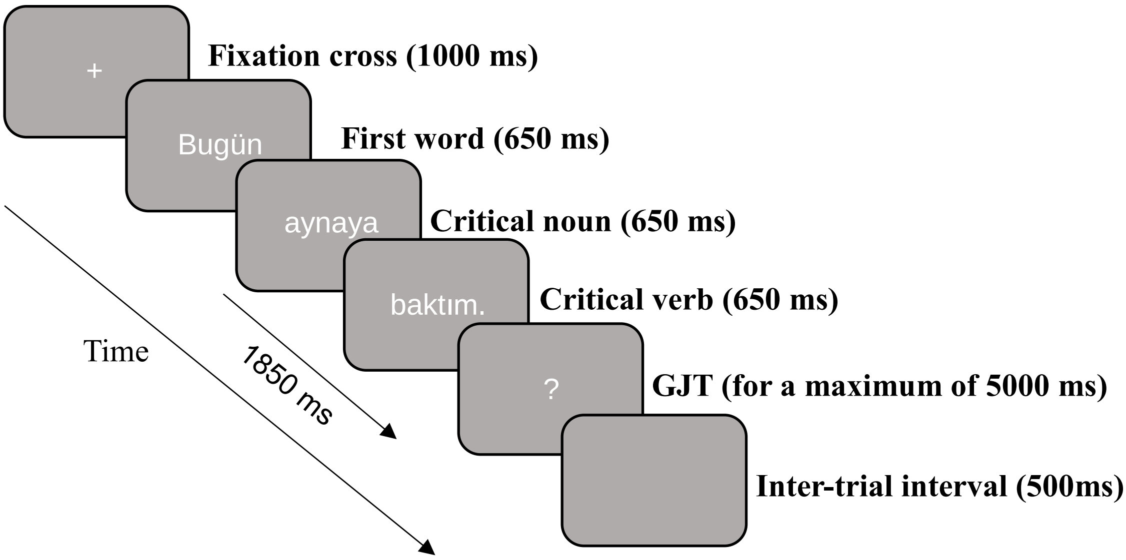


Figure 3.1. Schematic illustration of the sentence trial structure with word durations. EEG data were time-locked to the onsets of the critical noun and verb.

3.2.5 Experiment 2: EEG recording

It was the same EEG recording procedure as described in LDT, considering that the two experiments were conducted consecutively, and only at the beginning of the study, which was prior to the LDT, the cap and electrodes were placed on each participant.

3.2.6 Experiment 2: EEG data processing

The EEG sentence data were segmented into 1000-ms-long epochs time-locked to the onset of the critical nouns or verbs (plus a 100 ms pre-word baseline). The same EEG processing procedures were followed as in Experiment 1. Consequent to the visual inspection and individual evaluation of all trials for artifacts, data from two L1 participants were excluded due to having more than 50% artifacts on experimental trials and some technical issues. Data from seven L2 participants were also excluded due to a high artifact rate (more than 50%). After excluding these participants, artifact rejection affected 12.16% of experimental trials (L1:11.42%; L2:12.75%).

Based on the clean data free of ocular and muscular artifacts, single-subject ERPs were formed and filtered offline (i.e., a low pass filter of 40Hz) in order to be used to calculate the grand-average ERPs across all subjects. According to the visual inspection of grand average waveforms across all scalp electrodes in both L1 and L2 data, we specified post-noun onset latency window of interest as 300-450 ms for N400 (the same time window as in LDT) as an index of the morphological processing of the case-inflected nouns. To address the scalp distribution of this ERP effect statistically, two factors were introduced into the analyses: a) *region* representing anterior/posterior distribution contrasting electrode locations from the front to the back of the head (frontal vs. central vs. parietal locations); and b) *hemipshere* representing left/right distribution contrasting electrode location at left, center and right side of the head. At the end, four regions of interest as in LDT were formed: left frontal (F3, F7, FC3, FT7), right frontal (F4, F8, FC4, FT8), left parietal (CP3, TP7, P3, P7), right parietal (CP4, TP8, P4, P8).

In accordance with the grand average ERP waveforms, 300-500 ms and 500-700 ms have been specified as the post-verb onset latency windows for early negativities (i.e., LAN and N400) and the late positivity (i.e, P600), respectively, which are expected to be the indices of case violation recognition during the processing of the matrix verb. Consequently, a single average amplitude was obtained for each condition for each electrode for each subject in these time windows with generous end points to capture even potentially slower L2 morphosyntactic processing. Based on the previous literature and the scalp topographic maps of the above ERP components, the fifteen central electrodes for N400 effects (F3, Fz, F4, FC3, FCz, FC4, C3, Cz, C4, CP3, CPz, CP4, P3, Pz, P4) and five left-anterior electrodes for LAN effects (F7, F3, Fz, FT7, FC3) and finally eleven centro-posterior electrodes for strong and consistent P600 effects (P7, P3, Pz, P4, P8, CP3, CPz, CP4, C3, Cz, C4) were selected for statistical analyses of verb processing across grammatical and ungrammatical sentences.

At the end, only trials that elicited a correct behavioral response (correct acceptance or correct rejection) were retained for the final analysis of verb processing. Thus, the final dataset contained 22,288 data points (87.84% out of total 25,348 data points: L1=88.57%; L2=86.81%).

3.2.7 Experiment 2: Behavioral results and statistical analyses

Reliability for Expeirment 2 was quite high (α=.96). The following accuracy analyses included data from participants with an accuracy rate (AR) above the chance level (50%) in the critical item set. Accordingly, one L2 participant's data was excluded. In addition, twenty-four critical trials were removed due to an error during verb presentation. Based on the unknown words or verb-object case assignments detected through the offline task, no item was excluded from individual data sets. Overall, the above exclusions constituted 1.64% of critical trials.

Table 3.3. Mean percentage AR and std.dev. results for GJT (Experiment 2)

Subject Group	Condition	Mean AR % (SD)
L1 (n=39)	Gr Nominative	94.19(23)
	Gr Genitive	96.66(18)
	Gr Accusative	98.89(11)
	Gr Dative	98.45(12)
	Ungr Accusative	96.74(18)
	Ungr Dative	95.30(21)
L2 (n=32)	Gr Nominative	82.93(38)
	Gr Genitive	89.49(31)
	Gr Accusative	90.27(30)
	Gr Dative	79.01(41)
	Ungr Accusative	66.84(47)
	Ungr Dative	55.66(50)

Descriptive statistics (Table 3.3) for mean ARs in native speakers indicate that the grammatical sentences with an accusative object yielded the highest AR (*mean*=98.89). Amongst the grammatical sentences, it was followed by its dative counterpart (*mean*=98.45) and the sentences with a genitive possessor noun (*mean*=96.66) and the ones with a nominative subject (*mean*=94.19)[29] in the L1

[29] The lowest ARs for the grammatical sentences with a nominative subject in L1 group might have been induced by the frequently used passive verb constructions in these sentences. Consistent with our

group. In the L2 group, it was also the grammatical sentences with an accusative object that yielded the highest AR (*mean*=90.27), while the ones with a dative object yielded the lowest AR (*mean*=79.01). In regards to the ungrammatical sentences, the ones, where a dative object preceded an accusative-assigning verb, yielded higher ARs across L1 (*mean*=96.74) and L2 (*mean*=66.84) subject groups. Figure 3.2 further visualizes these descriptive results in boxplots.

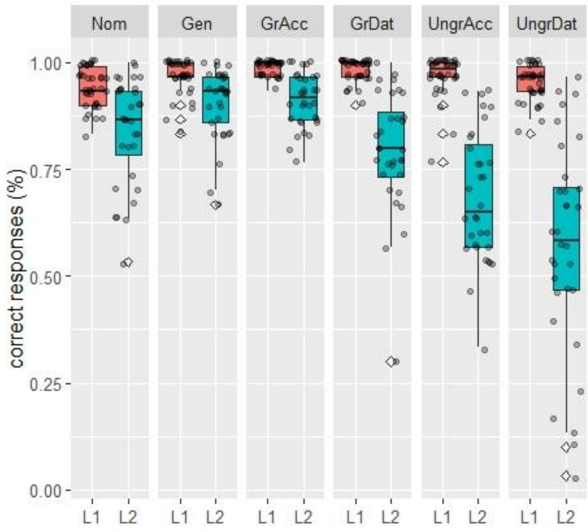


Figure 3.2. Boxplot of accuracy results for GJT (Experiment 2). Each circle indicates an individual participant's mean score. Diamonds indicate outliers.

Consistent with Research Questions 3 and 4 on the degree of L1 and L2 sensitivity to case violations detectable at the verb, only the sentences with an accusative or a dative object were included in the statistical analyses below. First, the accuracy results were submitted to a logistic mixed-effects model (glm function, Jaeger, 2008), with *grammaticality* (grammatical vs. ungrammatical), *verb case assignment type* (accusative vs. dative), *subject group* (L1 vs. L2) and their

research questions, the nominative and genitive conditions are discussed only for the ERP analyses of noun processing, not for ARs or ERP analyses of verb processing.

interactions as fixed effects. Given the differences in surface frequencies and number of letters across accusative- and dative-assigning verbs, verb frequency and length were also added to the model as covariates, based on the forward selection. As in LDT, these two continuous variables were first centered and scaled for possible model convergence failure, and then entered into the model with crossed-random effects for subjects and items. The maximal model with fully crossed-random effects was fit first (Barr, Levy, Scheepers, & Tily, 2013), and followed by model simplification. Potential convergence difficulties were avoided by specifying uncorrelated random effects. As determined by model comparisons conducted through ANOVAs, the model with the maximal random effects structure, which included random slopes of grammaticality, verb case assignment and their interactions for subjects and the random slopes of the same fixed effects, along with the subject group, and their interactions for items, was the best-fitting model. As in Experiment 1, statistical analyses and data plotting were carried out in *R* (version 3.5.3, R Core Team, 2019), using the software packages, *lme4* in order to construct mixed-effects models with the *bobyqa* optimizer (Bates, Mächler, Bolker, & Walker, 2019) and *ggplot2* for plotting.

Table 3.4. Logistic Mixed-Effects Model Table for GJT accuracy results (Experiment 2)

Fixed Effects	**Estimate**	**Std. Error**	**z**	**Pr >|z|**
Group	-3.02	0.57	-5.29	<.001 ***
Verb Freq	0.28	0.06	4.37	<.001 ***
Verb Length	-0.10	0.05	-2.07	.038 *
Group Reference Level: L1				
Grammaticality	-0.86	0.42	-2.03	.042 *
Verb Case Assignment Type	3.43	1.03	3.33	<.001 ***
Verb Case Assignment Type × Group	-4.34	1.04	-4.17	<.001 ***
Group Reference Level: L2				
Grammaticality	-1.57	0.20	-8.07	<.001 ***

Verb Case Assignment Type	-0.92	0.19	-4.81	<.001 ***
Grammaticality × Verb Case Assignment	0.41	0.24	1.71	.087 .
Verb Case Assignment Type × Group	4.36	1.03	4.23	<.001 ***

Signif. codes: *** <0.001; ** <0.01; * <0.05; . <0.1
Sample model formula: QMark.ACC ~ 1 + Grammaticality*VerbType*SubjGroup + VerbFreq.s + VerbLength.s + (1 + Grammaticality*VerbType || Subject) + (1 + Grammaticality*VerbType*SubjGroup || ItemNo)

First and foremost, the analysis of the mixed-effects logistic regression revealed a significant main effect of subject group with L2 learners displaying significantly lower ARs, compared to native speakers, ($\beta = -3.02$, $SE = 0.57$, $z = -5.30$, $p < .001$). There were also significant main effects of verb frequency, ($\beta = 0.28$, $SE = 0.64$, $z = 4.37$, $p < .001$), and verb length, ($\beta = -0.10$, $SE = 0.05$, $z = -2.07$, $p < .05$) across both subject groups. The main effect of grammaticality with ungrammatical sentences yielding lower ARs was statistically significant in both L1, ($\beta = -0.86$, $SE = 0.42$, $z = -2.03$, $p < .05$) and L2 groups, ($\beta = -1.57$, $SE = 0.20$, $z = -8.07$, $p < .001$). Critically, the model further revealed significant main effects of verb case assignment type with a significantly lower AR in sentences with the dative-assigning verbs, relative to the accusative-assigning verbs, across both L1, ($\beta = 3.43$, $SE = 1.03$, $z = 3.34$, $p < .001$) and L2 groups, ($\beta = -0.92$, $SE = 0.19$, $z = -4.81$, $p < .001$).

3.2.8 Experiment 2: ERP results and statistical analyses

The examination of the ERP waveforms (Figure 3.3) for the same case-inflected nouns as in LDT (with the addition of the nominative condition, which shares the same stem as with the other case conditions) show that the genitive nouns once again appear to yield an enhanced negativity over fronto-central electrodes from approximately 300-450 ms in L1 group. On the other hand, the dative objects seem to be producing slightly larger N400 effects than other case-inflected nouns in the L2 group. Across both participant groups, the accusative objects and nominative subjects seem to be eliciting the smallest negativity within the same 300-450ms time window as in LDT.

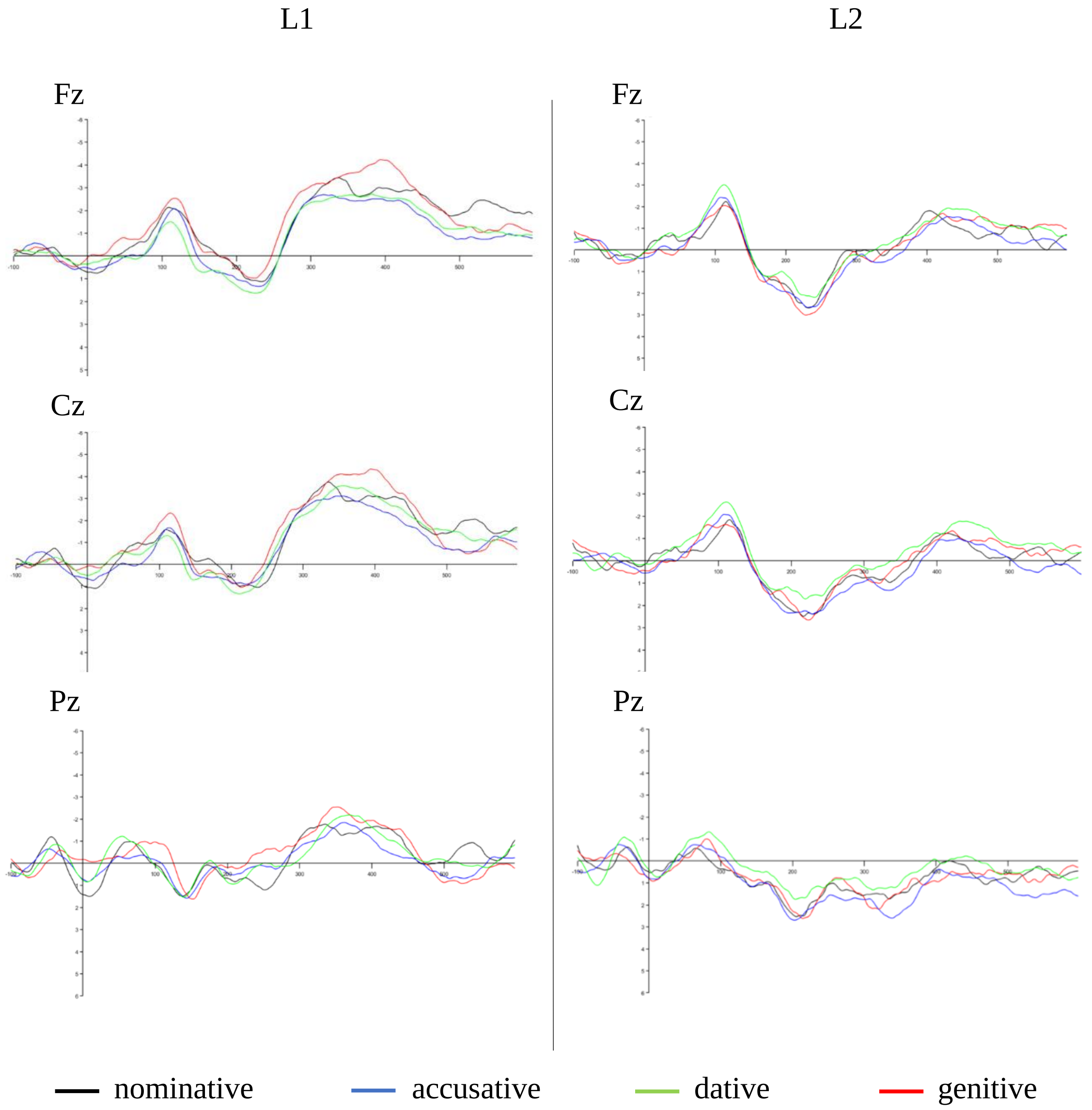


Figure 3.3. Grand average ERPs for different case-inflected noun forms (40 Hz low pass filter). The ordinate indicates the onset of the target noun. Timing is given in milliseconds. Negative voltage is plotted upwards.

To capture the peak difference between these case forms, 300-450 ms time window was chosen on the basis of examination of the waveforms. Analogous to LDT, averaged ERPs from this time window were analyzed with a 2 × 2 × 2 × 2 mixed-design ANOVA with Group (L1/L2) as a between-subject factor and Case (nominative/accusative/dative/genitive), Hemisphere (left/right) and Region (anterior/posterior) as within-subject factors. All sentences in six critical conditions were included in the analyses, that is, the sentences with case violations were also included because the violation could not be noticed at the site of the noun itself. No unknown words, as detected by the offline task, were excluded either. Statistical analyses were conducted in *R* (version 3.5.3, R Core Team, 2019), using the *afex* package (version 0.23-0, Singmann et al., 2019). The Geisser and Greenhouse (1959) correction for violations of sphericity was applied to all repeated measures with more than one degree of freedom, and corrected significance levels and uncorrected degrees of freedom were reported.

Table 3.5. Mixed Model ANOVA Table for N400 (300-450 ms) amplitudes across case-inflected nouns in GJT (Type 3 tests) (Experiment 2)

Effect	Num Df	Den Df	F	Pr (>F)
Group	1	61	1.96	.167
Case	3	183	0.54	.607
Hemisphere (Hem)	1	61	7.06	.012 *
Region	1	61	91.93	<.001 ***
Group × Region	1	61	3.64	.061 .
Case × Hem	3	183	3.01	.038 *
Group × Case × Hem	3	183	5.02	.004 **
Group × Hem × Region	1	61	8.82	.004 **
Post-hoc Tests on ROIs				
Left Anterior				
Group	1	61	6.48	.014 *
Case	3	183	0.17	.879
Group × Case	3	183	4.03	.014 *
Left Posterior				

Group	1	61	0.46	.499
Case	3	183	1.24	.297
Group × Case	3	183	1.69	.182
Right Anterior				
Group	1	61	2.77	.102
Case	3	183	1.20	.309
Group × Case	3	183	0.32	.778
Right Posterior				
Group	1	61	1.03	.314
Case	3	183	1.16	.322
Group × Case	3	183	0.46	.655
Post-hoc Test on Left Anterior ROI				
L1				
Case	3	108	2.80	.049 *
L2				
Case	3	108	1.64	.209
Signif. codes: *** <0.001; ** <0.01; * <0.05; . <0.1				

As seen in Table 3.5, the ANOVA across all 4 quadrant ROIs revealed significant three-way interactions of Group × Case × Hemisphere, $F(3,183)=5.02$, $p<0.01$, and Group × Hemisphere × Region, $F(1,61)=8.82$, $p<0.01$. Following these interactions, post-hoc analyses were carried out for each ROI with factors Group and Case. Moreover, based on the interaction of Group × Case in left anterior ROI, $F(3,183)=4.03$, $p=0.01$ (see Figure 3.4), separate analyses for each subject group were further conducted. A main effect of Case was found only in L1 group with a very focal distribution over left anterior electrode sites, $F(3,108)=2.80$, $p<0.05$.

