The processing of Person and Number features in Turkish: An Event Related Potentials (ERP) Study[1]

Mehmet Aygüneş[1], Itır Kaşıkçı[2], Özgür Aydın[3], Tamer Demiralp[4,5]

ORCID: [1]0000-0002-0327-6905, [2]0000-0002-5357-330X, [3]0000-0003-2925-4146, [4,5] 0000-0002-6803-734X

[1]*Istanbul University, Department of Linguistics, Fatih, Istanbul*
[2] *Istanbul Commerce University, Department of Psychology, Beyoglu, Istanbul*
[3] *Ankara University, Department of Linguistics, Sıhhiye, Ankara*
[4] *Istanbul University, Department of Physiology, Fatih, Istanbul*
[5] *Istanbul University, Hulusi Behcet Life Sciences Research Laboratory, Fatih, İstanbul*

[1]*mehmet.aygunes@istanbul.edu.tr,* [2] *ikasikci@ticaret.edu.tr,*
[3]*aydino@ankara.edu.tr,*[4]*demiralp@istanbul.edu.tr*

(Received 12 August 2020; Accepted 2 June 2021)

ABSTRACT: Agreement is one of the most studied linguistic features in the field of language processing. There are two views regarding the processing of Person and Number features. According to the first view, Person and Number features are defined as distinct probes in derivation, while the latter view suggests that these features are bundle features. The current study investigated whether there is any difference in the processing of Person and Number features in Turkish using Event Related Potentials (ERP). Results revealed N400 + P600 patterns in the processing of both Person and Number features, with a greater N400 amplitude for the Person feature than in the Number feature. A greater N400 amplitude suggests more resources are required for the processing of a Person feature than the Number feature. Supporting the distinct features view mentioned above, our results show that there is a difference in the processing of Person and Number features and we claim that Person feature has a privileged linguistic status.

*Keywords***:** Agreement, syntactic processing, event related potentials, N400, P600.

[1] This research was supported by TUBITAK (Project ID: 111K230).

http://dx.doi.org/10.18492/dad.779572
Dilbilim Araştırmaları Dergisi, 2021/1, 31-52.

Türkçede Kişi ve Sayı özelliklerinin işlemlenmesi: Olaya İlişkin Beyin Potansiyelleri (OİP) Çalışması

ÖZET: Uyum, dil işlemleme çalışmalarında en çok çalışılan konulardandır. Kişi ve sayı özelliklerinin işlemlenmesi ile ilgili iki temel görüş bulunmaktadır. Kişi ve Sayı özelliklerinin türetime ayrık sondalar olarak girdiğini öne süren birinci görüşün karşısında ikinci görüş bu özelliklerin demet özellikler olduğunu iler sürmektedir. Bu çalışmada Türkçede kişi ve sayı özelliklerinin işlemlenmesi sürecinde bir farklılığın olup olmadığı Olaya İlişkin Potansiyeller (OİP) ile incelenmiştir. Çalışma sonucunda gerek Kişi özelliklerinin gerekse Sayı özelliklerinin işlemlenmesinde N400+P600 bileşeni oluştuğu ancak Kişi özelliğinin N400'ün genliğinin Sayı özelliğine göre daha büyük olduğu ve iki özelliğin farklılaştığı belirlenmiştir. Kişi özelliğinde daha büyük N400 genliğinin oluşması bu özelliğin işlemlenmesinde, Sayı özelliğinin işlemlenmesine göre daha fazla kaynağa ihtiyaç olduğunu görülmektedir. Elde edilen bulgular Kişi ve Sayı özelliklerinin işlemlenmesinde farklılık olduğunu ve Kişi özelliğinin ayrıcalıklı bir dilbilimsel konuma sahip olduğunu göstermektedir.

Anahtar Sözcükler: Uyum, sözdizimsel işlemleme, olaya ilişkin potansiyeller, N400, P600

---

1 Introduction

Agreement is defined as the matching of the φ-features (Person, Number, and Gender) between two constituents, and it is one of the most studied topics in theoretical linguistics, language typologies, and psycholinguistics. Related studies are given in the following section in detail. Overall, studies primarily question whether there is a difference in the licensing of φ-features which leads to a hierarchy among them. In recent years, cognitive processing of φ-features has also been studied and discussed in psycholinguistics. The motivation of this paper is to investigate any probable difference in the cognitive processing of Number and Person features in Turkish.