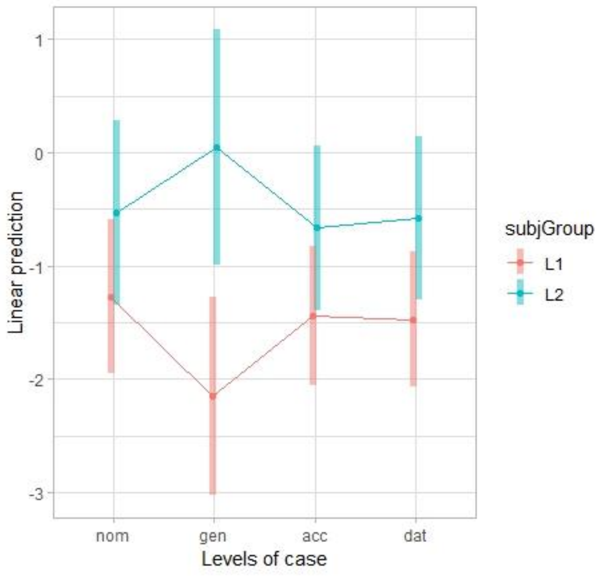


Figure 3.4. The interaction between Group and Case in N400 effects in left anterior ROI (Experiment 2).

Within this left anterior ROI, planned comparisons were conducted in L1 group (with Holm adjustments for p-values) by using effects coding for each case condition. No significant difference was found between any case conditions. Yet, the differences which showed the greatest N400 effects were between the genitive and nominative, (β = -0.88, SE = 0.39, |t| = -2.29, *p* = .17) and between the genitive and the accusative conditions, (β = -0.71, SE = 0.31, |t| = -2.25, *p* = .17), which was followed by the difference between the genitive and dative conditions, (β = -0.68, SE = 0.34, |t| = -1.98, *p* = .22) (see scalp topographic maps, Figure 3.5).

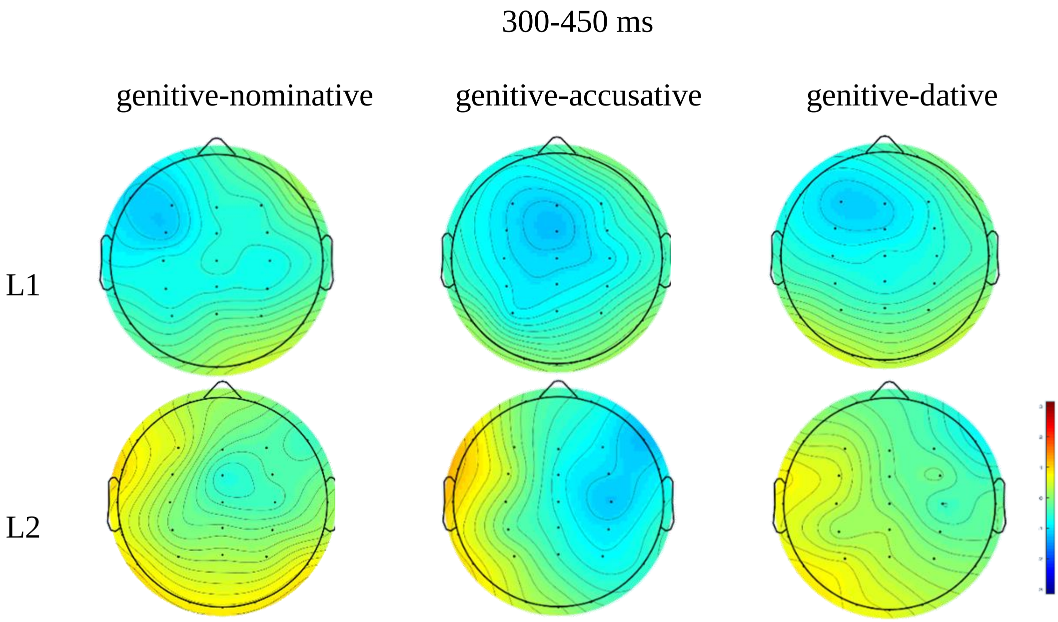


Figure 3.5. Scalp topographic maps showing the N400 distribution of planned comparisons between (a) genitive and nominative, (b) genitive and accusative and (c) genitive and dative case conditions within the 300-450 ms post-noun onset.

The examination of the ERP waveforms (Figure 3.6) during the processing of the matrix verb, where case violation was supposed to be recognized, reveals a robust P600 effect in L1 group, which peaked at around 600 ms, with a maximal activity over the posterior electrode sites (see the topographic maps, Figure 3.7). However, in the L2 group, no P600 effect is observed[30], and instead the ERP waveforms within 500-700 ms seem to be cluttered. Only after 800 ms, they seem to be slightly separated in two groups based on the previous object case type, with the dative case leading to larger positivity. A difference in P600 effects between the two ungrammatical conditions further appears in L1 group with the accusative verb preceded by a dative object leading to more positivity at around 600 ms. Lastly, in

[30] This lack of P600 was observed even in L2 learners whose metalinguistic knowledge on correct case assignments was excellent, as revealed by the offline task given at the end of the study.

300-350 ms, the grammatical accusative condition is less negative than the other conditions, and only in a later time window (350-450 ms) ungrammatical sentences with a case violation appear to be eliciting a larger negativity in L1 group, which was prominent at fronto-central electrodes. In L2 group, there is even a stronger pattern in 300-450 ms, where the grammatical accusative condition is less negative than the other conditions. Unlike in L1 group, the larger negativity as a sign of grammaticality effect in both accusatives and datives continues over 900 ms-time-window. As displayed by the topographic plots (Figure 3.7), the early enhanced negativity for ungrammatical accusatives is maximal in right fronto-central electrodes, whereas it is more prominent in posterior regions for ungrammatical datives.

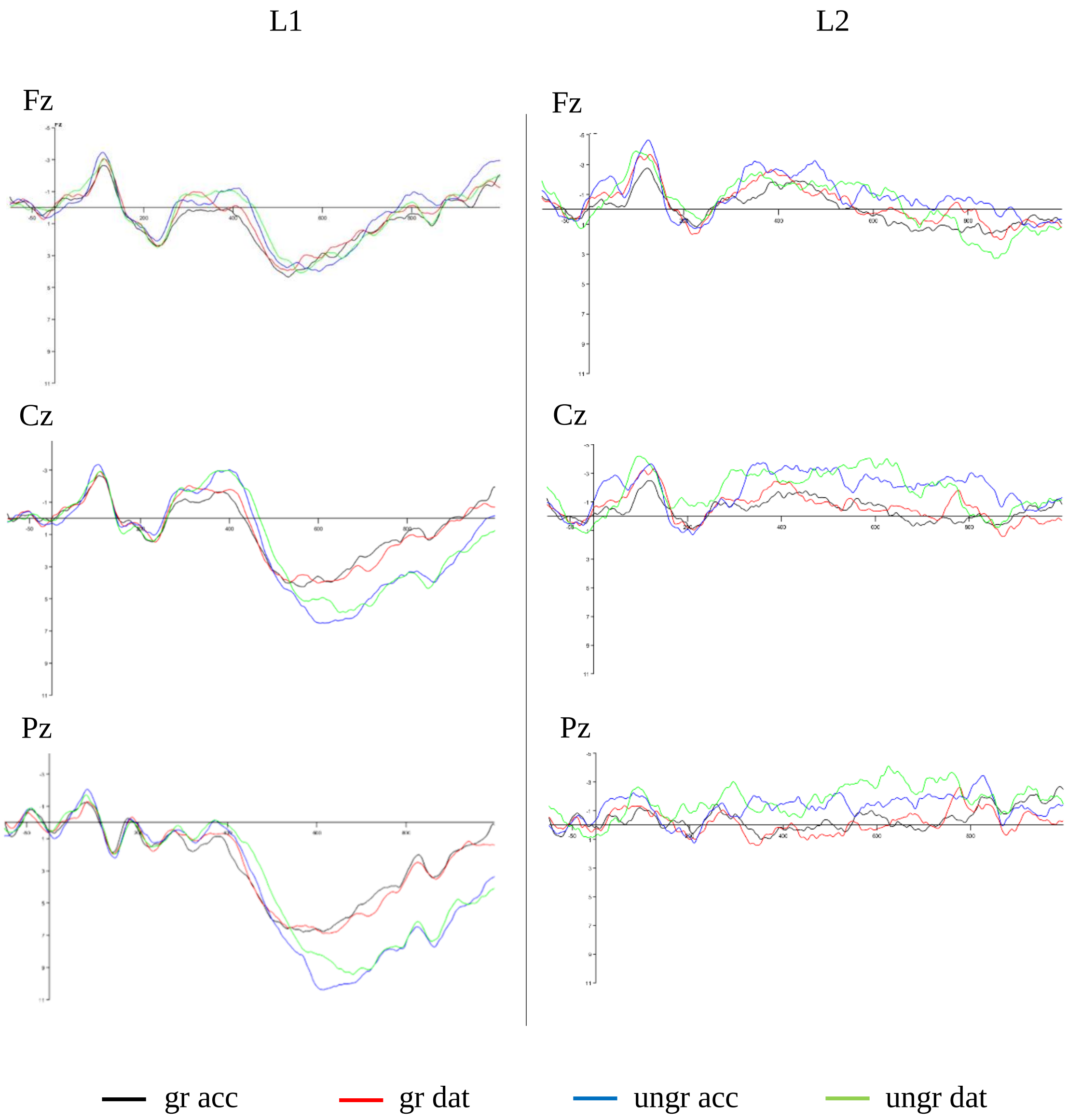


Figure 3.6. Grand average ERPs for grammatical and ungrammatical sentences across accusative- and dative-assigning verbs (40 Hz low pass filter). The ordinate indicates the onset of the critical verb (disambiguation point). Timing is given in milliseconds. Positive voltage is plotted downwards.

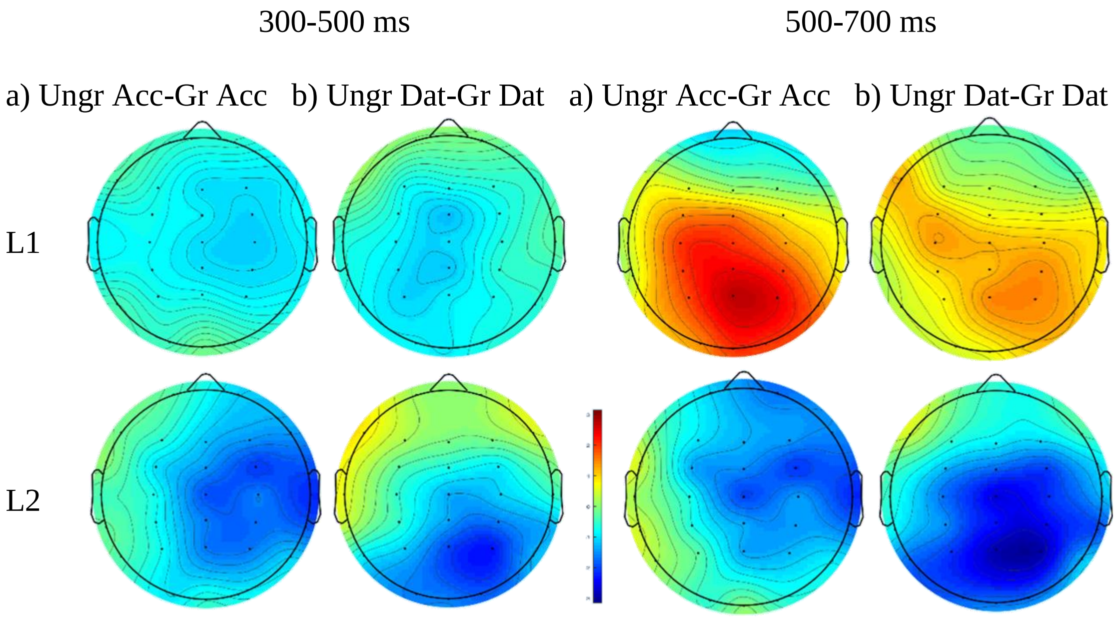


Figure 3.7. Scalp topographic maps showing the N400, LAN and P600 distribution of planned comparisons between (a) ungrammatical accusative and grammatical accusative, and (b) ungrammatical dative and grammatical dative case conditions within the 300-500 ms post-verb onset.

First, the averaged ERPs from the eleven centro-parietal electrodes within the 500-700 ms time window were analyzed with a 2 × 2 × 2 mixed-design ANOVA with Group (L1/L2) as a between-subject factor and Grammaticality (grammatical/ungrammatical), Verb case assignment type (accusative/dative) as within-subject factors. Only correct responses (correct acceptance or rejection) were included in the analyses. No items were excluded based on subject's metalinguistic knowledge of verb case assignment, as detected by the offline task. Statistical analyses were conducted in *R* (version 3.5.3, R Core Team, 2019), using the *afex* package (version 0.23-0, Singmann et al., 2019).

Table 3.6. Mixed Model ANOVA Table for P600 (500-700 ms) amplitudes across critical matrix verbs in GJT (Type 3 tests) (Experiment 2)

Effect	Num Df	Den Df	F	Pr (>F)
Group	1	61	18.20	<.001 ***
Grammaticality	1	61	0.05	.825
Verb Case Assignment Type	1	61	1.98	.164
Group × Grammaticality	1	61	6.84	.011 *
Post-hoc Tests on Group				
L1				
Grammaticality	1	36	4.57	.039 *
Verb Case Assignment Type	1	36	1.65	.208
Grammaticality × Verb Case Assignment Type	1	36	0.37	.546
L2				
Grammaticality	1	25	2.70	.113
Verb Case Assignment Type	1	25	0.59	.450
Grammaticality × Verb Case Assignment Type	1	25	1.02	.322
Signif. codes: *** <0.001; ** <0.01; * <0.05; . <0.1				

As displayed in Table 3.6, statistical analyses first found a Group × Grammaticality interaction, $F(1,61)=6.84$, $p=0.01$. Figure 3.8 below visualizes this interaction by giving predicted mean ERP effects for different conditions (grammatical vs. ungrammatical). As seen in the figure, native speakers' sensitivity to ungrammaticality generated by case errors is reflected with more positivity, whereas L2 learners' is reflected with more negativity. Separate ANOVAs for each subject group revealed a significant main effect of grammaticality on P600 effects only in L1 group, $F(1,36)=4.57$, $p<0.05$. On the other hand, the visual difference in the magnitude of P600 effects by the two ungrammatical conditions, which was manifest in the ERP waveforms (Figure 3.6) and topographic maps (Figure 3.7), was not statistically significant.

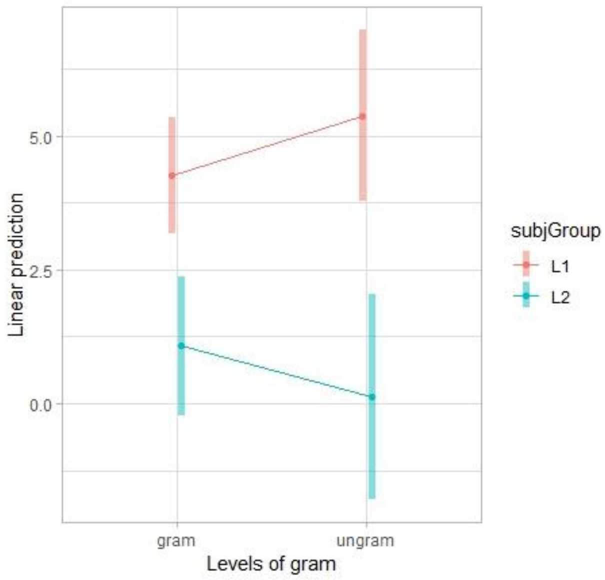


Figure 3.8. The interaction between Group and Grammaticality in P600 effects (Experiment 2).

With regard to the biphasic N400-P600 or LAN-P600 effects, as observed in Figure 3.7, separate ANOVAs for each ERP component were performed within the 300-500 ms time window. The averaged ERPs from the fifteen central electrodes, representative of typical N400 effects, were analyzed with the same 2 × 2 × 2 mixed-design ANOVA with Group (L1/L2) as a between-subject factor and Grammaticality (grammatical/ungrammatical), Verb case assignment type (accusative/dative) as within-subject factors.

The ANOVA results indicate a significant main effect of Group with remarkably larger N400 effects in L2 group, $F(1,61)=5.13$, $p<.05$ (Table 3.7). The significant main effect of Grammaticality on N400 amplitudes was also found across both subject groups, $F(1,61)=13.39$, $p<.001$. The same ANOVA design was used for the analysis of the averaged ERPs from the five left anterior electrodes, and elicited the significant main effect of Grammaticality, $F(1,61)=7.44$, $p<0.01$. In sum, both early negativity components, namely N400 and LAN, were found to be associated with ungrammatical case assignment in both subject groups. In other words, significantly larger N400 and LAN responses to ungrammaticality was found in both L1 and L2 groups. In L1 group, they were further followed by late positivities, maximal over centro-parietal electrode sites (see Figure 3.7).

Table 3.7. Mixed Model ANOVA Table for N400 and LAN (300-500 ms) amplitudes across critical matrix verbs in GJT (Type 3 tests) (Experiment 2)

Effect	Num Df	Den Df	F	Pr (>F)
N400				
Group	1	61	5.13	.027 *
Grammaticality	1	61	13.39	<.001 ***
Verb Case Assignment Type	1	61	0.41	.527
Group × Grammaticality	1	61	0.34	.561
Group × Verb Case Assignment Type	1	61	0.00	.979
Grammaticality × Verb Case Assignment Type	1	61	0.63	.432
Group × Grammaticality × Verb Case Assignment Type	1	61	0.03	.856
LAN				
Group	1	61	2.73	.103
Grammaticality	1	61	7.44	.008 **
Verb Case Assignment Type	1	61	0.40	.532
Group × Grammaticality	1	61	0.14	.711
Group × Verb Case Assignment Type	1	61	2.77	.910
Grammaticality × Verb Case Assignment Type	1	61	0.01	.102
Group × Grammaticality × Verb Case Assignment Type	1	61	0.00	.947

Signif. codes: *** <0.001; ** <0.01; * <0.05; . <0.1

3.3 Experiment 2: Discussion

The first set of GJT results reports the analyses of the neural responses (i.e., N400s) during the L1 and L2 morphological processing of the same case-inflected nouns as in LDT within a sentence context (i.e., nominative subjects, genitive possessor nouns, accusative and dative objects) in order to examine whether the differences in their processing costs are generated by lexical or sentence processes.

The results indicate that no significant difference in N400 amplitudes during the sentence-level processing of different-case inflected nouns was found, even in L2 group. Even though the visual examination of the ERP waveforms (Figure 3.3) and scalp topographic maps (Figure 3.5) shows a similar pattern to single word-level case processing in L1 group (i.e., a graded pattern in N400 effects, where the nominative and accusative conditions elicited the smallest N400s, followed by the dative and genitive conditions), the magnitude of this pattern is different during this sentence-level case processing. Put differently, during sentence processing, L1 group shows larger N400 contrasts between the genitive and other case forms than in LDT, although these contrasts still could not reach any significance. L2 group, on the other hand, do not show any significant differences in N400 effects of different cases, which was present in LDT. Overall, only L1 group displays a case type effect on N400 amplitudes with a maximal activity in left anterior ROI (see more pronounced N400 effects in right anterior ROI in LDT). Consequently, it can be argued that across subject groups, sentence context plays an opposite effect on N400 effects of different case markings, especially the genitive case, which seems to be more costly for native speakers when placed in a sentence.

The second set of GJT results reports the analyses of both behavioral (i.e., ARs) and neural responses (i.e., P600, N400 and LAN) during the L1 and L2 morphosyntactic processing of structural (i.e., the substitution of the dative for the accusative) vs. lexical case violation (i.e., the substitution of the accusative for the dative) on the object, as disambiguated by the upcoming matrix verb. As expected, the behavioral results show a significant decrease in ARs for ungrammatical sentences across both subject groups.[31] Furthermore, ARs are significantly reduced for the dative-assigning verbs in L2 group, which can be attributed to the relatively lower surface frequency of these verbs, compared to their accusative counterparts, and the lexical (more idiosyncratic) nature of the dative case in general (Neeleman & Weerman, 1999; Woolford, 2006). There was also a marginally significant interaction between grammaticality and verb case assignment type in L2 group only, which implies that there was somewhat less sensitivity to lexical, relative to structural, case violations (for L2 learners' selective reading slowdown observed for structural case violations only, see Hopp & León Arriaga, 2016).