The paper starts with the theoretical background of these hierarchy related discussions by reporting typological and theoretical studies of Person and Number features. Then, the findings of the studies which examine the cognitive processing of the above-mentioned features are shared. Lastly, agreement paradigms and their fundamental features in Turkish are introduced, the findings of this study are reported and evaluated.

1.1 Typological and Theoretical Approaches Regarding Person and Number Features

Greenberg (1963) states that there is a hierarchy among Person, Number and Gender features. Accordingly, if a language possesses Gender feature it must have Number feature. However, if it has Number feature it must have Person but not necessarily Gender feature. This leaded to the Feature Hierarchy Hypothesis, which suggests the order of these features as Person>Number>Gender (Greenberg, 1963). Shlonsky (1989) affirms that Person, Number, and Gender features are located in separate nodes in the Agreement Phrase: [Tense Phrase (TP) [Person P (PP) [Number P (NP) [Gender P (GP) [Verb P (VP)…]]]]]]. Harley and Ritter (2002) argue that the Person and Number features are encoded as distinctly based on their Morphosyntactic Feature Geometry, and the Person feature is encoded in the speaker (first person) and addressee (second person), while the third person bears the Number feature.

In theoretical syntax, there are two views regarding agreement features. The first view suggests that the Person, Number and Gender features are in the form of bundle features and are identical in the feature matching process (Chomsky, 1995, 2000, 2004) whereas the second suggests that these features enter the derivation as distinct probes (Baker, 2008; Béjar & Rezác, 2003; Bianchi, 2006; Linn & Rosen, 2003; Nevins, 2011; Preminger, 2011; Sigurðsson, 2004).

Research on Georgian and Basque showed that Person and Number can independently agree with the subject (Bejar, 2000; Rezác, 2003). Baker (2008, 2011) states that Person agreement requires a more specialized syntactic structure than Number and Gender agreement. Baker proposes a universal structural condition on person agreement: Structural Condition on Person Agreement (SCOPA) for the Person feature. Preminger (2011), on the other hand, suggests that while the Person agreement in Basque is established even if it is long-distance, the Number agreement can be problematic in a long-distance environment, thus the Person and Number features are distinct probes.

Sigurðsson (2004) claims that there are three groups of features in the phrase structure: Speech, Grammatical and Event features. In this respect, Speech features are in the Complementizer Phrase (CP) while Grammatical features are in the TP and Event features are in VP: [$_{CP}$ ... , Speech features [$_{IP}$ Grammatical features [$_{vP}$ Event features ...]]]. In addition, φ-features have a different type of interpretive procedure and interact with a different phrase structure. For instance, Person features interact with Speech features and express the status of the speech act, while Number features interact with only Grammatical features and express the numerosity of participants. In order to license Person features, these features must be matched with the T (Tense) head, and then with the CP, which includes the speech participant features. Number features do not need to match with the CP; it is acceptable for them to match only the T head for Number licensing. This configuration also suggests that Number features reflect a grammatical feature while Person features reflect a discursive feature.

On the other hand, according to the feature-based approach developed by Nevins (2011), the Person feature comes as a binary feature in the form of [± participant] and [± speaker], whereas the Number feature is privative. In other words, only [plural] form is syntactically specified for Number features while singular arguments [singular] are not. Thus, Person agreement has equipollent oppositions while Number agreement has privative-zero opposition, and unmarked Number features [singular] are never syntactically active or are never referred to in the syntax. Therefore, Nevins (2011) claims that Person contains more features than Number.

Overall, there are two views in the literature, one represented by researchers who consider the Person and Number features as bundle features and the other by those who claim that these features are assigned as distinct features.

1.2 Processing-based Approaches for Person and Number Features

Among the psycholinguistics studies, there are two viewpoints regarding the processing difference between the categories that form the agreement features: Those who claim there is no difference (Silva-Pereyra & Carreiras, 2007) and the ones who report differences (Carminati, 2005; Díaz et al., 2011; Mancini et al., 2011; Mancini et al., 2014; Nevins et al., 2007; Zawiszewski et al., 2015; Zawiszewski & Friederici, 2009).

In a self-paced reading study, Carminati (2005) shows that if the Person feature is presented along with ambiguity, it leads to longer reading times than if the Number feature is presented with ambiguity. In other words, the Person feature causes more processing cost than the Number feature. Aygüneş (2012) and Aygüneş (2013b) investigated Person and Number features via a repair-based judgement task and showed that there were differences in the repair of Person mismatch and Number mismatch condition. Aygüneş (2012, 2013b) also reported that these differences were not affected by word order as agreement relations were established before movement operations.

Person and Number features were also studied using Event Related Potentials (ERP). ERP is a method in which the electrical activity produced by the brain in response to a certain stimulus is measured using electroencephalogram (EEG). ERP components are classified based on their polarity, peak time and distribution on the scalp. The components frequently mentioned in language processing experiments are N400, LAN and P600. N400, first defined by Kutas and Hillyard (1980a, 1980b), has a negative polarity, peaks approximately 400 ms after the stimulus presentation, and shows a distribution slightly lateralized to the right in the posterior region of the scalp. Kutas and Hillyard (1980a) found that the N400 reflects a lexical-semantic matching difficulty; however, this component may also be sensitive to morphological and syntactic processing (Bornkessel, McElree, Schlesewsky, & Friederici, 2004; Choudhary et al., 2009; Frisch & Schlesewsky, 2001; Mancini et. al., 2011a; 2011b; Zawiszewski et. al., 2015).

LAN, which peaks at 250-500 ms post-stimulus interval and distributed in the left anterior region of the scalp, is attributed to the mismatches between the subject and the verb (Burkhardt, Fanselow & Schlesewsky,2007; Coulson, King, & Kutas 1998b; De Vincenzi et. al., 2003; Hagoort & Brown, 2000b; Münte, Matzke, & Johannes 1997; Roehm et. al., 2005). It has also been associated with the operations related to verbal working memory (Kluender & Kutas, 1993a; 1993b; Münte et. al., 1998). P600 peaks with a positive polarity approximately 600 ms after stimulus presentation, and it is observed to be widely distributed in the middle posterior region of the scalp. The P600 is linked to errors during the processing of syntactic parsing (Friederici & Mecklinger, 1996; Hagoort et al., 1993; Hagoort, Wassenaar, & Brown, 2003; Osterhout et. al., 1994) repair of ungrammatical sentences (Coulson et al., 1998; Hagoort et al., 1993; Neville et al., 1991; Osterhout & Mobley, 1995) and the need for re-analysis of the garden path sentences (Mecklinger et. al., 1995; Osterhout & Holcomb, 1992).

There are only a few ERP studies examining the Person and Number features. Silva-Pereyra and Carreiras (2007) reported that there is no difference in the processing of Person and Number features for the first/second person, singular/plural forms in Spanish. As a result, they suggest that the Person and Number features are bundle features, thus the Feature Hierarchy Hypothesis is not valid. Nevins et. al. (2007), on the other hand, argue that when a mismatch occurs in both the Number and Gender features, the processing of these features is not any different than the processing of a Gender or Number mismatch alone. However, they further argued that a mismatch in both the Person and Gender features caused a larger P600 amplitude than a Gender or Person mismatch alone and claimed that this situation, which they observed in Hindi, is due to the privileged linguistic status of Person feature.

Mancini et. al. (2011a) state that dissociation of Person and Number features processing should be tested using third person, thus test sentences constructed with the first and second person (as in Silva-Pereyra & Carreiras, 2007) will reveal no difference. The ERP experiment of Mancini et. al. (2011a) was in Spanish and it included the third person. They reported a difference in the processing of Person and Number features: N400 + P600 were obtained in the processing of the Person and LAN + P600 were obtained in processing of the Number. They argued that the LAN component in Number was observed because of its grammatical characteristic, and the N400 component in Person was observed due to its discursive features such as being a speaker, an addressee, etc.

Mancini et. al. (2014) examined the processing of Person and Number features in Italian by using self-paced reading. Their first experiment included the structures with the first Person. For the experiment, Person mismatch, Number mismatch and Person + Number mismatch conditions were created. No difference was found between the Person and Number features. The second experiment included the structures with the third Person singular and looked at the processing of the same type of mismatch conditions. Here, they found a difference between Number and Person mismatches. A difference in reading

times was also reported for Number and Person + Number mismatches, and reading times significantly increased when Person feature was processed. All in all, Mancini et. al. (2014) support the findings in Mancini et al. (2011a) and conclude that there is a difference in the processing of the Person and Number features, and this difference only occurs with third person.