In line with the previous research (Frisch & Schlesewsky, 2001, 2005), the ERP results further show that native speakers were sensitive to case violations, as indexed by enhanced P600 for the erroneous conditions. Yet, the visual blip for the structural case violation, that is the replacement of the accusative with the dative, in the ERP waveforms (Figure 3.6) was not statistically significant, which substantiates the behavioral finding of non-differential sensitivity in L1 group to the two types of case anomalies as reported above. On the other hand, even advanced L2 learners were not sensitive to case violations, as suggested by the absence of P600 differences between the grammatical and ungrammatical sentences (for similar results, see Mueller, Hirotani, & Friederici, 2007). This lack of sensitivity confirms that L2 learners, unlike native speakers, did not perform a fast retrieval and analysis of the case marking on the previous object in order to construct a case concord, which would

[31] L2 learners show above-chance performance for all conditions (see Table 3.3), but it is important to note that these ARs were derived from the data that was not free of unknown verb case assignments as detected through the offline task. Therefore, it is likely that the clean data may further lower ARs to the below-chance degree in L2 group, especially in the ungrammatical dative condition.

allow them to recognize the incongruent case morphology at the verb position. Nonetheless, L2 learners, similar to native speakers, showed significantly larger negativities (N400 and LAN) during verb processing for ungrammatical case assignments. These enhanced early negativities without the concomitant late positivities might be associated with L2 learners' initial reliance on the lexical semantics of the matrix verb, along with the preceding object, rather than the morphosyntactic cues, such as case marking and its proper assignment (see *the shallow structure hypothesis* by Clahsen & Felser, 2006, 2017). Alternatively, in line with Romanova and Gor's (2017) study on gender and number agreement in noun phrases, the pattern of early sensitivity without any evidence with later reparsing may indicate that L2 learners notice the mismatch between the case of the noun and the case-assigning verb, but do not attempt to reparse the sentence.

In conclusion, native speakers and advanced L2 learners show different morphological processing patterns of different case markings. In other words, when the same case-inflected nouns from LDT were placed in a sentence, the differences in the magnitude of their processing costs, as measured by N400s, appeared, especially in L1 group (i.e., the genitive produced larger N400 effects, compared to other case conditions, than in LDT, though these differences were still not significant). This finding can further imply that the differences in L2 processing difficulties of different case forms are driven by lexical processes, rather than sentence processes. On the other hand, native speakers' and L2 learners' morphosyntactic processing patterns of case errors qualitatively differed from each other, as attested by both behavioral and ERP measures. L2 learners' ARs, for example, were significantly lower for the sentences with a dative-assigning verb, independent of their grammaticality. The lack of P600 modulations by grammaticality can further attest to the non-nativelikeness of L2 case violation processing. In this respect, the sole presence of enhanced N400 and LAN effects for the processing of ungrammatical sentences by L2 learners, unlike the biphasic N400-P600 or LAN-P600 effects by native speakers, simply provides an additional support for the distinct reanalysis mechanisms and thus a qualitative distinction between L1 and L2 morphosyntactic processing of case, which is evidenced by the lexical (N400) and partly syntactic (LAN in the absence of P600) processing by L2 learners.

Chapter 4: General Discussion & Conclusion

Given the paucity of previous literature on the processing of noun case marking, this study holds importance in that it compares both the morphological processing of case markers across words and sentence contexts, and their morphosyntactic processing within the same sentence contexts across native and nonnative speakers of Turkish, an agglunative language with a rich case inflectional system. In this respect, it primarily seeks to examine whether the case-intrinsic properties (i.e., structural vs. lexical dichotomy, argumenthood, and type frequency) play any role in L1 and L2 morphological processing during word recognition in isolation or in a sentence. It further investigates L1 and L2 morphosyntactic processing of case violations and whether their sensitivity to these errors is modulated by the case type (i.e., structural vs. lexical case violations on the object). To this end, this exploratory study set out to examine the behavioral and neural mechanisms involved in case marking processing costs during lexical access and sentence comprehension by native speakers and advanced L2 learners of Turkish.

Within the continuing debate about the neurocognitive nature of word decomposition models (Marslen-Wilson & Tyler, 1997), the present study is compatible with the idea that advanced L2 learners, similar to native speakers, go beyond affix stripping during lexical access and reach the morphological information of different case markers through recombination and checking mechanisms (also see Gor et al., 2017a). The behavioral data of Experiment 1 present a clear distinction between the processing costs of the genitive and other cases (i.e., nominative as revealed by L1 and L2 RTs, and object case forms as revealed by L2 ARs and RTs) during online word recognition. Thus, it can be claimed that the genitive processing cost was more pronounced in L2 learner group, such that only their behavioral data revealed a notable RT difference between the genitive and other oblique-case forms. Interestingly, the ERP data present this distinction in morphological processing costs of the accusative and the genitive cases as well as the accusative (structural) and dative (lexical) cases only in L2 group. To summarize, the greater processing difficulty associated with the genitive case was established by both behavioral and neural data, and it seems to be contingent on its non-argumenthood, in that unlike other oblique-case forms (i.e., accusative and dative), it is not an argument of a verb. The morphological processing cost differences between the structural and lexical cases in L2 group, as previously shown by Karatas, Gor and Lau (in preparation) were however revealed only by the neural data.

The differential processing costs of these case markers observed during word recognition in isolation become more pronounced in L1 group when they are placed in a sentential context. During this sentence-level processing, the genitive case, in particular, leads to larger N400 effects, compared to other case forms, than in LDT, although these differences between the genitive and other cases do not reach a significant level. Thus, the differential behavioral patterns in the previous SPR study (e.g., extremely long RTs for the genitive nouns in both subject groups, and longer RTs for the dative nominalized objects, relative to their accusative counterparts, by L2 learners) are not supported by these non-significant differential ERP patterns. Thus, these findings imply that the aforementioned L1 and L2 difficulty with the genitive or L2 difficulty with the dative case processing is at the level of form, rather than a sentence structure, as further established by Experiment 1 (LDT) findings, where L2 learners displayed significantly larger N400 effects for these two cases, relative to the accusative. In addition, the study provides counterevidence against the phrase-level processing advantage of the nominative or citation nouns, especially by highly proficient L2 learners (see Gor et al., 2017b). The fact that even the nominative nouns are not processed more easily than the oblique-case conditions with an overt morpheme by L2 learners may further imply that the comparisons were not fair, given the different syntactic structures for each case-inflected noun, particularly the frequent use of passive constructions in the sentences with a nominative subject.[32]

In regards to the morphosyntactic processing of structural (accusative) and lexical (dative) object case markings, Experiment 2 reveals that even though L2 learners' behavioral data signal certain sensitivity to case violations with the above-chance rejection rates for ungrammatical sentences, their ERP data indicate that the primary index of syntactic reanalysis, that is P600, was missing, albeit the presence of early negativities for these case anomalies. This lack of P600s may lend support to the *shallow structure hypothesis* (Clahsen & Felser, 2006, 2017), such that native-like morphosyntactic processing of case markings can be missing even at advanced proficiency levels (for similar behavioral results, see Karatas, Gor, & Lau, in preparation). However, the native-like pattern for early negativities in L2 group may further posit that they are engaged in both the lexical (N400) and syntactic (LAN) processing of the verb to find out the ungrammatical case assignment. The finding that L2 learners, like native speakers, evaluate the verb argument structure (LAN) and semantic fit (N400), is clearly in constrast with the claim for shallow representations and shallow structure processing in L2 learners. Yet, it is important to note that these

[32] It is noteworthy to remember that Turkish is a head-final language, where the verb follows both its subject and object. Therefore, in the current experiment design, the reader can only guess what type of verb will come while and/or after processing the critical case-inflected noun.

advanced L2 learners also displayed significantly lower accuracy scores, especially for dative-assigning verbs, which can lead us to question their proficiency levels and hence understand the absence of P600 responses to case anomalies in GJT. In this light, the nonnative-like variability in L2 morphosyntactic processing of case assignments, which suggests their failure to quickly integrate case morphology, along with its abstract properties, into an incremental representation of a sentence during real-time language comprehension, can also be attributed to their non-advanced proficiency levels.

L2 failure to exploit case marking in the same way as native speakers do, may also originate from mapping or processing problems at the morphology-syntax interface, albeit intact functional projections and feature values (see Jiang, 2004; 2007). In other words, their inability to retrieve and compute the essential case information on the previous constituent during the processing of the following verb may be triggered by the computational burden during this online judgment task, where participants could not go back and reread a word. In brief, the presentation design might also constrain the access, retrieval and activation of the explicit knowledge of the crucial case assignment by L2 learners who exhibited above-chance performance for the ungrammatical sentences.

Last but not least, neither subject groups' neural responses to the critical matrix verb differed across structural vs. lexical case violation types (i.e., substitution of the dative for the accusative or vice versa) on the object, though L2 learners' behavioral responses gave a hint of this distinction (i.e., lower ARs for lexical case violations) (also see Hopp & León Arriaga, 2016). Overall, these empirical results of the current GJT demonstrate that the advanced L2 learners' morphosyntactic processing patterns diverge from native speakers' in a qualitative manner, which can be related to either incompleteness in their knowledge representation or processing problems revealed in online task formats.

4.1 Implications

This behavioral and neurolinguistic study makes significant contributions to both theory and practice of teaching and learning agglunative languages with a rich inflectional system, such as Turkish. From the theoretical perspective, the findings identify the source of word- and sentence-level processing difficulties associated with different case forms as well as the behavioral and neural correlates of native and nonnative morphosyntactic processing patterns. On the practical side, this study informs language educators about what aspects of the Turkish case paradigm (e.g., "non-argument" or "lexical" case marking) are challenging even for highly successful L2 learners and therefore need further pedagogical intervention. Given that highly proficient L2 learners could not cope with the morphosyntactic computations through structure-based parsing strategies, case marking requires extra attention from teachers and stake-holders in language training.

We hope that this study will serve as a reference for Turkish teaching practitioners and textbook designers as to how to teach the Turkish case system in a more efficient way. Given that these L2 learners, who have been intensively exposed to Turkish for at least four years, could not display the native-like processing of Turkish case violations, it is possible that they need a larger amount of explicit input and training (i.e., explicit-deductive learning) to attain the target-like knowledge of the notably troublesome Turkish case assignment, particularly for the lexical dative cases. In this sense, Turkish instructors can make use of the activities that will foster

L2 learners' awareness of the idiosyncracies in the dative case assignment so that they can deploy the Turkish case system more efficiently and effectively in everyday speech production and comprehension (Jackson, 2008). Overall, the findings here highlight the dire need of instructional attention to boosting L2 learners' sensitivity to distinct case features and their distributional characteristics in a diverse range of L2 input, which can be missing even at the advanced stages of the acquisition of an agglutinative language like Turkish.

4.2 Limitations and future directions

More research is needed to address the limitations of the current study. Only then can the results of the present study be generalized to other nonnative speaker populations. For example, the study employed a customized language background questionnaire to recruit highly-advanced L2 learners, mainly based on the length of their exposure to Turkish (i.e., length of stay in Turkey and daily use of Turkish). However, given that L2 learners' rejection rates for ungrammatical sentences were not as high as native speakers' and they could not show any P600 effects for case errors, a more standardized questionnaire, such as LEAP-Q (Language Experience and Proficiency Questionnaire, Marian, Blumenfeld, & Kaushanskaya, 2007), or a proficiency test specifically designed for the current study could have been administered. Considering that case marking is notably difficult to acquire even by advanced L2 learners, future research should exert caution in selecting only near-native L2 learners (Hopp, 2006) or the ones whose L1 also denotes grammatical functions through case marking so that they can cope with case assignment with as much ease as native speakers. It is possible that with such a highly proficient L2 group and a positive L1-based bias, more parallel results between L1 and L2 morphosyntactic processing of case violations can be reported even in online tasks (Hopp, 2010).

Another way to obtain more comparable results across L1 and L2 groups with the current data may concern the data analysis techniques. For example, the current EEG analyses in the GJT task included only the correct responses; however, incorrect responses on follow-up questions about grammaticality cannot be automatically interpreted as deviant processing of the verb. Given that excluding all the “incorrect” trials reduces the statistical power, additional EEG analyses including incorrect trials should be conducted and results should be compared accordingly.

Appendices

A2.1 Language background questionnaire

I. Personal Information (Will Remain Confidential)

Identification Code:____
E-mail address:__________________________________
Sex: Female__________Male:_________
Date of Birth:________________Place of Birth (country):__________________________
Occupation:____
Highest Level of Schooling: Secondary__High school__College__Graduate School____
Dominant hand: Right________ Left________ Both____________

II. Linguistic Information

Mother Tongue: ____
Language of Education:
Primary School:___________________________Secondary School:__________________
High School:______________________________University:_________________________
Age of first exposure to Turkish: _____Place of first exposure to Turkish:____________
How long have you been learning Turkish?_____________________________________
How often do you use Turkish? Always___Often___Sometimes___Rarely___Never___
Where do you generally use Turkish? Home: ____Work/School: ____Social: ________
How long have you been in Turkey? ________Is it your first time in Turkey? ________
If not, when was it and how long did you stay?
Age of arrival:_____________________ Length of stay: ___________________________

III. Turkish Language Proficiency

Have you ever taken any standardized Turkish Proficiency Test?____________________
If yes, what was your score in the following areas?
Reading_____Writing_____Speaking______Listening_____Overall______
How would you rate your linguistic ability in Turkish in the following areas?

	Beginner	Intermediate	Advanced	Near-Native
Reading				
Writing				
Speaking				
Listening				
Overall Competence				

IV. Second/Foreign Language(s): (in the order of acquisition/learning)
Second/Foreign Language 1:_____________________________

	Beginner	Intermediate	Advanced	Near-Native
Reading				
Writing				
Speaking				
Listening				
Overall Competence				

Second/Foreign Language 2: ______________________________

	Beginner	Intermediate	Advanced	Near-Native
Reading				
Writing				
Speaking				
Listening				
Overall Competence				

Second/Foreign Language 3:______________________________

	Beginner	Intermediate	Advanced	Near-Native
Reading				
Writing				
Speaking				
Listening				
Overall Competence				

Second/Foreign Language 4:______________________________

	Beginner	Intermediate	Advanced	Near-Native
Reading				
Writing				
Speaking				
Listening				
Overall Competence				

A2.2 Table of stimuli for Experiment 1 (Lexical Decision Task)

Lemma Translation	Gen Noun	Gen Freq	AccWord	Acc Freq	DatWord	Dat Freq
uncle	amcanın	5,54	amcayı	1,58	amcaya	2,13
car	arabanın	27,15	arabayı	21,55	arabaya	20,09
malfunctioning (n)	arızanın	0,75	arızayı	0,61	arızaya	0,32
mirror	aynanın	8,92	aynayı	2,43	aynaya	13,36
garden	bahçenin	12,19	bahçeyi	5,62	bahçeye	24,57
guard(n)	bekçinin	1,64	bekçiyi	0,61	bekçiye	1,05
document	belgenin	7,44	belgeyi	6,27	belgeye	3,37
building	binanın	25,26	binayı	5,98	binaya	7,54
budget	bütçenin	8,11	bütçeyi	2,35	bütçeye	5,31
avenue	caddenin	5,64	caddeyi	2,41	caddeye	7,16
mosque	caminin	13,64	camiyi	2,55	camiye	11,29
funeral	cenazenin	1,24	cenazeyi	1,82	cenazeye	2,25
punishment	cezanın	7,2	cezayı	7,36	cezaya	4,6
sentence	cümlenin	8,35	cümleyi	13,26	cümleye	3,41
bag	çantanın	2,88	çantayı	5,94	çantaya	2,29
bazaar	çarşının	2,11	çarşıyı	0,89	çarşıya	2,29
roof	çatının	1,87	çatıyı	0,77	çatıya	2,53
fountain	çeşmenin	3,3	çeşmeyi	0,63	çeşmeye	1,4
surrounding	çevrenin	22,44	çevreyi	21,07	çevreye	32,66
soup	çorbanın	2,19	çorbayı	3,47	çorbaya	2,21
balance	dengenin	9,51	dengeyi	10,68	dengeye	5,37
magazine	derginin	13,52	dergiyi	6,16	dergiye	4,89
nature	doğanın	29,07	doğayı	14,52	doğaya	16,89
dress	elbisenin	4,54	elbiseyi	5,58	elbiseye	1,48
apple	elmanın	2,41	elmayı	3,18	elmaya	0,55
bill	faturanın	1,18	faturayı	1,93	faturaya	0,53
anecdote	fıkranın	1,13	fıkrayı	1,34	fıkraya	0,8
hurricane	fırtınanın	2,39	fırtınayı	1,34	fırtınaya	1,74
night	gecenin	56,04	geceyi	23,42	geceye	13,3
ship	geminin	16,24	gemiyi	5,39	gemiye	7,93
food	gıdanın	1,2	gıdayı	0,75	gıdaya	1,4
week	haftanın	15,47	haftayı	3,77	haftaya	11,6
carpet	halının	6,63	halıyı	1,68	halıya	1,78
map	haritanın	3,2	haritayı	2,41	haritaya	2,49
patient(n)	hastanın	31,16	hastayı	7,7	hastaya	12,1
mistake	hatanın	3,51	hatayı	6,02	hataya	3,77
towel	havlunun	0,32	havluyu	1,22	havluya	0,91
teacher	hocanın	12,61	hocayı	3,1	hocaya	5,25
needle	iğnenin	1,91	iğneyi	2,74	iğneye	0,97
interest	ilginin	9,65	ilgiyi	10,68	ilgiye	3,32
boatyard	iskelenin	3,08	iskeleyi	0,51	iskeleye	6,91

castle	kalenin	6,24	kaleyi	3,53	kaleye	6,1
door	kapının	55,98	kapıyı	83,53	kapıya	39,44
town	kasabanın	8,13	kasabayı	2,23	kasabaya	7,38
fight(n)	kavganın	6,2	kavgayı	4,18	kavgaya	7,87
cat	kedinin	6,51	kediyi	5,98	kediye	3,51
rent(n)	kiranın	0,57	kirayı	1,89	kiraya	5,41
neighbor	komşunun	5,58	komşuyu	0,89	komşuya	3,1
topic	konunun	46,84	konuyu	84,14	konuya	66,06
bridge	köprünün	8,67	köprüyü	5,25	köprüye	2,7
sheep	kuzunun	1,01	kuzuyu	1,2	kuzuya	0,57
adventure	maceranın	1,7	macerayı	1,01	maceraya	2,57
cave	mağaranın	4,87	mağarayı	1,07	mağaraya	3,53
store	mağazanın	2,98	mağazayı	0,61	mağazaya	2,33
neighborhood	mahallenin	14,11	mahalleyi	2,62	mahalleye	6,08
court	mahkemenin	15,71	mahkemeyi	1,91	mahkemeye	24,92
article	makalenin	3,45	makaleyi	1,8	makaleye	1,38
view	manzaranın	2,49	manzarayı	5,11	manzaraya	2,66
seagull	martının	1,24	martıyı	0,65	martıya	0,39
table	masanın	45,76	masayı	6,04	masaya	44,73
distance	mesafenin	4,2	mesafeyi	6,14	mesafeye	1,99
matter (n)	meselenin	9,55	meseleyi	13,36	meseleye	6,12
fruit	meyvenin	2,9	meyveyi	1,74	meyveye	1,64
customer	müşterinin	16,2	müşteriyi	5,23	müşteriye	11,64
nanny	ninenin	1,54	nineyi	0,28	nineye	0,63
money	paranın	45,68	parayı	61,39	paraya	22,87
napkin	peçetenin	0,08	peçeteyi	0,41	peçeteye	0,49
window	pencerenin	18,75	pencereyi	7,79	pencereye	11,82
curtain	perdenin	6,49	perdeyi	6,79	perdeye	3,14
market	piyasanın	13,12	piyasayı	4,6	piyasaya	39,03
appointment	randevunun	0,32	randevuyu	1,01	randevuya	1,07
stage	sahnenin	11,21	sahneyi	8,05	sahneye	41,81
page	sayfanın	6,51	sayfayı	7,52	sayfaya	5,51
insurance	sigortanın	45,98	sigortayı	0,41	sigortaya	0,97
stove	sobanın	5,62	sobayı	1,85	sobaya	1,58
dining table	sofranın	2,35	sofrayı	5,9	sofraya	9,41
joke	şakanın	0,77	şakayı	1,42	şakaya	2,43
password	şifrenin	0,37	şifreyi	1,74	şifreye	0,28
bottle	şişenin	3,18	şişeyi	5,19	şişeye	2,29
signboard	tabelanın	0,69	tabelayı	0,99	tabelaya	0,39
field	tarlanın	3	tarlayı	1,95	tarlaya	4,83
backgammon	tavlanın	0,3	tavlayı	0,36	tavlaya	0,41
treatment	tedavinin	6,97	tedaviyi	3,69	tedaviye	12,25
hill	tepenin	8,29	tepeyi	2,76	tepeye	9,75
tray	tepsinin	2,37	tepsiyi	3,26	tepsiye	4,83
tailor	terzinin	0,85	terziyi	0,16	terziye	0,69