Zawiszewski et. al. (2015) tested the relationship between the Person and Number features by using the second person singular in the Basque language. The sentences contained grammatical sentences as well as sentences with Person, Number and Person + Number mismatches. They found that N400 was elicited in all conditions involving a mismatch, but there is no significant difference between Person and Number mismatch conditions in terms of the amplitude of N400. On the other hand, the amplitude of P600 was significantly different between Person and Number mismatches and a larger P600 was observed in both Person and Person + Number mismatch conditions. Overall, Zawiszewski et. al. (2015) conclude that there is a difference in the processing of the Person and Number features, so these features act like distinct probes.

As listed above, different findings have been revealed in a small number of studies on the processing of Person and Number features. In four studies examining the relationship between Person and Number features, it was stated that there is a difference in the processing of Person and Number features and that there is a hierarchy in the processing, such as Person>Number (Mancini et. al., 2011a; Mancini et. al., 2014; Nevins et. al., 2007; Zawiszewski et. al., 2015). On the other hand, Silva-Pereyra and Carreiras (2007) reported that the Person and Number features have a similar effect on the processing cost. It is noteworthy that there are crucial structural differences in the studies reporting processing differences between Person and Number features. Some studies suggest that there is a difference in processing between person and number features only with third person (Mancini et. al., 2011a; Mancini et. al., 2014). These studies indicate that it is not possible to create a pure Number mismatch, and there will be contamination of Person mismatch in Number mismatches with Persons except third person. However, Zawiszewski et. al. (2015) show that the processing difference between Person and Number features occurs with Persons other than third person, such as second person.

1.3 Agreement Paradigms in Turkish

Agreement paradigms in Turkish are generally classified into three groups (Banguoğlu, 1974; Ergin, 1992)[2]. The first group of agreement suffixes originates from possessive suffixes, and they are used only with morphemes *–DI (e.g. Biz gel-di-k)* and *–sA (e.g. Biz gel-se-k).* Yu and Good (2000) and Good and

[2] For a more detailed description of agreement paradigms in Turkish, see Aygüneş (2013a).

Yu (2005) name the first agreement paradigm as *k-paradigm* and suggest that this paradigm refers to real suffixes. On the other hand, the second group of agreement suffixes originated from pronouns, and they are used with all conjugations except suffixes *–DI*, *–sA* and the imperative form. Yu and Good (2000) and Good and Yu (2005) name the second agreement paradigm as *z-paradigm* and suggest that this paradigm consists of clitics. It is argued that there are several differences between the k-paradigm and z-paradigm- in other words, between being a real suffix and a clitic. (Yu and Good, 2000; Good and Yu, 2005). According to this view, the k-paradigm can be seen both at the end of the predicate and between Tense-Aspect-Mood (TAM) markers while the z-paradigm can appear only at the end of the predicate.

k-paradigm	*z-paradigm*
Ben köpeği sev-di-m.	Ben köpeği sev-miş-im.
I dog.ACC like-PAST-1SG	I dog.ACC like-EVI-1SG
'I liked the dog'	'I supposedly liked the dog'
Ben köpeği sev-di-m-se.	*Ben köpeği sev-iyor-um-muş.
I dog.ACC like-PAST-1SG-CON	I dog.ACC likeIMP-1SG-EVI
'If I liked the dog'	'I supposedly like the dog '

Secondly, Kabak (2007) states that the k-paradigm does not allow suspended affixation; while the z-paradigm does. To put it another way, k-paradigm establishes a strong relation with TAM, which appear before it, since it is a real suffix whereas the z-paradigm can appear in a suspended way as it is a clitic.

k-paradigm	*z-paradigm*
*Çalış-tı ve başar-dı-k.	Çalış-ır ve başar-ır-ız.
work-PAST and succeed-PAST-1P(k)	work-AOR and succeed-AOR-1P(z)
Çalış-tı-k ve başar-dı-k.	Çalış-ır-ız ve başar-ır-ız.
work-PAST-1P and succeed-PAST-1P(k)	work-AOR-1P and succeed-AOR-1P(z)
'We worked and succeed'	'We work and succeed'

(Kabak,2007:316)

Lastly, it is stated that the k-paradigm receives stress, but the z-paradigm does not receive stress as in clitics (Zwicky and Pulum, 1983), and the stress is placed right before the agreement suffixes in this paradigm.

k-paradigm	*z-paradigm*
sev-di-**k**	sev-**miş**-iz
love-PAST-1PL	love-EVI-1PL
'We loved'	'We supposedly loved'

As a third paradigm in Turkish (mixed paradigm in Sezer, 2001), apart from the k-paradigm, which is suggested to be a real suffix, and the z-paradigm, which is

suggested to be a clitic, there is an agreement paradigm which can be approached as a unitary paradigm in parallel with Kornfilt (1997) and which is used with the imperative and optative mood. Although the morpheme –sIn, which appears in the imperative mood, is sometimes considered as a suffix, only indicating the agreement category and sometimes as a portmanteau morph, indicating both agreement and mood, Aydın (2007) claimed that –sIn does not show agreement category. Kornfilt (1984) primarily makes a distinction between a "nominal" and "verbal" agreement paradigm in Turkish. According to her view, the three above-mentioned paradigms are verbal agreement paradigms while the paradigm which consists of suffixes added to nouns or which is known as "possessive suffixes" is a nominal agreement paradigm. In conclusion, Turkish agreement paradigms consist of the mixed paradigm, which is used with the imperative and optative mood, the k paradigm, which is used with morphemes -DI and -sA and apart from these, the z-paradigm, which is used with tense/mood markers. Besides these, there is also a nominal agreement paradigm in Turkish (Table 1).

Table 1. Agreement paradigms in Turkish

	***k*-paradigm**	***z*-paradigm**	**mixed paradigm**	**nominal paradigm**
1sg	*–m*	*–Im*	*–(y)Im*	*–(I)m*
2sg	*–n*	*–sIn*	*–sIn*	*–(I)n*
3sg	*–Ø*	*–Ø*	*–Ø*	*–(s)I(n)*
1pl	*–k*	*–Iz*	*–lIm*	*–(I)mIz*
2pl	*–nIz*	*–sInIz*	*–sInIz /–In(Iz)*	*–InIz*
3pl	*(–lAr)*	*(–lAr)*	*(–lAr)*	*–(lAr)I*

Person and Number categories in Turkish is marked by a single portmanteau morph. Besides, although the morpheme *-nIz* is considered as a unique morpheme, it is argued that this morpheme consists of the morphs *-n* and *-Iz* diachronically. Moreover, it is observed that the Number category in the conjugation for third person plural is presented with a different morpheme (*-lAr*) from the Person category. Therefore, even though the Person and Number categories are considered as a portmanteau morph in the k-paradigm, there are traces where the two categories may differ.

This study focuses on the Person and Number features which are included in the verbal agreement paradigm in order to provide consistency in the literature on the sentence processing. Our stimuli consist only of the k-paradigm which is one of the verbal agreement paradigms in Turkish that are used in the test sentences. The main reason for this is to examine the processing of the Person and Number features of the real agreement suffixes instead of clitics. The second reason is that all the suffixes that are in the k-paradigm consist of a single

syllable, unlike the other agreement paradigms. Therefore, the k-paradigm also displays a more balanced distribution between the conditions in terms of the length of suffixes and minimizes the contamination of the processes that are different from the parameters that the study aims to measure.

1.4 Research Questions

This study aims to test whether there is a difference in the processing of Person and Number features in Turkish using ERP. In this context, the research questions of the study are as follows:

i) Is there a difference between Person and Number features in terms of cognitive processing?

ii) Is the Person>Number hierarchy of the Feature Hierarchy Hypothesis valid for Turkish?

iii) Which ERP components are effective in the processing of Person and Number features in Turkish?

In line with the theoretical and experimental findings, we hypothesized that the processing of Person and number features differs. Thus, we predict that different ERP components will be elicited or the same ERP component with different amplitudes will be elicited for the two features during the processing of Person and Number features. If a greater amplitude of N400/LAN and/or P600 is observed, it will suggest that more resources are required especially for the processing of the Person feature and support the Feature Hierarchy Hypothesis, which is in the form of Person>Number. Thus, the difference between the processing of Person and Number features will support the idea that the Person and Number features enter the derivation as distinct probes (Sigurðsson, 2004) or the theoretical views that they display a different feature distribution (Nevins, 2011), contrary to the idea that the Person and Number features are bundle features (Chomsky, 1995, 2000, 2004).

2 Methods

2.1 Participants

Thirty-four university undergraduates (age range: 20-32, mean age: 26.64) (19 female) participated in this study. All were native speakers of Turkish, right-handed, and had normal or corrected vision. They all filled and signed the "Informed Volunteer Consent Form" approved by Ankara University Faculty of Medicine Clinical Research Evaluation Board with decision Number 28-485.