aunt	teyzenin	3,85	teyzeyi	1,32	teyzeye	1,42
plastic bag	torbanın	1,64	torbayı	2,51	torbaya	2,51
country	ülkenin	176,47	ülkeyi	38,64	ülkeye	50,44
peak	zirvenin	2,82	zirveyi	1,46	zirveye	10,32
FILLERS						
spice	baharat	3,39				
pea	bezelye	4,44				
bean	fasulye	9,35				
spinach	ıspanak	4,97				
ant	karınca	11,33				
butterfly	kelebek	16,2				
peach	şeftali	5,37				
chestnut	kestane	6,22				
roof tile	kiremit	3,85				
reporter	muhabir	7,38				
ribbon	kurdele	1,66				
roasted chickpea	leblebi	3,97				
pasta	makarna	8,29				
furniture	mobilya	7,99				
interview	mülakat	4,52				
spider	örümcek	11,68				
daisy	papatya	7,48				
umbrella	şemsiye	6,1				
gun	tabanca	10,34				
hell	cehennem	16,1				
parsley	maydanoz	10,66				
magnet	mıknatıs	3,35				
chat (n)	muhabbet	17,58				
eggplant	patlıcan	7,12				
orange	portakal	18,37				
chair	sandalye	16,44				
garlic	sarımsak	10,91				
ginger	zencefil	1,8				
blanket	battaniye	5,39				
stationary	kırtasiye	2,57				
terrible	berbat	15,25				
generous	cömert	7,79				
crazy	çılgın	17,33				
angry	kızgın	20,82				
busy	meşgul	28,43				
needy	muhtaç	25,65				
regretful	pişman	24,19				
lazy	tembel	11,37				
stubborn	inatçı	8,8				
available	müsait	12,96				

naughty	şımarık	5,82
jealous	kıskanç	5,6
fifth	beşinci	29,87
patient	sabırlı	12,85
orange	turuncu	10,32
shy	utangaç	8,37
perfect	mükemmel	51,01
without sugar	şekersiz	2,17
round	yuvarlak	31,83
handsome	yakışıklı	25,63
seriously	cidden	5,03
immediately	derhal	40,21
officially	resmen	36,19
quite	bayağı	23,03
in vain	boşuna	37,85
knowingly	bilerek	28,18
bravely	cesurca	1,78
childishly	çocukça	5,47
straight	doğruca	8,09
without permission	izinsiz	6,83
runningly	koşarak	25,34
rarely	nadiren	10,3
angrily	öfkeyle	17,9
soon	yakında	35,72
slowly	yavaşça	28,61
as a family	ailecek	3,22
early	erkenden	23,21
roughly	tahminen	2,7
obligatorily	mecburen	8,41
in the morning	sabahleyin	10,1
don't touch	dokunma	7,2
(he) brought	götürdü	26,48
(he) stopped by	uğramış	18,61
tell him to leave (it)	bıraksın	2,25
(he) invited	çağırmış	3,57
don't behave	davranma	5,47
tell him to listen	dinlesin	1,14
don't send	gönderme	18,75
(he) won	kazanmış	27,15
(he) used	kullandı	23,24
tell him to say	söylesin	4,6
(he) climbed	tırmandı	2,84
(he) must understand	anlamalı	1,44
(he) will carry	taşıyacak	9,33
(he) is working	çalışıyor	87,12

(he) is changing	değişiyor	22,93
(he) will want	isteyecek	7,08
(he) is speaking	konuşuyor	39,82
(he) must protect	korumalı	2,33
(he) will walk	yürüyecek	2,92
NONWORDS (illegal combinations)		
mud-not	çamurma	
wood-ing	ahşapıyor	
evening-will	akşamacak	
gold-will	altınacak	
soldier-must	askermeli	
lion-not	aslanma	
yoghurt drink-must	ayranmalı	
knife-ing	bıçakıyor	
ticket-will	biletecek	
insect-must	böcekmeli	
pastry-ing	börekiyor	
cloud-must	bulutmalı	
answer-must	cevapmalı	
sheet-not	çarşafma	
fork-ing	çatalıyor	
snack-ing	çereziyor	
type-will	çeşitecek	
soil-not	toprakma	
stick-not	çubukma	
hole-ing	çukuruyor	
drum-not	davulma	
soap-will	sabunacak	
gum-will	sakızacak	
city-will	şehirecek	
plate-ing	tabakıyor	
mimic-must	taklitmeli	
installment-not	taksitme	
agriculture-will	tarımacak	
history-not	tarihme	
vacation-must	tatilmeli	
chicken-ing	tavukuyor	
nail-ing	tırnakıyor	
price-must	ücretmeli	
time-ing	vakitiyor	
comma-must	virgülmeli	
leaf-must	yaprakmalı	
star-not	yıldızma	
ring-not	yüzükme	
olive-ing	zeytiniyor	

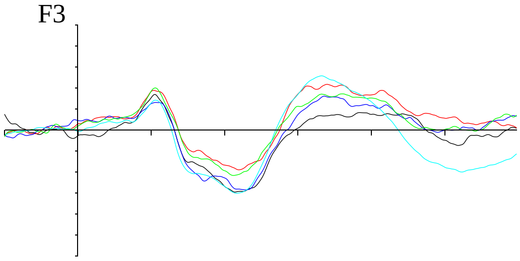
chain-must	zincirmeli
possible-3rd p -s	mümküner
glad-3rd p -s	memnunar
great-will	harikacak
honest-3rd p -s	dürüster
weird-3rd p -s	acayiper
free-will	bedavacak
red-will	kırmızıcak
outside-not	dışarıma
after all-3rd p -s	nitekimer
together-not	beraberme
tomorrow-ing	yarınıyor
upstairs-3rd p -s	yukarır
alone-ing	yalnızıyor
again-will	tekraracak
disgust-pl	iğrenler
resemble-pl	benzeler
wash-derv for nouns	yıkalık
bring-pl	getirler
believe-derv for nouns	inanlık
scream-derv, nouns	bağırlık

A2.3 Grand average waveforms for the electrodes from four different ROIs. Negative voltage is plotted upwards (Experiment 1: Lexical Decision Task)

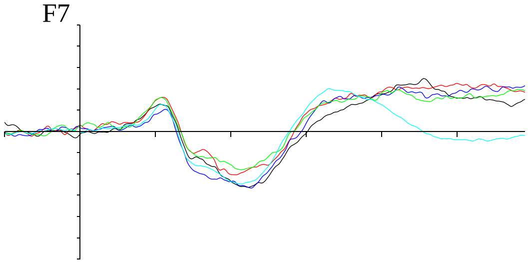
L1 (n=37)

Left anterior ROI

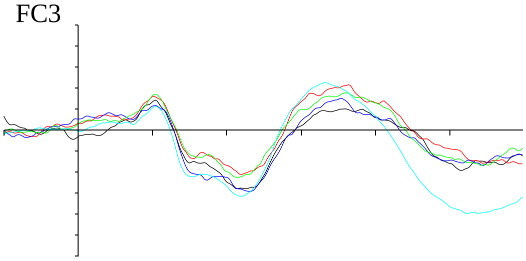
F3



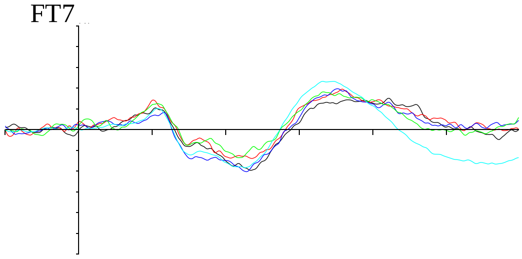
F7



FC3

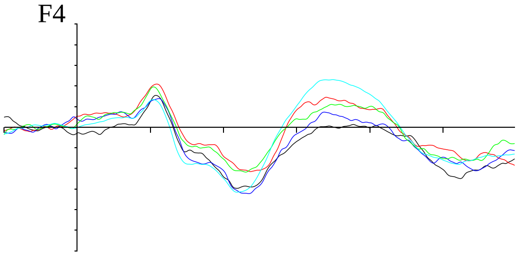


FT7

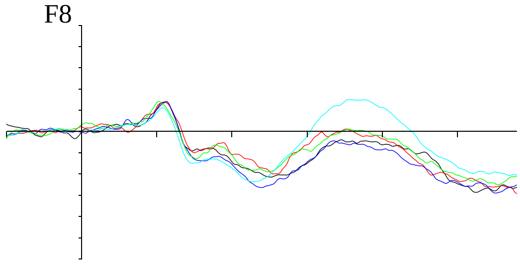


Right anterior ROI

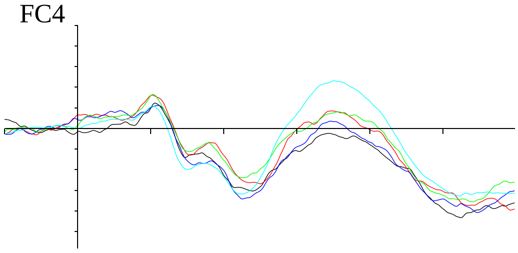
F4



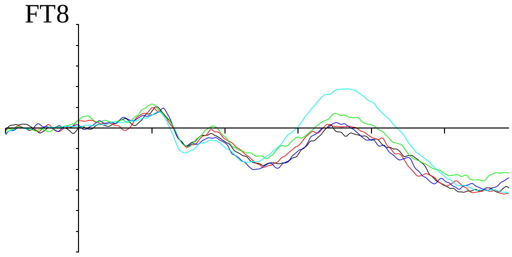
F8

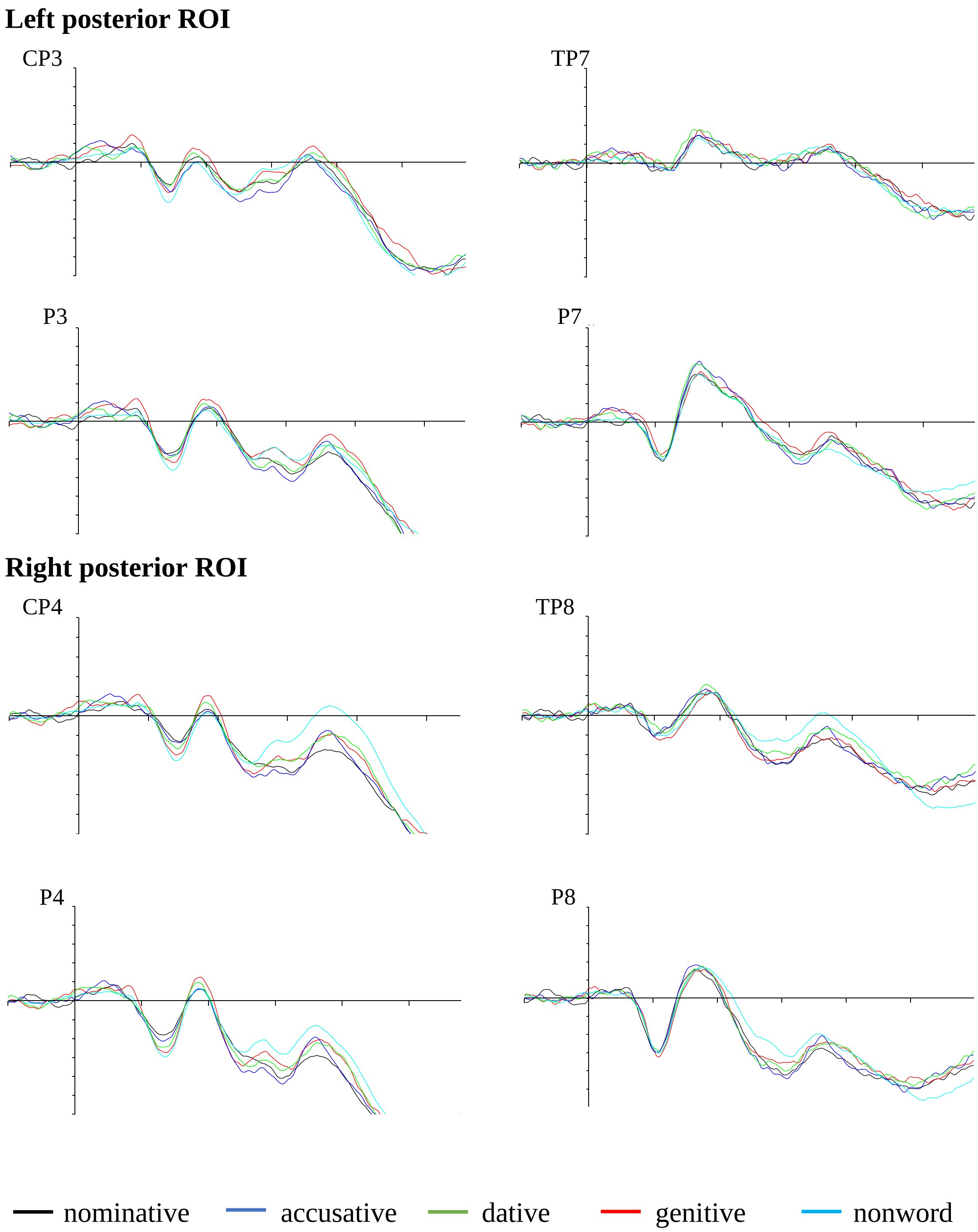


FC4



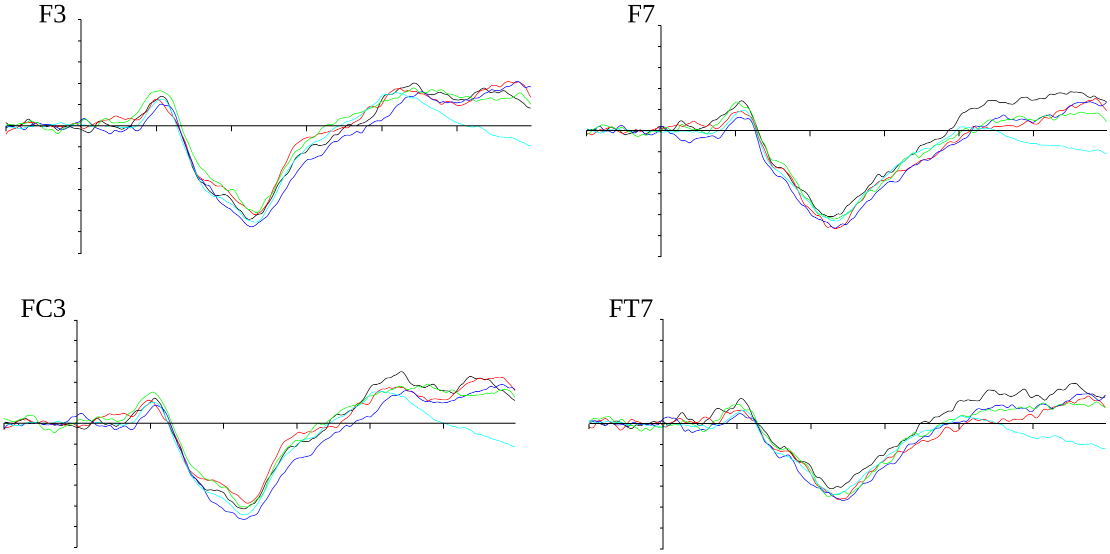
FT8



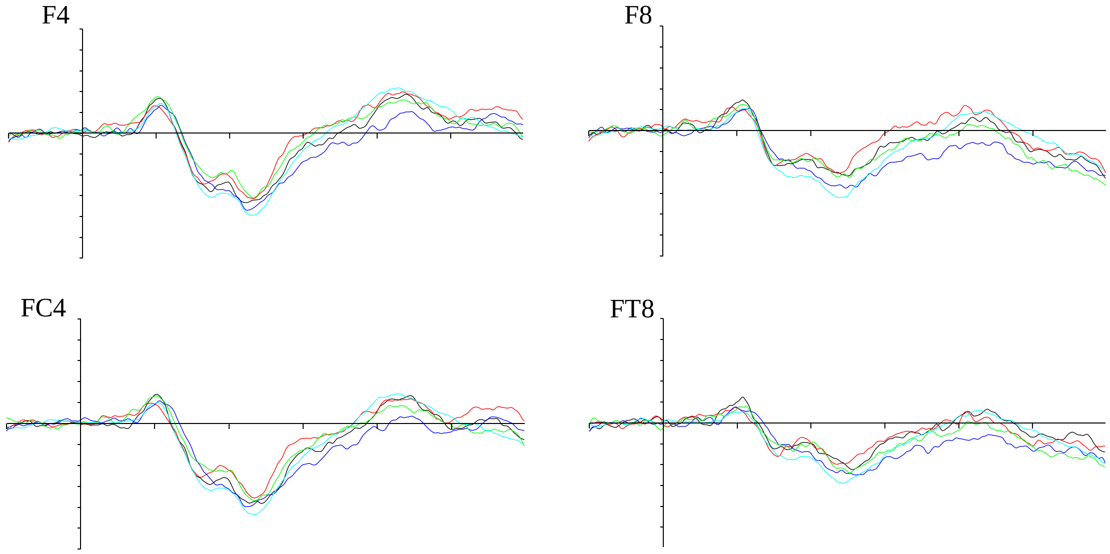

Left posterior ROI
CP3
TP7
P3
P7
Right posterior ROI
CP4
TP8
P4
P8
nominative
accusative
dative
genitive
nonword

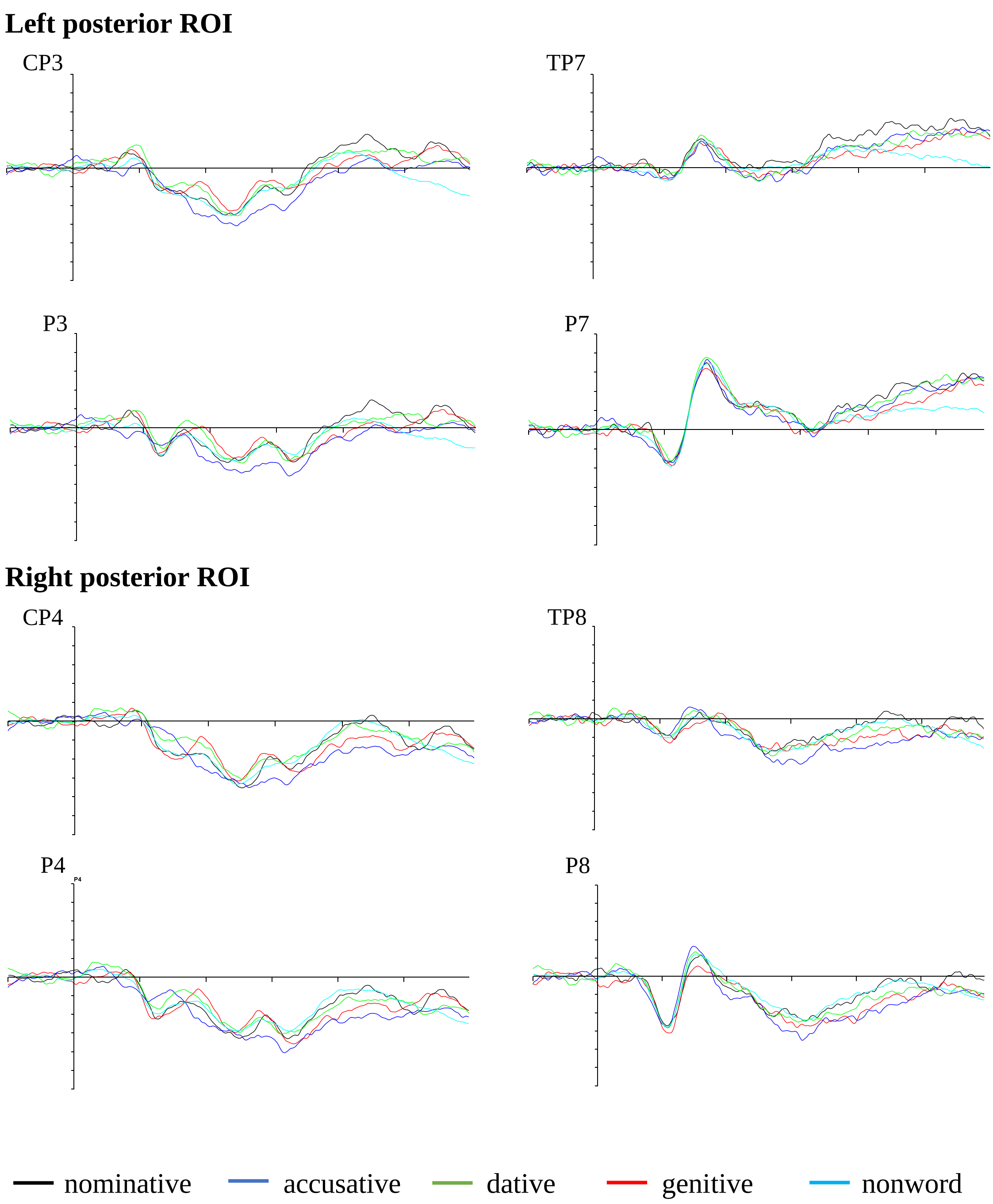
L2 (n=32)