2.2 Materials

The study had a similar experimental design used by Silva-Pereyra and Carreiras (2007). The experimental set involved four conditions: Grammatical, Person mismatch, Number mismatch, and Person-Number mismatch. There were 100 sentences for each of these conditions and 400 sentences in total (Table 2). In addition, 200 grammatical clauses were used as fillers to equalize the number of the grammatical sentences and ungrammatical ones, but these sentences were not included in the analysis process. The sentence structure involved subjects with the first Person singular *ben* 'I', the first Person plural *biz* 'we', the second Person singular *sen* 'you' and the second Person plural *siz* 'you', and each condition was represented in equal numbers. Subject-object-verb sequence was used in all of the sentences and past tense suffix –DI was added to all the verbs. The k-paradigm was used as the agreement paradigm.

Table 2. Sample sentences used in the experiment set

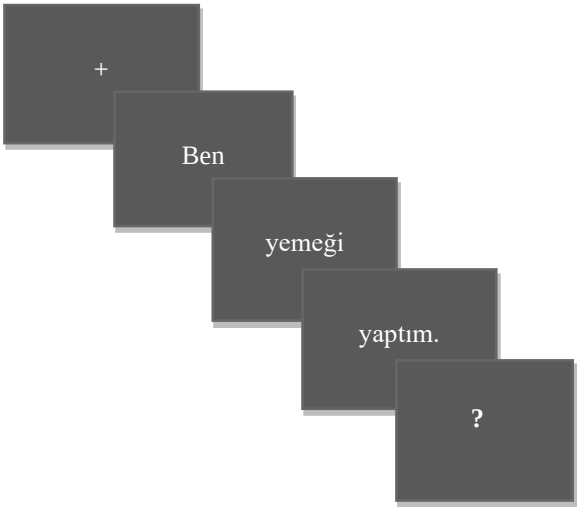
	Grammatical	Person Mis.	Number Mis.	Person+ Number Mis.	N
Ben yemeği	yaptım	yaptın	yaptık	yaptınız	
I meal.ACC	make. PAST.1SG	make. PAST.2SG	make. PAST.1PL	make. PAST.1PL	100
Sen kahveyi	içtin	içtim	içtiniz	içtik	
you coffee. ACC	drink. PAST.2SG	drink. PAST.1SG	drink. PAST.2PL	drink. PAST.1PL	100
Biz tahtayı	sildik	sildiniz	sildim	sildin	
we board. ACC	clean.PAST. 1PL	clean.PAS T.2PL	clean. PAST.1SG	clean. PAST.2SG	100
Siz müzeyi	gezdiniz	gezdik	gezdin	gezdim	
you museum.ACC	visit. PAST.2PL	visit. PAST.1PL	visit. PAST.2SG	visit. PAST.1SG	100
TOTAL	100	100	100	100	400

2.3 Procedure

All participants were individually tested in a dimly lit cabinet known as the Faraday Cage, isolated from sound and electromagnetic interference. The participants were seated in front of the computer monitor with a distance of 110 cm. The sentences in the experiment were presented visually and word by word in white letters on a dark gray background. Stimulus presentation started with a

fixation cross that remained in the middle of the screen for 1000 ms, which was followed by a blank screen for 300 ms. Afterwards, the words were presented for 500 ms with 300 ms of blank screen between the words. At the end of each sentence, a question mark was presented for 2000 ms (Figure 1). After seeing the question mark, the participants were asked to press the left key if it was grammatical and the right key if it was ungrammatical. After the question mark disappeared from the screen, 300 ms of blank screen was presented and the presentation of the other sentence started. The ERP experiment lasted about three hours.

Figure 1. Stimulus presentation and duration



2.4 EEG Recording and Analysis

Electroencephalogram (EEG) data was collected through a standard 32-channel Brain Amp system and was referenced on-line to linked earlobes. Electro-oculogram (EOG) was recorded from the electrodes placed in the nasal and external quantus region of the right eye to monitor eye movements. During the EEG recordings, the electrode impedance was kept below 10 kΩ for scalp electrodes and 5 kΩ for ground and EOG electrodes. The sampling rate was 500 Hz during EEG recording. Artifact correction for eye artifacts was done using Independent Component Analysis (ICA). The EEG signal was filtered between 0.1 Hz -15 Hz. The epochs were time-locked to the onset of verbs, which were the critical words for the study, with a 200 ms pre-stimulus and 800 ms post-stimulus interval. The baseline correction was applied in the -200 ms and 0 ms

pre-stimulus time window. The analysis of these time windows was done based on the average amplitude values. In the study, 270-450 ms time window for LAN and N400, 500-750 ms time window for P600 was analysed. Statistical analysis was carried out by grouping the electrodes equally. The electrode grouping was performed based on the distribution of anterior-posterior and left-right hemisphere (Table 3).