Left anterior ROI



Right anterior ROI




Left posterior ROI
CP3
TP7
P3
P7
Right posterior ROI
CP4
TP8
P4
P8
nominative
accusative
dative
genitive
nonword

A2.4 Additional statistical reporting for Experiment 1 (Lexical Decision Task)

A2.4.1 Mixed model behavioral AR estimates in Experiment 1

Fixed Effects	Estimate	Std. Error	z	Pr >|z|
Reference Condition: Nominative				
L1				
(Intercept)	5.865	0.453	12.950	<.001
Group	-2.345	0.463	-5.070	<.001
Item Freq	0.669	0.184	3.645	<.001
Item Length	0.392	0.131	2.985	.003
Accusative	-0.414	0.512	-0.809	.419
Dative	-0.910	0.487	-1.867	.062
Gen	-1.336	0.495	-2.698	.007
Accusative × Group	0.502	0.518	0.970	.332
Dative × Group	1.314	0.501	2.626	.009
Genitive × Group	0.851	0.497	1.715	.086
L2				
(Intercept)	3.519	0.296	11.886	<.001
Accusative	0.089	0.315	0.280	.779
Dative	0.405	0.324	1.249	.212
Genitive	-0.485	0.318	-1.525	.127
Reference Condition: Accusative				
L1				
(Intercept)	5.451	0.349	15.616	<.001
Dative	-0.495	0.355	-1.395	.163
Genitive	-0.922	0.387	-2.384	.017
Nominative × Group	-0.502	0.518	-0.970	.332
Dative × Group	0.812	0.417	1.949	.051
Genitive × Group	0.349	0.412	0.848	.396
L2				
(Intercept)	3.608	0.249	14.499	<.001
Dative	0.317	0.220	1.439	.150
Genitive	-0.573	0.249	-2.301	.021
Reference Condition: Dative				
L1				
(Intercept)	4.955	0.307	16.121	<.001
Genitive	-0.427	0.353	-1.210	.226
Genitive × Group	-0.463	0.389	-1.190	.234
L2				
(Intercept)	3.924	0.262	14.992	<.001
Genitive	-0.890	0.261	-3.407	<.001

A2.4.2 Mixed model behavioral RT estimates in Experiment 1

	Fixed Effects				Random Effects (sd)	
	Estimate	**Std. Error**	**z**	**Pr >|z|**	**subject**	**item**
Reference Condition: Nominative						
L1						
(Intercept)	6.444	0.026	245.044	<.001	0.153	0.038
Group	0.440	0.042	10.534	<.001	—	L1:0.076 L2:0.099
Item Freq	-0.010	0.004	-2.515	.012		
Item Length	0.015	0.006	2.618	.009		
Accusative	0.025	0.013	1.963	.050	<.001	0.016
Dative	0.027	0.014	1.984	.047	0.015	0.038
Gen	0.050	0.015	3.385	<.001	0.040	0.026
Accusative × Group	0.022	0.025	0.894	.372	—	—
Dative × Group	0.006	0.025	0.234	.815	—	—
Genitive × Group	0.081	0.027	3.060	.002	—	—
L2						
(Intercept)	6.884	0.035	198.490	<.001		
Accusative	0.047	0.026	1.823	.071		
Dative	0.033	0.026	1.243	.216		
Genitive	0.131	0.027	4.841	<.001		
Reference Condition: Accusative						
L1						
(Intercept)	6.469	0.026	251.256	<.001	0.153	0.011
Dative	0.002	0.010	0.171	.864	<.001	0.039
Genitive	0.024	0.013	1.891	.059	0.039	0.027
Dative × Group	-0.016	0.014	-1.165	.244	—	—
Genitive × Group	0.059	0.017	3.547	<.001	—	—
L2						
(Intercept)	6.931	0.030	228.868	<.001		
Dative	-0.014	0.011	-1.290	.197		
Genitive	0.083	0.014	5.881	<.001		
Reference Condition: Dative						
L1						
(Intercept)	6.471	0.026	251.307	<.001	0.153	0.000
Genitive	0.023	0.013	1.804	.071	0.038	0.028
Genitive × Group	0.075	0.017	4.522	<.001	—	—
L2						
(Intercept)	6.916	0.030	228.402	<.001		
Genitive	0.099	0.014	6.964	<.001		

A2.4.3 Mixed Model ANOVA Table for N400 (300-450 ms) amplitudes across real-words and nonwords in Experiment 1 (Type 3 tests)

Effect	Num Df	Den Df	F	Pr (>F)
Group	1	67	0.153	.696
Condition	1	67	7.998	.006
Hemisphere (Hem)	1	67	16.262	<.001
Region	1	67	30.787	<.001
Group × Condition	1	67	0.008	.930
Group × Hem	1	67	0.409	.525
Group × Region	1	67	5.328	.024
Condition × Hem	1	67	45.897	<.001
Condition × Region	1	67	0.361	.550
Hem × Region	1	67	17.705	<.001
Group × Condition × Hem	1	67	7.187	.009
Group × Condition × Region	1	67	0.081	.778
Group × Hem × Region	1	67	5.763	.019
Condition × Hem × Region	1	67	0.167	.683
Group × Condition × Hem × Region	1	67	2.847	.096
Post-hoc Tests				
Left Hemisphere				
Group	1	67	0.01	.90
Condition	1	67	0.00	.97
Group × Condition	1	67	1.28	.26
Right Hemisphere				
Group	1	67	0.35	.55
Condition	1	67	25.67	<.001
Group × Condition	1	67	0.84	.36

A2.4.4 Mixed Model ANOVA Table for N400 (300-450 ms) amplitudes across case-inflected nouns in Experiment 1 (Type 3 tests)

Effect	Num Df	Den Df	F	Pr (>F)
Group	1	67	0.150	.699
Case	3	201	2.098	.107
Hemisphere (Hem)	1	67	29.294	<.001
Region	1	67	27.830	<.001
Group × Case	3	201	1.935	.130
Group × Hem	1	67	1.603	.210
Group × Region	1	67	4.976	.029
Case × Hem	3	201	1.932	.130
Case × Region	3	201	1.665	.178
Hem × Region	1	67	16.591	<.001
Group × Case × Hem	3	201	2.833	.043
Group × Case × Region	3	201	1.654	.180
Group × Hem × Region	1	67	7.572	.008
Case × Hem × Region	3	201	3.542	.017
Group × Case × Hem × Region	3	201	1.327	.267
Post-hoc Tests on ROIs				
Left Anterior				

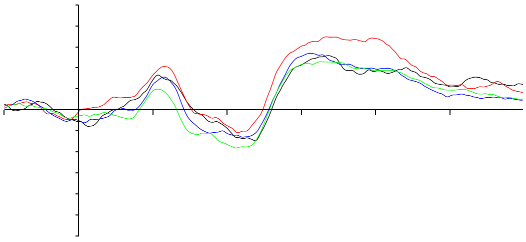
Group	1	67	3.299	.074
Case	3	201	0.659	.553
Group × Case	3	201	0.626	.572
Left Posterior				
Group	1	67	1.524	.221
Case	3	201	1.143	.332
Group × Case	3	201	2.013	.116
Right Anterior				
Group	1	67	0.071	.791
Case	3	201	5.099	.002
Group × Case	3	201	2.206	.091
Right Posterior				
Group	1	67	1.227	.271
Case	3	201	1.789	.152
Group × Case	3	201	3.155	.027
Post-hoc Test on Right Posterior ROI				
L1				
Case	3	108	1.216	.307
L2				
Case	3	93	3.554	.022

A3.1 Grand average waveforms for the electrodes from four different ROIs. Negative voltage is plotted upwards (Experiment 2: Grammaticality Judgment Task)

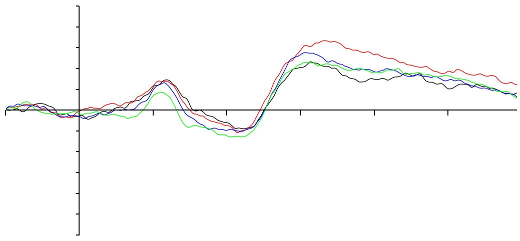
L1 (n=37)

Left anterior ROI

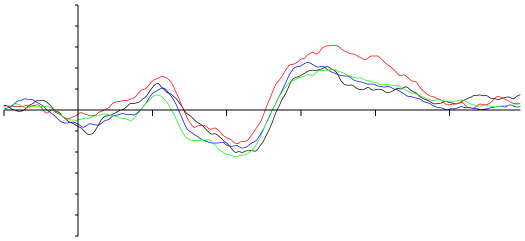
F3



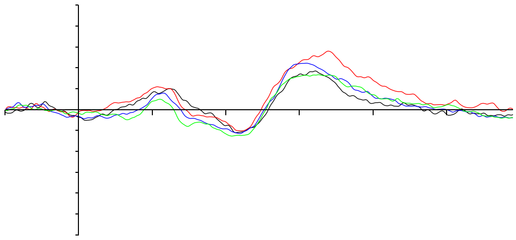
F7



FC3

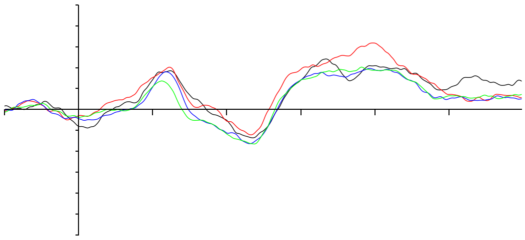


FT7

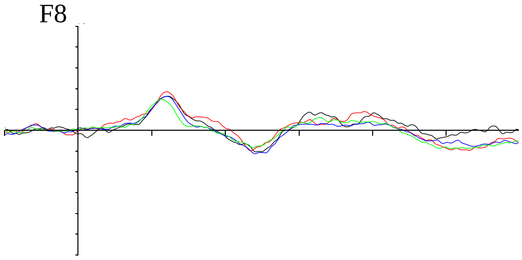


Right anterior ROI

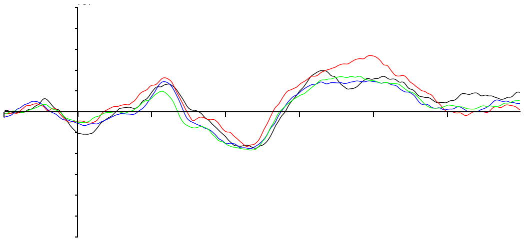
F4



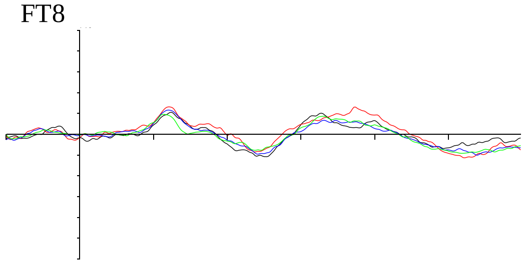
F8

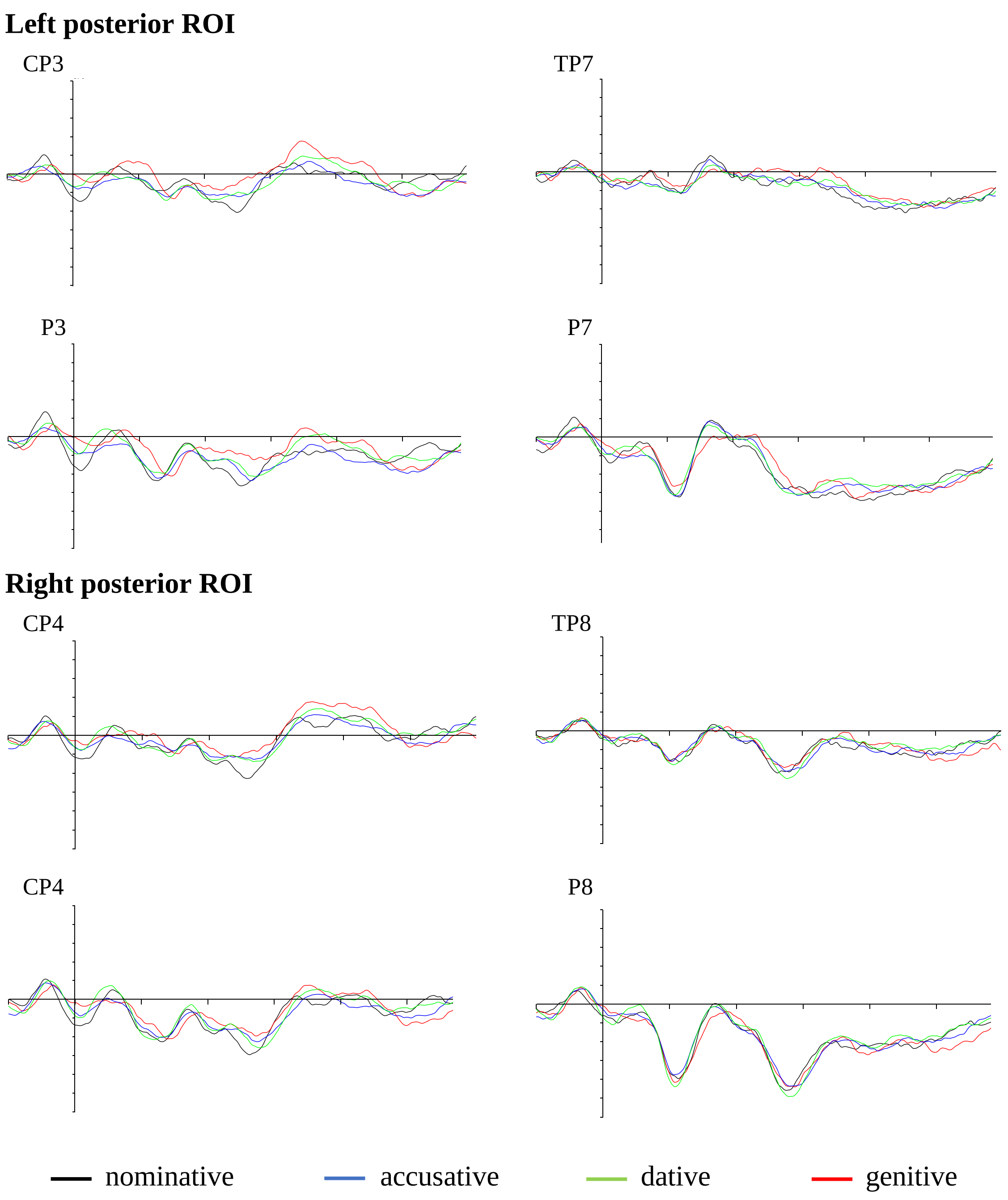


FC4



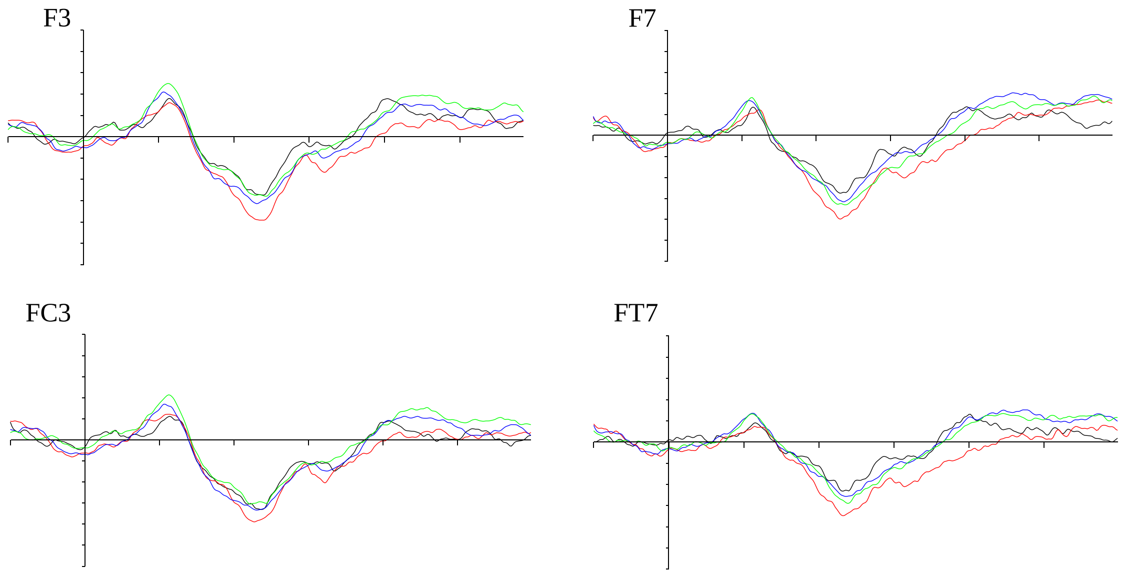
FT8



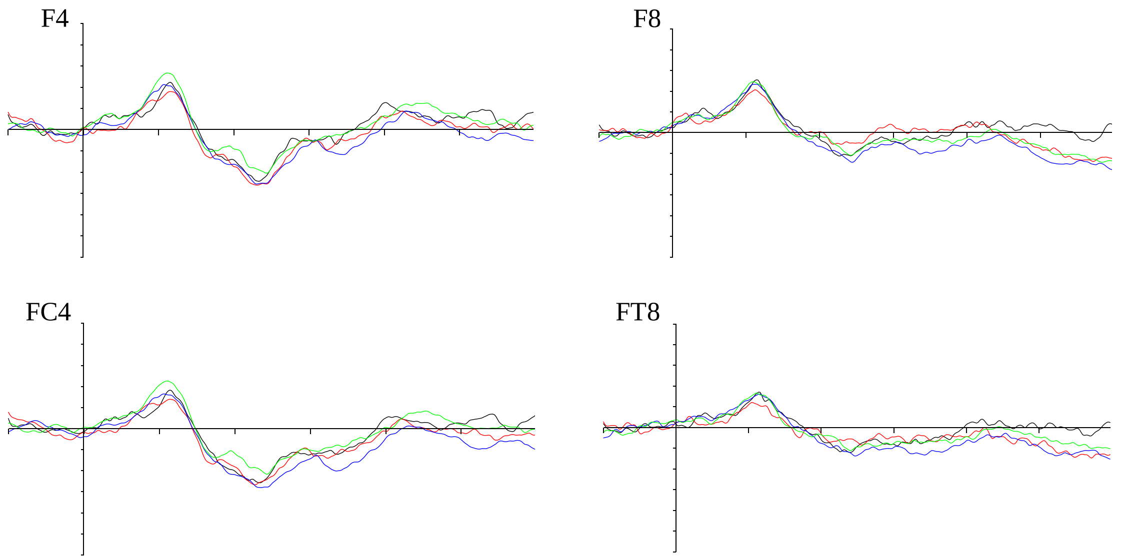

Left posterior ROI
CP3
TP7
P3
P7
Right posterior ROI
CP4
TP8
CP4
P8
nominative
accusative
dative
genitive