Table 3. Electrode groups used in statistical analysis

ROI		Left	Right
Frontal	F	F3,F7	F4,F8
	FC	FC3,FT7	FC4,FT8
Posterior	CP	CP3,TP7	CP4,TP8
	P	P3,P7	P4,P8

For statistical analysis, repeated measures ANOVA was carried out based on Conditions (4 levels: Grammatical, Person mismatch, Number mismatch, Person-Number mismatch) × ROI (2 levels: frontal, posterior) × Hemisphere (2 levels: left hemisphere, right hemisphere). Greenhouse-Geisser correction (Greenhouse-Geisser, 1959) was applied to all repeated measures with more than one degree of freedom in the numerator.

3 Results

3.1 270-450 ms Time Window

In the 270-450 ms time window, all mismatch conditions elicited a greater negativity than the grammatical condition (Figure 2), and the lateralization of the negativity was found in the right hemisphere (Figure 3). This negativity is interpreted as the N400 component.

There was a significant main effect of Condition, F (3,99) = 12.186, p<.001, Condition × Hemisphere interaction, F (3,99) = 8.753, p<.00, and Condition × ROI × Hemisphere interaction, F (3,99) = 3.102, p<.05, but there was no such significant effect of Condition × ROI interaction, F (3,99) = 1.080, p> .05. When the conditions were compared pairwise, a significant difference between Person and Number mismatch was found. Moreover, there was no difference between Person mismatch and Person-Number mismatch while there was a difference between Number mismatch and Person-Number mismatch, and a greater amplitude of the N400 component was observed for Person-Number mismatch. (Table 4). Therefore, in this time window, it was observed that the N400 component is elicited in the processing of Person and Number features, but the amplitude of the N400 was greater for Person mismatch than Number mismatch.

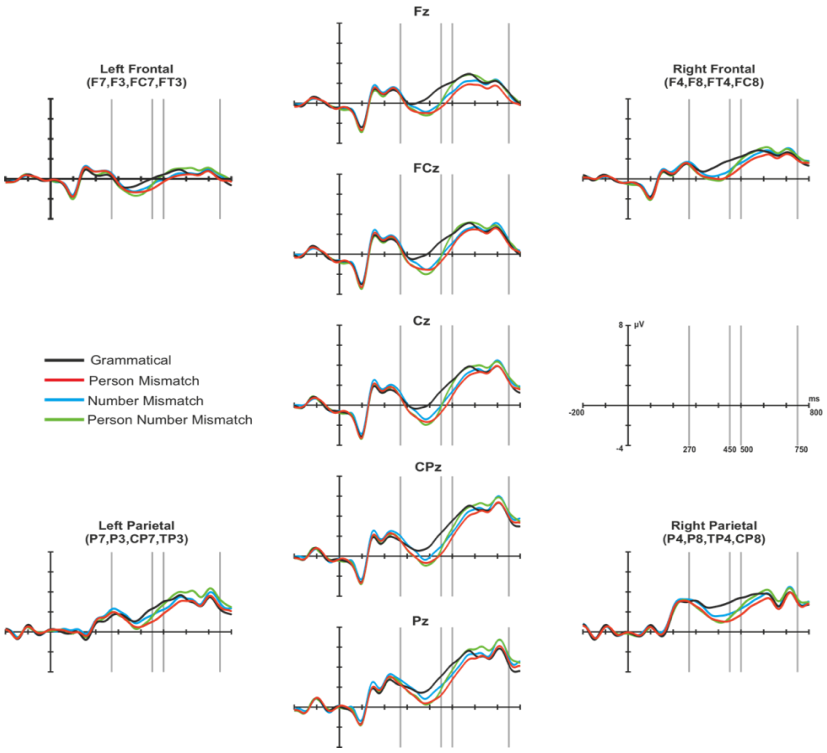
This finding shows that a difference arises during the processing of Person and Number features.