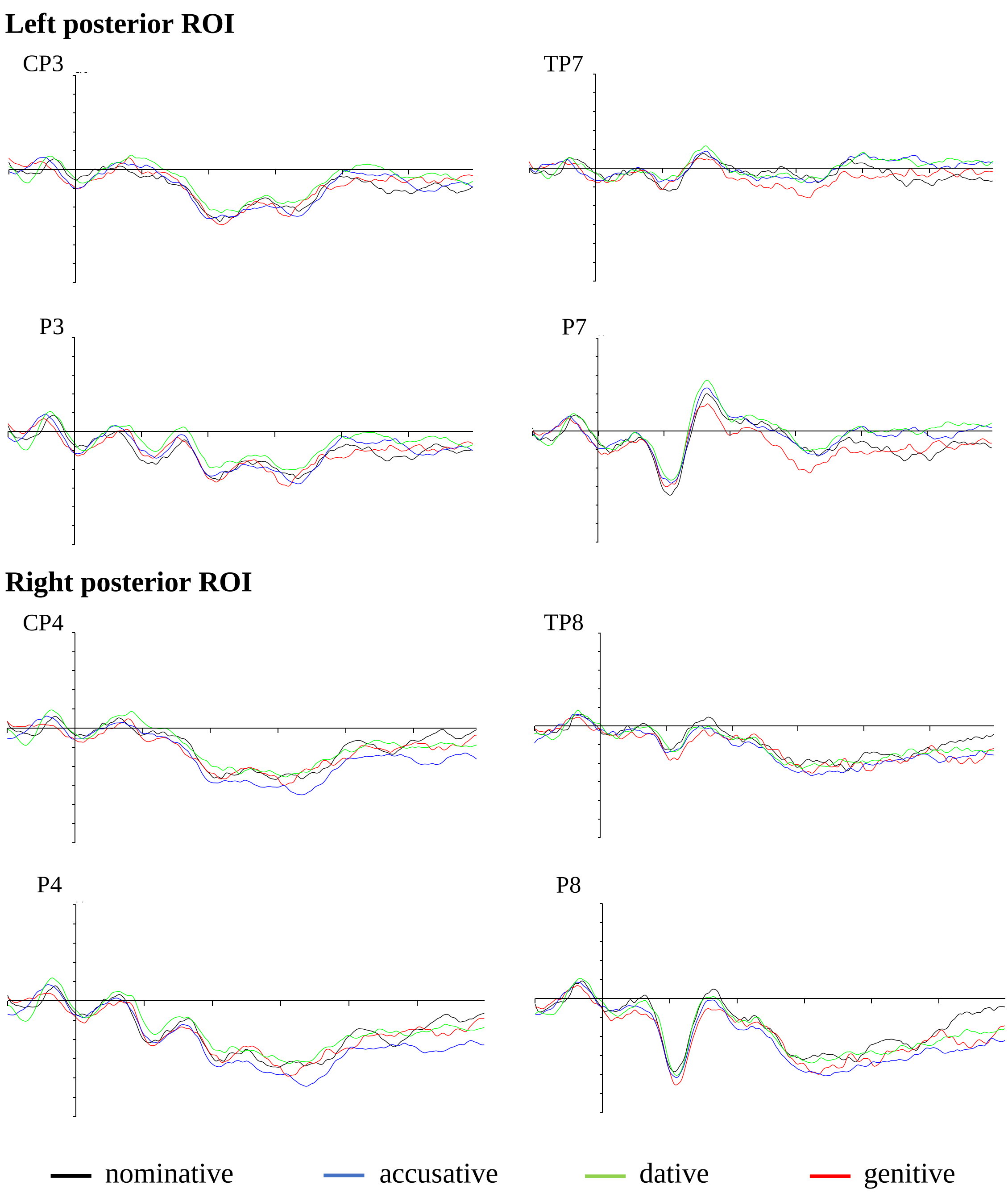
L2 (n=26)

Left anterior ROI



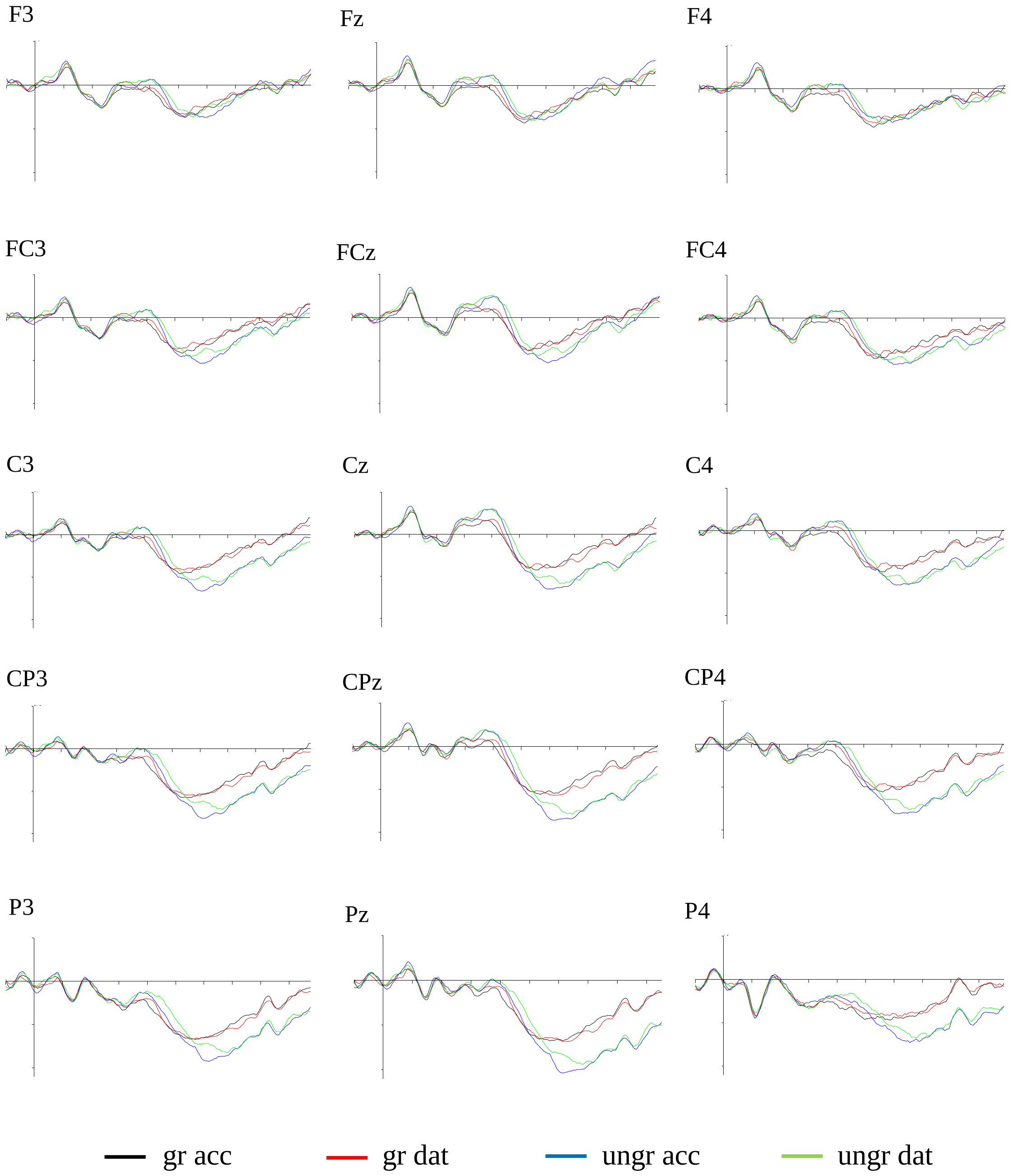
Right anterior ROI



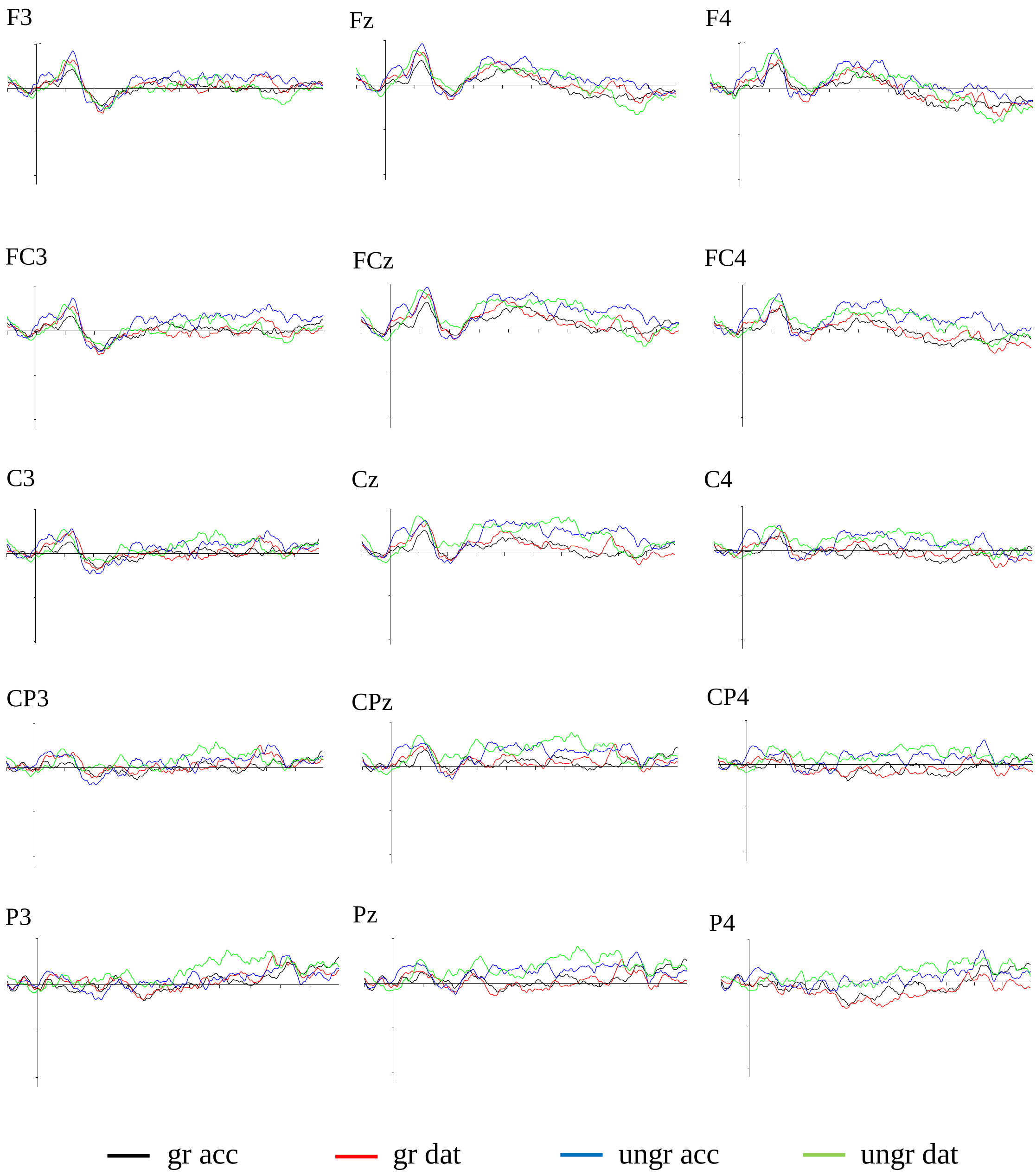

Left posterior ROI
CP3
TP7
P3
P7
Right posterior ROI
CP4
TP8
P4
P8
nominative
accusative
dative
genitive

A3.2 Grand average waveforms for central electrodes used for matrix verb processing. Positive voltage is plotted upwards (Experiment 2: Grammaticality Judgment Task)

L1 (n=37)



L2 (n=26)


F3
Fz
F4
FC3
FCz
FC4
C3
Cz
C4
CP3
CPz
CP4
P3
Pz
P4
gr acc
gr dat
ungr acc
ungr dat

A3.3 Additional statistical reporting for Experiment 2 (Grammaticality Judgment Task)

A3.3.1 Mixed model behavioral AR estimates in Experiment 2

Fixed Effects					Random Effects	
	Estimate	**Std. Error**	**z**	**Pr >|z|**	**subject**	**item**
Group Reference Level: L1						
(Intercept)	5.534	0.557	9.945	<.001	0.425	0.271
Grammaticality	-0.855	0.421	-2.032	.042	0.678	0.000
Verb Case Assignment Type	3. 427	1.028	3.334	<.001	0.594	0.000
Group	-3.020	0.571	-5.290	<.001		L1: 1.506 L2: 0.348
Item Freq	0.282	0.064	4.369	<.001		
Item Length	-0.101	0.049	-2.071	.038		
Grammaticality × Verb Case Assignment Type	-0.031	0.872	-0.036	.971	0.719	0.050
Grammaticality × Group	-0.717	0.452	-1.585	.113		L1: 0.000 L2: 0.000
Verb Case Assignment Type × Group	-4.341	1.041	-4.169	<.001		L1: 5.099 L2: 0.022
Grammaticality × Verb Type × Group	0.439	0.895	0.490	.624		L1: 0.842 L2: 0.476
Group Reference Level: L2						
(Intercept)					0.424	0.433
Grammaticality	-1.571	0.195	-8.068	<.001	0.678	<.001
Verb Case Assignment Type	-0.915	0.190	-4.807	<.001	0.595	<.001
Grammaticality × Verb Case Assignment	0.408	0.238	1.711	.087	0.718	0.000
Grammaticality × Group	0.718	0.452	1.588	.112		L1:<.001 L2: 0.002
Verb Case Assignment Type × Group	4.362	1.030	4.234	<.001		L1: 0.020 L2: 5.114
Grammaticality × Verb Case Assignment × Group	-0.463	0.872	-0.531	.595		L1: 0.477 L2: 0.677

A3.3.2 Mixed Model ANOVA Table for N400 (300-450 ms) amplitudes across case-inflected nouns in Experiment 2 (Type 3 tests)

Effect	Num Df	Den Df	F	Pr (>F)
Group	1	61	1.961	.167
Case	3	183	0.544	.607
Hemisphere (Hem)	1	61	7.062	.012
Region	1	61	91.928	<.001
Group × Case	3	183	1.110	.339
Group × Hem	1	61	0.400	.529
Group × Region	1	61	3.639	.061
Case × Hem	3	183	3.013	.038
Case × Region	3	183	0.892	.434

Hem × Region	1	61	0.015	.904
Group × Case × Hem	3	183	5.016	.004
Group × Case × Region	3	183	0.631	.572
Group × Hem × Region	1	61	8.820	.004
Case × Hem × Region	3	183	0.920	.419
Group × Case × Hem × Region	3	183	1.913	.140
Post-hoc Tests on ROIs				
Left Anterior				
Group	1	61	6.480	.014
Case	3	183	0.170	.879
Group × Case	3	183	4.033	.014
Left Posterior				
Group	1	61	0.464	.499
Case	3	183	1.236	.297
Group × Case	3	183	1.688	.182
Right Anterior				
Group	1	61	2.765	.102
Case	3	183	1.203	.309
Group × Case	3	183	0.319	.778
Right Posterior				
Group	1	61	1.031	.314
Case	3	183	1.156	.322
Group × Case	3	183	0.463	.655
Post-hoc Test on Left Anterior ROI				
L1				
Case	3	108	2.797	.049
L2				
Case	3	108	1.640	.209

A3.3.3. Mixed Model ANOVA Table for P600 (500-700 ms) amplitudes across critical matrix verbs in Experiment 2 (Type 3 tests)

Effect	Num Df	Den Df	F	Pr (>F)
Group	1	61	18.196	<.001
Grammaticality	1	61	0.050	.825
Verb Case Assignment Type	1	61	1.983	.164
Group × Grammaticality	1	61	6.840	.011
Group × Verb Case Assignment Type	1	61	0.108	.744
Grammaticality × Verb Case Assignment Type	1	61	1.433	.236
Group × Grammaticality × Verb Case Assignment Type	1	61	0.203	.654
Post-hoc Tests on Group				
L1				
Grammaticality	1	36	4.568	.039
Verb Case Assignment Type	1	36	1.647	.208
Grammaticality × Verb Case Assignment Type	1	36	0.371	.546

L2				
Grammaticality	1	25	2.701	.113
Verb Case Assignment Type	1	25	0.589	.450
Grammaticality × Verb Case Assignment Type	1	25	1.021	.322

A3.3.4. Mixed Model ANOVA Table for N400 and LAN (300-500 ms) amplitudes across critical matrix verbs in Experiment 2 (Type 3 tests)

Effect	Num Df	Den Df	F	Pr (>F)
N400				
Group	1	61	5.132	.027
Grammaticality	1	61	13.387	<.001
Verb Case Assignment Type	1	61	0.405	.527
Group × Grammaticality	1	61	0.342	.561
Group × Verb Case Assignment Type	1	61	0.001	.979
Grammaticality × Verb Case Assignment Type	1	61	0.625	.432
Group × Grammaticality × Verb Case Assignment Type	1	61	0.033	.856
LAN				
Group	1	61	2.733	.103
Grammaticality	1	61	7.443	.008
Verb Case Assignment Type	1	61	0.395	.532
Group × Grammaticality	1	61	0.139	.711
Group × Verb Case Assignment Type	1	61	2.765	.910
Grammaticality × Verb Case Assignment Type	1	61	0.005	.102
Group × Grammaticality × Verb Case Assignment Type	1	61	0.000	.947

A3.4 List A in Experiment 2 (Grammaticality Judgment Task)

Condition	Sentence
GrNom	Laflarından ötürü dün pazarcı **amca** özür diledi. ***uncle*** *apologized.*
GrAcc	Geçenlerde şu karşıdaki dilenci **amcayı eleştirdim.** ***uncle-ACC criticized(I).***
GrDat	Akşamleyin bu üstü açık **arabaya bindim.** ***car-DAT got on(I).***
GrGen	Dün şurdaki son model **arabanın** lastiği patladı. ***car's*** *tire punctured.*
UngrAcc	*Bugün dükkanda küçük bir **arızaya onardım.** ***malfunctioning-DAT fixed(I).***
UngrDat	*İnşaat alanında ciddi bir **arızayı sebep oldum.** ***malfunctioning-ACC caused(I).***
GrNom	Yarım saat boyunca banyodaki **ayna** konuşuldu. ***mirror*** *was talked.*
GrAcc	Bugünkü fotoğraf çekiminden önce **aynayı sildim.** ***mirror-ACC wiped(I).***
GrDat	Akşamki büyük düğün için **bahçeye indim.** ***garden-DAT got down(I).***
GrGen	İftar yemeği için arka **bahçenin** otları kesildi. ***garden's*** *weed was cut.*
UngrAcc	*Düzensiz çalışma programından dolayı **bekçiye kovdum.** ***watchman-DAT fired(I).***
UngrDat	*Saçma sapan hareketleri yüzünden **bekçiyi kızdım.** ***watchman-ACC got angry(I).***
GrNom	Başvurular için gerekli son **belge** kayboldu. ***document*** *got lost.*
GrAcc	Geçen cuma bu dosyadaki **belgeyi teslim ettim.** ***document-ACC submitted(I).***
GrDat	Saatler sonra pasaporttan sorumlu **binaya ulaştım.** ***building-DAT reached(I).***
GrGen	Sonunda Emniyet Müdürlüğü'ne bağlı **binanın** içi tadilattaydı. ***building's*** *inside was in restoration.*
UngrAcc	*Daha geçtiğimiz Mart ayında **bütçeye yeniledim.** ***budget-DAT renewed(I).***
UngrDat	*Kurul toplantısından sonra bu **bütçeyi katkıda bulundum.** ***budget-ACC contributed(I).***
GrNom	Bugünkü tören için telaşla **cadde** ışıklandırıldı. ***street*** *was lit up.*
GrAcc	Gençlik Festivali için heyecanla **caddeyi düzenledim.** ***street-ACC organized(I).***
GrDat	Bayram öncesi Edirne'deki tarihi **camiye gittim.** ***mosque-DAT went(I).***
GrGen	Tur kapsamında bu görkemli **caminin** tarihçesi verildi.

	mosque's *history was given.*
UngrAcc	*Zincirlikuyu Mezarlığı'nda bu öğlen **cenazeye bekledim.** ***funeral-DAT waited(I).***
UngrDat	*Namazdan sonra iki saat **cenazeyi katıldım.** ***funeral-ACC attended(I).***
GrNom	Bugün adliyede bu gereksiz **ceza** gündemdeydi. ***punishment*** *was on agenda.*
GrAcc	Seksen liralık bu saçma **cezayı kabullendim.** ***punishment-ACC accepted(I).***
GrDat	Türkçe dersinde bu ilginç **cümleye rastladım.** ***sentence-DAT came across(I).***
GrGen	Derste çok uzun bir **cümlenin** anlamı tartışıldı. ***sentence's*** *meaning was discussed.*
UngrAcc	*Değerli taşlarla süslü bu **çantaya taşıdım.** ***bag-DAT carried(I).***
UngrDat	*Kadıköy Pazarı'nda bu deri **çantayı aşık oldum.** ***bag-ACC fell in love(I).***
GrNom	Dün akşam vakti Beşiktaş'taki **çarşı** kalabalıktı. ***bazaar*** *was crowded.*
GrAcc	Sabahleyin saat dokuz gibi **çarşıyı dolaştım.** ***bazaar-ACC roamed(I).***
GrDat	Bu sabah erken saatlerde **çatıya çıktım.** ***roof-DAT went up(I).***
GrGen	Aşırı yağmurlu bir günde **çatının** kiremitleri düştü. ***roof's*** *tiles fell.*
UngrAcc	*Gezi sonunda köy girişindeki **çeşmeye fark ettim.** ***fountain-DAT realized(I).***
UngrDat	*Biraz önce şurdaki tarihi **çeşmeyi koştum.** ***fountain-ACC ran(I).***
GrNom	Çeşitli projeler kapsamında burdaki **çevre** gelişti. ***environment*** *developed.*
GrAcc	Akrabalarla beraber bu güzel **çevreyi korudum.** ***environment-ACC protected(I).***
GrDat	Akşamki davet için sabahtan **çorbaya karar verdim.** ***soup-DAT decided(I).***
GrGen	Bugünkü yemek için ilk **çorbanın** baharatı konuldu. ***soup's*** *spice was put.*
UngrAcc	*İşle özel hayat arasındaki **dengeye sağladım.** ***balance-DAT provided(I).***
UngrDat	*Arkadaşlar ile aile arasındaki **dengeyi dikkat ettim.** ***balance-ACC paid attention(I).***
GrNom	Geçen pazartesi bu harika **dergi** bakkaldaydı. ***magazine*** *was in the grocery store.*
GrAcc	Geçtiğimiz Mayıs ayında bu **dergiyi yayımladım.** ***magazine-ACC published(I).***
GrDat	Kimyasal atıklarla mis gibi **doğaya zarar verdim.** ***nature-DAT harmed(I).***

GrGen	Bu korkunç projeyle birlikte **doğanın** huzuru kaçtı. ***nature's*** *peace went away.*
UngrAcc	*Mezuniyet töreni için bu **elbiseye giydim.** ***dress-DAT wore(I).***
UngrDat	*Parti uğruna bu dar **elbiseyi sığdım.** ***dress-ACC fit(I).***
GrNom	Piknik sepetindeki şu kırmızı **elma** kurtluydu. ***apple*** *was with the worm.*
GrAcc	Bu poşetteki en büyük **elmayı ısırdım.** ***apple-ACC bit(I).***
GrDat	Sabahleyin belediyede bu ayki **faturaya itiraz ettim.** ***bill-DAT objected(I).***
GrGen	İnternet üzerinden geçen ayki **faturanın** fişi istendi. ***bill's*** *receipt was wanted.*
UngrAcc	*Dün yolculuk boyunca bu **fıkraya anlattım.** ***anecdote-DAT told(I).***
UngrDat	*Geçenlerde sınıfta bu komik **fıkrayı güldüm.** ***anecdote-ACC laughed(I).***
GrNom	Bu akşam dışardaki korkunç **fırtına** hızlandı. ***storm*** *sped up.*
GrAcc	Bugün sahilde o büyük **fırtınayı hissettim.** ***storm-ACC felt(I).***
GrDat	Kız Kulesi'ndeki o güzel **geceye değer verdim.** ***night-DAT gave value(I).***
GrGen	Çırağan Sarayı'ndaki o özel **gecenin** sonu muhteşemdi. ***night's*** *end was wonderful.*
UngrAcc	*Dün İzmir Limanı'ndaki şu **gemiye izledim.** ***ship-DAT watched(I).***
UngrDat	*Geçenlerde Boğaz'daki şu büyük **gemiyi atladım.** ***ship-ACC jumped(I).***
GrNom	Vitamin bakımından zengin bu **gıda** tavsiye edildi. ***food*** *was advised.*
GrAcc	Hamilelik süresince hep bu **gıdayı tükettim.** ***food-ACC consumed(I).***
GrDat	Aksiliklerle dolu yorucu bir **haftaya başladım.** ***week-DAT started(I).***
GrGen	Toplantılarla dolu yoğun bir **haftanın** planı yapıldı. ***week's*** *plan was made.*
UngrAcc	*Geçenlerde milyon dolarlık şu **halıya satın aldım.** ***carpet-DAT purchased(I).***
UngrDat	*Bir hevesle dükkandaki yumuşacık **halıyı dokundum.** ***carpet-ACC touched(I).***
GrNom	Tüm yolculuk boyunca elimdeki **harita** incelendi. ***map*** *was examined.*
GrAcc	Seyahat sırasında hep bu **haritayı takip ettim.** ***map-ACC followed(I).***
GrDat	Ameliyattan sonra yan odadaki **hastaya eşlik ettim.**

	patient-DAT accompanied(I).
GrGen	Dün tekerlekli sandalyedeki bir **hastanın** annesi ağladı. ***patient's*** *mother cried.*
UngrAcc	*Bugün böylesine büyük bir **hataya tekrarladım.** ***mistake-DAT repeated(I).***
UngrDat	*Son derece ciddi bir **hatayı engel oldum.** ***mistake-ACC prevented(I).***
GrNom	Bu sabah banyodaki pis **havlu** yıkandı. ***towel*** *was washed.*
GrAcc	Bugün denizden sonra ıslak **havluyu değiştirdim.** ***towel-ACC changed(I).***
GrDat	Yarım saat boyunca derste **hocaya küfrettim.** ***teacher-DAT swore(I).***
GrGen	Bütün gün okulda şu **hocanın** çocuğu ağladı. ***teacher's*** *kid cried.*
UngrAcc	*Dün hemşire odasında yanlışlıkla **iğneye düşürdüm.** ***needle-DAT dropped(I).***
UngrDat	*Bugün acil serviste birden **iğneyi bastım.** ***needle-ACC stepped(I).***
GrNom	Konser sonrasındaki bu yoğun **ilgi** mutlu etti. ***interest*** *made happy.*
GrAcc	Röportaj öncesindeki bu özel **ilgiyi hak ettim.** ***İnterest-ACC deserved(I).***
GrDat	Bir kova dolusu fırçayla **iskeleye yanaştım.** ***boatyard-DAT approached(I).***
GrGen	Bir grup işçiyle Beşiktaş'taki **iskelenin** önü doluydu. ***boatyard's*** *front was full.*
UngrAcc	*Büyük bir orduyla Viyana'daki **kaleye yıktım.** ***castle-DAT demolished(I).***
UngrDat	*İleri bir teknikle Roma'daki **kaleyi saldırdım.** ***castle-ACC attacked(I).***
GrNom	Akşam üzeri telaş içinde **kapı** yumruklandı. ***door*** *was punched.*
GrAcc	Sabahleyin uykulu bir halde **kapıyı açtım.** ***door-ACC opened(I).***
GrDat	Dağlık bölgedeki bu ıssız **kasabaya taşındım.** ***town-DAT moved(I).***
GrGen	Deniz kenarındaki bu şirin **kasabanın** adı tuhaftı. ***town's*** *name was weird.*
UngrAcc	*Dün öğlen okul çıkışındaki **kavgaya önledim.** ***fight-DAT stopped(I).***
UngrDat	*Bu akşam sokak ortasındaki **kavgayı karıştım.** ***fight-ACC got involved(I).***
GrNom	Apartman girişindeki o yaralı **kedi** öldü. ***cat*** *died.*
GrAcc	Merdiven altındaki şu yavru **kediyi okşadım.** ***cat-ACC petted(I).***

GrDat	Dolardaki artışla birlikte yeni **kiraya karşı çıktım.** ***rent-DAT opposed(I).***
GrGen	En sonki zamla birlikte **kiranın** tutarı arttı. ***rent's*** *amount increased.*
UngrAcc	Yan dairedeki şu zengin **komşuya kıskandım.** ***neighbor-DAT got jealous(I).***
UngrDat	Alt kattaki şu güzel **komşuyu seslendim.** ***neighbor-ACC called out(I).***
GrNom	Dönem sonunda anca bu **konu** işlendi. ***topic*** *was covered.*
GrAcc	Sınavlardan önce bu zor **konuyu kavradım.** ***topic-ACC grasped(I).***
GrDat	İlerdeki o meşhur taş **köprüye yöneldim.** ***bridge-DAT directed(I).***
GrGen	Dünyaca ünlü o tarihi **köprünün** tadilatı vardı. ***bridge's*** *restoration there was.*
UngrAcc	*Yol kenarındaki bu minik **kuzuya sevdim.** ***lamb-DAT loved(I).***
UngrDat	*Şu ilerdeki annesinden ayrı **kuzuyu sarıldım.** ***lamb-ACC hugged(I).***
GrNom	Karadeniz'de yedi günlük bir **macera** yaşandı. ***adventure*** *was experienced.*
GrAcc	Amerika'da üç aylık bir **macerayı kaçırdım.** ***adventure-ACC missed(I).***
GrDat	Dağdaki çatışma sırasında bu **mağaraya saklandım.** ***cave-DAT hid(I).***
GrGen	Savaş anında bu gizli **mağaranın** yolu tehlikeliydi. ***cave's*** *way was dangerous.*
UngrAcc	Akşam geç vakitte bu **mağazaya temizledim.** ***store-DAT cleaned(I).***
UngrDat	Dün erken saatlerde bu **mağazayı girdim.** ***store-ACC entered(I).***
GrNom	Şehirden uzak bu sakin **mahalle** tercih edildi. ***neighborhood*** *was preferred.*
GrAcc	Çam ağaçlarıyla dolu bu **mahalleyi özledim.** ***neighborhood-ACC missed(I).***
GrDat	Kayıp dosya nedeniyle dün **mahkemeye başvurdum.** ***court-DAT applied(I).***
GrGen	Çalıntı dosya iddiasıyla bugün **mahkemenin** sonucu iptal edildi. ***court's*** *result was canceled.*
UngrAcc	*Dün Antalya'daki konferansta bu **makaleye sundum.** ***article-DAT presented(I).***
UngrDat	*Geçen gün sempozyumda bu **makaleyi tepki gösterdim.** ***article-ACC reacted(I).***
GrNom	Gün batımındaki o muhteşem **manzara** aklımızdaydı. ***view*** *was in our mind.*
GrAcc	Dün akşam Boğaz'daki eşsiz **manzarayı seyrettim.**

	view-ACC watched(I).
GrDat	Kaldırım kenarındaki kanadı kırık **martıya acıdım.** ***seagull-DAT had a pity(I).***
GrGen	Arka balkondaki küçük yaralı **martının** annesi yoktu. ***seagull's*** *mother there was not.*
UngrAcc	*Bugün kahvaltıdan sonra sinirle **masaya topladım.** ***table-DAT tidied (I).***
UngrDat	*Dün akşam tartışma esnasında **masayı vurdum.** ***table-ACC hit(I).***
GrNom	Manisa ile Erzurum arasındaki **mesafe** saptandı. ***distance*** *was determined.*
GrAcc	Şehirler arasındaki bu uzun **mesafeyi ölçtüm.** ***distance-ACC measured(I).***
GrDat	Patronla işçiler arasındaki o **meseleye tanık oldum.** ***issue-DAT witnessed(I).***
GrGen	İş yerindeki o çirkin **meselenin** özü anlaşıldı. ***issue's*** *gist was understood.*
UngrAcc	*Güneş altında bu sulu **meyveye yedim.** ***fruit-DAT ate(I).***
UngrDat	*Sıcak aylarda sadece bu **meyveyi ihtiyaç duydum.** ***fruit-ACC needed(I).***
GrNom	Bugün dükkanda sorunlu bir **müşteri** vardı. ***customer*** *there was.*
GrAcc	Akşamüstü bakkalda eski bir **müşteriyi selamladım.** ***customer-ACC saluted(I).***
GrDat	Sabahleyin zemin kattaki yaşlı **nineye yardım ettim.** ***granny-DAT helped(I).***
GrGen	Geçenlerde doksan yaşındaki bir **ninenin** oğlu evlendi. ***granny's*** *son got married.*
UngrAcc	*Okul masrafları için bankadaki **paraya harcadım.** ***money-DAT spent(I).***
UngrDat	*Düğün masrafları için kasadaki **parayı güvendim.** ***money-ACC trusted(I).***
GrNom	Bugün uçuş boyunca cebimdeki **peçete** ıslaktı. ***napkin was wet.***
GrAcc	Otobüs yolculuğunda hep bu **peçeteyi kullandım.** ***napkin-ACC used(I).***
GrDat	Yağmurlu bir günde salondaki **pencereye yaslandım.** ***window-DAT leaned(I).***
GrGen	Karlı bir sabah mutfaktaki **pencerenin** kolu dondu. ***window's*** *handle got frozen.*
UngrAcc	*Bugün oyun sırasında yanlışlıkla **perdeye yırttım.** ***curtain-DAT tore(I).***
UngrDat	*Yüksek topuklu ayakkabılar yüzünden **perdeyi takıldım.** ***curtain-ACC tripped(I).***
GrNom	Dün akşamki ekonomi programında **piyasa** tartışıldı. ***market*** *was discussed.*

GrAcc	Ekonomik kriz sonrası Türkiye'deki **piyasayı değerlendirdim.** ***market-ACC evaluated(I).***
GrDat	Bugün telaş içinde dişçideki **randevuya yetiştim.** ***appointment-DAT caught(I).***
GrGen	Dün akşam üzeri kuafördeki **randevunun** saati ayarlandı. ***appointment's*** *time was set.*
UngrAcc	*Ödül töreninde dizi ekibiyle **sahneye paylaştım.** ***stage-DAT shared(I).***
UngrDat	*Bu müzik grubuyla birlikte **sahneyi yürüdüm.** ***stage-ACC walked(I).***
GrNom	Bilet iadesi için bu **sayfa** tarandı. ***page*** *was scanned.*
GrAcc	Bu haber sitesindeki her **sayfayı okudum.** ***page-ACC read(I).***
GrDat	Kaza sonrası ödemeler hakkında **sigortaya danıştım.** ***insurance-DAT consulted(I).***
GrGen	Yangından sonraki masraflar için **sigortanın** koşulları belliydi. ***insurance's*** *conditions were certain.*
UngrAcc	*Bir kova dolusu odunla **sobaya yaktım.** ***stove-DAT burned(I).***
UngrDat	*Bir paket kibritle bu **sobayı yaklaştım.** ***stove-ACC approached(I).***
GrNom	İftardan beş dakika önce **sofra** donatıldı. ***meal table was equipped.***
GrAcc	İşten sonra bu muhteşem **sofrayı hazırladım.** ***meal table-ACC prepared(I).***
GrDat	Son derece saçma bir **şakaya darıldım.** ***joke-DAT got offended(I).***
GrGen	Bugün yemekte salakça bir **şakanın** dozu fazlaydı. ***joke's*** *dose was too much.*
UngrAcc	*Bu kadar karışık bir **şifreye tahmin ettim.** ***password-DAT guessed(I).***
UngrDat	*Şu bilgisayardaki yirmi harfli **şifreyi hayret ettim.** ***password-ACC was amazed(I).***
GrNom	Havaalanında içi limonata dolu **şişe** devrildi. ***bottle*** *was toppled.*
GrAcc	İstasyonda suyla dolu bir **şişeyi kaybettim.** ***bottle-ACC lost(I).***
GrDat	Spor salonu önündeki büyük **tabelaya çarptım.** ***signboard-DAT crashed(I).***
GrGen	Alışveriş sırasında kocaman bir **tabelanın** demiri koptu. ***signboard's*** *chain broke.*
UngrAcc	*Daha beş dakika önce **tarlaya sattım.** ***field-DAT sold(I).***
UngrDat	*Dün kiraz ağaçlarıyla dolu **tarlayı geldim.** ***field-ACC came(I).***

GrNom	Dedem sayesinde iki günde **tavla** sevildi. ***backgammon*** *was loved.*
GrAcc	Sadece üç gün içinde **tavlayı öğrendim.** ***backgammon-ACC learned(I).***
GrDat	Böylesine umut verici bir **tedaviye destek verdim.** ***treatment-DAT gave support(I).***
GrGen	Diğer doktorlarla birlikte bu **tedavinin** süresi belirlendi. ***treatment's*** *duration was specified.*
UngrAcc	*Karlı günde bile şurdaki **tepeye gördüm.** ***hill-DAT saw(I).***
UngrDat	*Dört saatlik yoldan sonra **tepeyi tırmandım.** ***hill-ACC climbed(I).***
GrNom	Dün misafirlikte kahveyle dolu **tepsi** devrildi. ***tray*** *was toppled.*
GrAcc	Çikolatalarla dolu şurdaki gümüş **tepsiyi tuttum.** ***tray-ACC held(I).***
GrDat	Çalışkanlığından dolayı bu dükkandaki **terziye saygı duydum.** ***tailor-DAT respected(I).***
GrGen	Becerisinden ötürü yukarı sokaktaki **terzinin** kardeşi önerildi. ***tailor's*** *sibling was recommended.*
UngrAcc	*Sekiz çocuk annesi temizlikçi **teyzeye takdir ettim.** ***auntie-DAT admired(I).***
UngrDat	*Geçenlerde beş çocuklu bu **teyzeyi üzüldüm.** ***auntie-ACC felt sorry(I).***
GrNom	Sokak ortasında birden elimdeki **torba** koptu. ***bag*** *broke.*
GrAcc	Durakta elimdeki çöp dolu **torbayı salladım.** ***bag-ACC swang(I).***
GrDat	Kriz zamanında bu güzel **ülkeye inandım.** ***government-DAT believed(I).***
GrGen	Doğu'daki savaş sırasında bu **ülkenin** ordusu yoruldu. ***government's*** *army got tired.*
UngrAcc	*Sıkı bir çalışma sonucu **zirveye hedefledim.** ***peak-DAT aimed(I).***
UngrDat	*Zorlu bir süreç sonrasında **zirveyi kavuştum.** ***peak-ACC attained(I).***

Bibliography

Aksan, Y., & Aksan, M. (2009). Building a national corpus of Turkish: Design and implementation. *Working Papers in Corpus-Based Linguistics and Language Education, 3*, 299–310.

Aksu-Koç, A., & Slobin, D. I. (1985). The acquisition of Turkish. In D. I. Slobin (Eds.), *The cross-linguistic study of language acquisition* (pp. 839–878). Hillsdale, New Jersey: Lawrence ErlbaumAssociation.

Amenita, S., & Crepaldi, D. (2012). Morphological processing as we know it: An analytical review of morphological effects in visual word identification. *Frontiers in Language Sciences, 3*, 232.

Aydin, Ö., Aygünes, M., & Demiralp, T. (2016). Non-native syntactic processing of case and agreement evidence from event-related potentials. In A. Gürel (Eds.), *Second Language Acquisition of Turkish* (pp. 281–311). Amsterdam: John Benjamins.

Baayen, H., Dijkstra, T., & Schreuder, R. (1997). Singulars and plurals in Dutch: Evidence for a dual parallel route model. *Journal of Memory and Language, 37*, 94–119.

Baayen, R. H., Feldman, L. B., & Schreuder, R. (2006). Morphological influences on the recognition of monosyllabic monomorphemic words. *Journal of Memory and Language, 55*, 290–313.

Barr, D. J., Levy, R., Scheepers, C., & Tily, H. J. (2013). Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language, 68*(3), 255–278.

Basnight-Brown, D. M., Chen, L., Hua, S., Kostic´, A., & Feldman, L. B. (2007). Monolingual and bilingual recognition of regular and irregular English verbs: Sensitivity to form similarity varies with first language experience. *Journal of Memory and Language, 57*, 65–80.

Bates, D., Maechler, M., Bolker, B., & Walker, S. (2019). Linear Mixed-Effects Models using 'Eigen' and S4. Retrieved from http://cran.r-project.org/web/packages/lme4 .

Bilgin, O. (2016). *Frequency effects in the processing of morphologically complex Turkish words.* Unpublished Master's thesis, Bogazici University, Istanbul, Turkey.

Bornkessel, I., & Schlesewsky, M. (2006). The extended argument dependency model: a neurocognitive approach to sentence comprehension across languages. *Psychological Review, 113*, 787–821.

Bornkessel-Schlesewsky, I., & Schlesewsky, M. (2009). The role of prominence information in the real time comprehension of transitive constructions: A crosslinguistic approach. *Language and Linguistics Compass, 3*, 19–58.

Bosch, S. & Clahsen, H. (2016). Accessing morphosyntax in L1 and L2 word recognition: A priming study of inflected German adjectives. *The Mental Lexicon, 11*(1), 26–54.

Bosch, S., Krause, H., & Leminen, A. (2016). The time-course of morphosyntactic and semantic priming in late bilinguals: A study of German adjectives. Bilingualsim: Language and Cognition, 20(3), 435–456.

Butterworth, B. (1983). Lexical representation. In B. Butterworth (Eds.), *Development, writing and other language processes, Vol. 2,* London: Academic Press.

Chomsky, N. (2000). Minimalist inquiries. In R. Martin, D. Michaels, and J. Uriagereka (Eds.), *Step by Step: Essays on Minimalist Syntax in Honor of Howard Lasnik* (pp. 89–155). Cambridge, MA: The MIT Press.

Choudhary, K. K., Schlesewsky, M., Roehma, D., & Bornkessel-Schlesewsky, I. (2009). The N400 as a correlate of interpretively relevant linguistic rules: Evidence from Hindi. *Neuropsychologia, 47*, 3012–3022.

Clahsen, H., Eisenbeiss, S., Hadler, M., & Sonnenstuhl, I. (2001). The mental representation of inflected words: An experimental study of adjectives and verbs in German. *Linguistics 77*, 510–543.

Clahsen, H. & Felser, C. (2006). Grammatical processing in language learners. *Applied Psycholinguistics, 27*, 3–42.

Clahsen, H. & Felser, C. (2017). Some notes on the shallow structure hypothesis. *Studies in Second Language Acquisition, 40*(3), 693–706

Coughlin, C. E., & Tremblay, A. (2015). Morphological decomposition in native and non-native French speakers. *Bilingualism: Language and Cognition, 18*(3), 524–542.

Coulson, S., King, J., & Kutas, M. (1998). Expect the unexpected: Event-related brain response to morphosyntactic violations. *Language and Cognitive Processes, 13*, 21–58.

Delorme, A., & Makeig, S. (2004). EEGLAB: an open source toolbox for analysis of single-trial EEG dynamics including independent component analysis. *Journal of Neuroscience Methods, 134,* 9–21.

Díaz, B., Sebastián-Gallés, N., Erdocia, K., Mueller, J. L., & Laka, I. (2011). On the cross-linguistic validity of electrophysiological correlates of morphosyntactic processing: a study of case and agreement violations in Basque. *Journal of Neurolinguistics, 24*, 357–373.

Dussias, P. E. (2010). Uses of eye-tracking data in second language sentence processing research. *Annual Review of Applied Linguistics, 30*, 149–166.

Erguvanlı, E. E. (1984). *The function of word order in Turkish grammar*. Berkeley: University of California Press.

Foote, R. (2015). The storage and processing of morphologically complex words in L2 Spanish. *Studies in Second Language Acquisition, 39*(4), 735–767.

Friederici, A. D., & Frisch, S. (2000). Verb argument structure processing: The role of verb-specific and argument-specific information. *Journal of Memory and Language, 43*, 476–507.

Friederici, A. D., Hahne, A., & Mecklinger, A. (1996). The temporal structure of syntactic parsing: Event-related potentials during speech perception and word-by-word reading. *Journal of Experimental Psychology: Learning, Memory & Cognition, 22*, 1–31.

Frisch, S., & Schlesewsky, M. (2001). The N400 indicates problems of thematic hierarchizing. *Neuroreport, 12,* 3391–3394.

Frisch, S., & Schlesewsky, M. (2005). The resolution of case conflicts from a neurophysiological perspective. *Cognitive Brain Results, 25*, 484–498.

Gor, K. (2003). Symbolic rules versus analogy in the processing of complex verbal morphology. *Regards Croisés sur L'Analogie. Revue d'Intelligence Artificielle, 17*(5–6), 823–840.

Gor, K. (2004). The rules and probabilities model of native and second language morphological processing. In L. Verbitskaya & T. Chernigovskaya (Eds.), *Theoretical problems of linguistics. Papers dedicated to 140th anniversary of the Department of General Linguistics, St. Petersburg State University (pp. 51–75)*. St. Petersburg, Russia: Philological Faculty of St. Petersburg State University Press.

Gor, K., Chrabaszcz, A., & Cook, S. (2017a). Processing of native and nonnative inflected words: Beyond affix stripping. *Journal of Memory and Language, 93*, 315–332.

Gor, K., Chrabaszcz, A., & Cook, S. (2017b). A case for agreement: Processing of case inflection by early and late learners. *Linguistic Approaches to Bilingualism. First View.*

Gor, K., & Cook, S. (2010). Non-native processing of verbal morphology: In search of regularity. *Language Learning, 60*, 88–126.

Gor, K., & Jackson, S. (2013). Morphological decomposition and lexical access in a native and second language: A nesting doll effect. *Language and Cognitive Processes, 28*, 1065–1091.

Göksel, A., & Kerslake, C. (2005). *Turkish: A comprehensive grammar*. London: Routledge.

Greenhouse, S. W., & Geisser, S. (1959). On methods in the analysis of profile data. *Psychometrika, 24*, 95–112.

Gürel, A. (2000). Missing case inflection: Implications for second language acquisition. In C. Howell, S. A. Fish and T. Keith-Lucas (Eds.), *Proceedings of the 24th Boston University Conference on Language Development (BUCLD24)* (pp. 379–390) Somerville, MA: Cascadilla Press.

Hagoort, P., Brown, C., & Groothusen, J. (1993). The syntactic positive shift (SPS) as an ERP measure of syntactic processing. *Language and Cognitive Processes, 8*, 439–483.

Hahne, A., & Friederici, A. (1999). Electrophysiological evidence for two steps in syntactic analysis: early automatic and late controlled processes. *Journal of Cognitive Neuroscience*, *11*(2), 194–205.

Haznedar, B. (2006). Persistent problems with case morphology in L2 acquisition. In L. Conxita (Eds.), *Interfaces in Multilingualism: Acquisition and Representation* (pp. 179–206). Amsterdam: John Benjamins.

Hopf, J.-M., Bayer, J., Bader, M., & Meng, M. (1998). Event-related brain potentials and case ınformation in syntactic ambiguities. *Journal of Cognitive Neuroscience,10*(2), 264–279.

Hopp, H. (2006). Syntactic features and reanalysis in near-native processing. *Second Language Research, 22*, 369–397.

Hopp, H. (2010). Ultimate attainment in L2 inflection: Performance similarities between nonnative and native speakers. *Lingua, 120*, 901–931.

Hopp, H. (2015). Semantics and morphosyntax in L2 predictive sentence processing. *International Review of Applied Linguistics, 53*, 277–306.

Hopp, H., & León Arriaga, M. E . (2016). Structural and inherent case in the non-native processing of Spanish: Constraints on inflectional variability. *Second Language Research, 32,* 75–108.

Indefrey, P., Hagoort, P., Herzog, H., Seitz, R. J., & Brown, C. M. (2001). Syntactic processing in left prefrontal cortex is independent of lexical meaning. *Neuroimage, 14*, 546–555.

Jackson, C. N. (2008). Proficiency level and the interaction of lexical and morphosyntactic information during L2 sentence processing. *Language Learning, 58,* 875–909.

Jaeger, T. F. (2008). Categorical data analysis: Away from ANOVAs (transformation or not) and towards logit mixed models. *Journal of Memory and Language, 59*, 434–446.

Jiang, N. (2004). Morphological insensitivity in second language processing. *Applied Psycholinguistics, 25*, 603–634.

Jiang, N. (2007). Selective integration of linguistic knowledge in adult second language learning. *Language Learning*, *57*, 1–33.

Kaan, E., Harris, A., Gibson, E., & Holcomb, P. (2000). The P600 as an index of syntactic integration difficulty. *Language and Cognitive Processes, 15*, 159–201.

Karatas, N. B., Gor, K., & Lau, E. (in preparation). *Comparison of sensitivity to case violations across native and nonnative speakers of Turkish*.

Kilborn, K. (1989). Sentence processing in a second language: The timing of transfer. *Language and Speech, 32,* 1–23.

Kirkici, B., & Clahsen, H. (2013). Inflection and derivation in native and non-native language processing: Masked priming experiments on Turkish. *Bilingualism: Language and Cognition, 16*, 776–791.

Kluender, R., & Kutas, M. (1993). Bridging the gap: Evidence from ERPs on the processing of unbounded dependencies. *Journal of Cognitive Neuroscience, 5*, 196–214.

Kornfilt, J. (1997). *Turkish*. London: Routledge.

Kutas, M., & Federmeier, K. D. (2000). Electrophysiology reveals semantic memory use in language comprehension. *Trends in Cognitive Sciences, 4*, 463–469.

Kutas, M., & Federmeier, K. A. (2007). Event-related brain potential (ERP) studies of sentence processing. In M. G. Gaskell (Eds.), *The Oxford Handbook of Psycholinguistics* (pp. 385–406). Oxford: Oxford University Press.

Kutas, M., & Federmeier, K. D. (2011). Thirty years and counting: finding meaning in the N400 component of the event-related brain potential (ERP). *Annual review of psychology, 62*, 621–647.

Kutas, M., & Hillyard, S. A. (1980). Reading senseless sentences: Brain potentials reflect semantic incongruity. *Science, 207*, 203–205.

Lavric, A., Clapp, A., & Rastle, K. (2007). ERP evidence of morphological analysis from orthography: A masked priming study. *Journal of Cognitive Neuroscience, 19*, 866–877.

Lavric, A., Elchlepp, H., & Rastle, K. (2012). Tracking hierarchical processing in morphological decomposition with brain potentials. *Journal of Experimental Psychology: Human Perception and Performance, 38*(4), 811–816.

Lavric, A., Rastle, K., & Clapp, A. (2011). What do fully visible primes and brain potentials reveal about morphological decomposition? *Psychophysiology, 48*, 676–686.

Lehtonen, M., & Laine, M. (2003). How word frequency affects morphological processing in monolinguals and bilinguals. *Bilingualism: Language and Cognition, 6*, 213–225.

Lehtonen, M., Niska, H., Wande, E., Niemi, J., & Laine, M. (2006). Recognition of Inflected Words in a Morphologically Limited Language: Frequency Effects in Monolinguals and Bilinguals. *Journal of Psycholinguistic Research, 35*(2), 121–146.

Lehtonen, M., Vorobyev, V., Hugdahl, K., Tuokkola, T., & Laine, M. (2006). Neural correlates of morphological decomposition in a morphologically rich language: An fMRI study. *Brain and Language, 98*, 182–193.

Lehtonen, M., Cunillera, T., Rodríguez-Fornells, A., Hultén, A., Tuomainen, J., & Laine, M. (2007). Recognition of morphologically complex words in Finnish: Evidence from event-related potentials. *Brain Research, 1148*, 123–137.

Leminen, A., & H. Clahsen (2014). Brain potentials to inflected adjectives: Beyond storage and decomposition. *Brain Research, 1543*, 223–234.

Lopez-Calderon, J., & Luck, S. J. (2014). ERPLAB: an open-source toolbox for the analysis of event-related potentials. *Frontiers in Human Neuroscience, 8*, 213.

Marian, V., Blumenfeld, H. K., & Kaushanskaya, M. (2007). The Language Experience and Proficieny Questionnaire (LEAP-Q): Assessing language profiles in bilinguals and multilinguals. *Journal of Speech, Language and Hearing Research, 50*(4), 940–967.

Marslen-Wilson, W., Lorraine K. T., Rachelle W., & Lianne O. (1994). Morphology and meaning in the English mental lexicon. *Psychological Review, 101*, 3–33.

Marslen-Wilson, W. D., & Tyler, L. K. (2007). Morphology, language and the brain: The decompositional substrate for language comprehension. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences, 362*(1481), 823–836.

Milin, P., Đurdevic´, D. F., & del Prado Martin, F. M. (2009). The simultaneous effects of inflectional paradigms and classes on lexical recognition: Evidence from Serbian. *Journal of Memory and Language, 60*, 50–64.

Mitsugi, S., & MacWhinney, B. (2015). The use of case marking for predictive processing in second language Japanese. *Bilingualism, 1*(1), 1–17.

Morris, J., Frank, T., Grainger, J., & Holcomb, P. J. (2007). Semantic transparency and masked morphological priming: An ERP investigation. *Psychophysiology, 44*, 506–521.

Mueller, J. L., Hahne, A., Fujii, Y., & Friederici, A. D. (2005). Native and Nonnative Speakers' Processing of a Miniature Version of Japanese as Revealed by ERPs. *Journal of Cognitive Neuroscience, 17*(8), 1229–1244.

Mueller, J. L., Hirotani, M., & Friederici, A. D. (2007). ERP evidence for different strategies in the processing of case markers in native speakers and non-native learners. *BMC Neuroscience, 8*, 18.

Münte, T., Say, T., Clahsen, H., Schiltz, K., & Kutas, M., (1999). Decomposition of morphologically complex words in English: Evidence from event-related brain potentials. *Cognitive Brain Research, 7*, 241–253.

Neeleman, A., & Weerman, F. (1999). Morphological case. In L. Haegeman, J. Maling and J. McCloskey (Eds.), *Flexible Syntax: A Theory of Case and Arguments* (pp. 59–102). Dordrecht: Springer.

Neubauer, K., & Clahsen, H. (2009). Decomposition of inflected words in a second language. *Studies in Second Language Acquisition, 31*, 403–435.

Neville, H. J., Nicol, J., Brass, A., Forster, K. I., & Garrett, M. F. (1991). Syntactically based processing classes: evidence from event-related potentials. *Journal of Cognitive Neuroscience, 3*, 151–165.

Oldfield, R. C. (1971). The assessment and analysis of handedness: the Edinburgh Inventory. *Neuropsychologia*, *9*, 97–113.

Osterhout, L., & Holcomb, P. J. (1992). Event-related brain potentials elicited by syntactic anomaly. *Journal of Memory & Language, 31*, 785–806.

Osterhout, L., Holcomb, P. J., & Swinney, D. (1994). Brain potentials elicited by garden-path sentences: evidence of the application of verb information during parsing. *Journal of Experimental Psychology: Learning, Memory and Cognition*, *20*, 786–803.

Papadopoulou, D., Varlokosta, S., Spyropoulous, V., Kaili, H., Prokou, S., & Revithiadou, A. (2011). Case morphology and word order in second language Turkish: Evidence from Greek learners. *Second Language Research, 27*, 173–205.

Pinker, S. (1998). Words and rules. *Lingua, 106*, 219–242.

Pinker, S. (1999). *Words and rules: The ingredients of language*. New York: Basic Books.

Pinker, S., & Ullman, M. (2002). The past and future of the past tense. *Trends in Cognitive Science* , *6*(11), 456–463.

Portin, M., Lehtonen, M., Harrer, G., Wande, E., Niemi, J., & Laine, M. (2007a). L1 effects on the processing of inflected nouns in L2. *Acta Psychologica, 128,* 452–465.

Portin, M., Lehtonen, M., & Laine, M. (2007b). Processing of inflected nouns in late bilinguals. *Applied Psycholinguistics, 28*, 135–56.

Ratcliff, R. (1993). Methods for dealing with reaction time outliers. *Psychological Bulletin, 114*(3), 510–532.

Roehm, D., Bornkessel, I., Haider, H., & Schlesewsky, M. (2005). When case meets agreement: event-related potential effects for morphology-based conflict resolution in human language comprehension. *Neuroreport, 16*(8), 875–878.

Schlesewsky, M., Bornkessel, I., & Frisch, S. (2003). The neurophysiological basis of word order variations in German. *Brain and Language, 86*, 116–128.

Schlesewsky, M., Fanselow, G. and Frisch, S. (2003). Case as a trigger for reanalysis: some arguments from the processing of double case ungrammaticalities in German. In Fischer, S., van de Vijver, R. and Vogel, R., (Eds.), *Linguistics in Potsdam 21*, (pp. 31–60).

Schreuder, R., & Baayen, R. H. (1997). How complex simplex words can be. *Journal of Memory and Language, 37*, 118–139.

Silva, R., & Clahsen, H., (2008). Morphologically complex words in L1 and L2 processing: evidence from masked priming in English. *Bilingualism: Language and Cognition, 11*, 245–260.

Sofu, H. (1989). *Acquisition of case markers in Turkish: A cross-sectional study*. Unpublished Master's thesis, Çukurova University, Adana, Turkey.

Stowe, L.A., Kaan, E., Sabourin, L. & Taylor, R. (2018). The sentence wrap-up dogma. *Cognition, 176*, 232–247.

Szlachta, Z., Bozic, M., Jelowicka, A., & Marslen-Wilson, W. D. (2012). Neurocognitive dimensions of lexical complexity in Polish. *Brain and Language, 121*, 219–225.

Taft, M. (2004). Morphological decomposition and the reverse base frequency effect. *The Quarterly Journal of Experimental Psychology, 57A*(4), 745–765.

Taft, M., & Forster, K. I. (1975). Lexical storage and retrieval of prefixed words. *Journal of Verbal Learning and Verbal Behavior, 14*, 638–647.

Tanner, D., & VanHell, J. G. (2014). ERPs reveal individual differences in morphosyntactic processing. *Neuropsychologia, 56*, 289–301.

Topbaş, S., Maviş, I., & Başal, M. (1996). Acquisition of bound morphemes: Nominal case morphology in Turkish. In K. Imer and E. Uzun (Eds.), *Proceedings of the VIIIth International Conference on Turkish Linguistics* (pp. 22–36). Ankara: Ankara University Press.

Ullman, M. T. (2001). The neural basis of lexicon and grammar in first and second language: The declarative/procedural model. *Bilingualism: Language and Cognition, 4*, 105–122.

Van Petten, C., & Kutas. M, (1990), Interactions between sentence context and word frequency in event-related brain potentials. *Memory and Cognition, 18*, 380–393.

Weyerts, H., Penke, M., Dohrn, U., Clahsen, H., & Münte, T. (1997). Brain potentials indicate differences between regular and irregular German plurals. *Neuroreport*, *8*(4), 957–962.

Wickham, H., & Chang, W. (2012). ggplot2: An implementation of the grammar of graphics. Retrieved from http://cran.r-project.org/web/packages/ggplot2/index.html

Woolford, E. (2006). Lexical case, inherent case, and argument structure. *Linguistic Theory*, *37*, 111–130.

Yagoubi, R., Chiarelli, V., Mondini, S., Perrone, G., Danieli, M., & Semenza, C., (2008). Neural correlates of Italian nominal compounds and potential impact of headedness effect: an ERP study. *Cognitive Neuropsychology, 25*(4), 559–581.

Zawiszewski, A., Gutierrez, E., Fernandez, B., & Laka, I. (2011). Language distance and non-native syntactic processing: evidence from event-related potentials. *Bilingualism*, *14*, 400–411.

Zawiszewski, A., & Friederici, A. D. (2009). Processing canonical and non-canonical sentences in Basque: the case of object–verb agreement as revealed by event-related brain potentials. *Brain Research*, *1284*, 161–179.