Table 4. Pairwise comparisons in 270-450ms time window

	C		C×H		C×ROI×H	
Grammatical vs Person Mis.	14.849	***	14.242	***	n.s.	
Grammatical vs Number Mis.	5.073	*	17.140	***	n.s.	
Grammatical vs Person+Number Mis.	32.894	***	15.547	***	5.071	*
Person Mis. vs Number Mis.	7.643	**	n.s.		n.s.	
Person Mis. vs Person+Number Mis.	n.s.		n.s.		n.s.	
Number Mis. vs Person+Number Mis.	10.366	**	n.s.		n.s.	

* $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$, n.s.=not significant, Mis.=Mismatch, C=Condition, H=Hemisphere.

Figure 2. Grand-averaged ERPs time-locked to the verb onset



3.2 500-750 ms Time Window

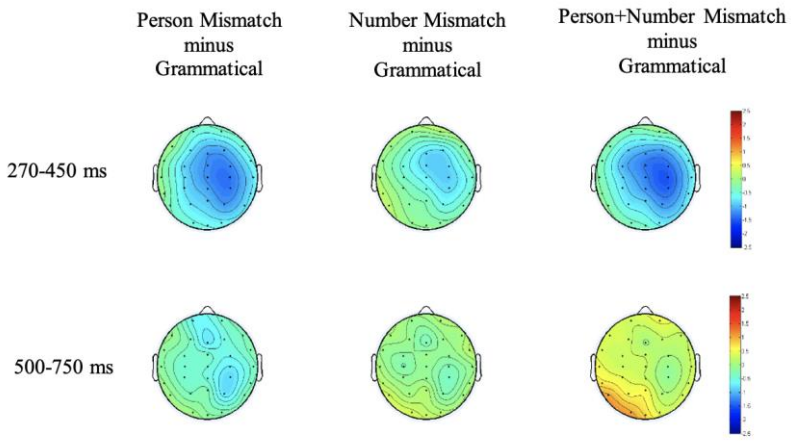
In the 500-750 ms time window, a positivity (P600) was elicited in all conditions (Figure 2) and it was larger in the Person + Number mismatch condition. It was observed especially in the left posterior area (Figure 3). Furthermore, while the main effect of Condition, F (3,99) = 4.621, p<.01 and Condition × ROI × Hemisphere interaction, F (3,99) = 3.138, p<.05, were statistically significant, Condition × ROI, F (3,99) = 0.943, p> .05, and Condition × Hemisphere interaction, F (3,99) = 2.639, p> .05, were not. When pairwise comparisons were examined, it was observed that there was not a difference between Person mismatch and Number mismatch, and the main difference arose between Person-Number mismatch and the other conditions in this time window. The pairwise comparisons related to F and p values of the statistical significance levels are presented in Table 5.

Table 5. Pairwise comparisons of the conditions in 500-750ms time window

	C	C×ROI×H
Grammatical vs Person Mis.	n.s.	n.s.
Grammatical vs Number Mis.	n.s.	n.s.
Grammatical vs Person+Number Mis.	n.s.	7.529*
Person Mism. vs Number Mis.	n.s.	n.s.
Person Mismatch vs Person+Number Mis.	17.619***	n.s.
Number Mism. vs Person+Number Mis.	4.560*	n.s.

* p≤.05, ** p≤.01, ***p≤.001, n.s.=not significant, Mis.=Mismatch, C=Condition, H=Hemisphere.

Figure 3. Topographical maps of the conditions



4 Discussion

The current study investigated whether there is a difference in the processing of Person and Number agreement features in Turkish using ERP. Previous studies have presented conflicting findings; some suggest that there are no differences in the processing of Person and Number features (Silva-Pereyra & Carreiras, 2007), while others suggest that there are differences in the processing of these features (Mancini et. al., 2011a; Mancini et. al., 2014; Nevins et. al., 2007; Zawiszewski et. al., 2015). As a result, it was hypothesized that if there is a difference in the processing of the Person and Number features, the Person mismatch should have a greater impact in the N400 / LAN and/or P600 components compared to the Number mismatch. Also, given that the mismatch in a single feature can have different effects than the conditions with mismatches in two features (Barber & Carreiras, 2003), it was hypothesized that the mismatch in the Person and Number features together would have a greater effect than the Number mismatch, in particular.

In the first time window, Person, Number and Person-Number mismatch conditions showed a larger N400 amplitude lateralized to the right hemisphere, compared to Grammatical condition (Figure 3). The N400 is generally defined as a component that peaks in the posterior region of the scalp and is slightly lateralized to the right hemisphere (Kutas & Hillyard, 1980). When the conditions are evaluated for the N400 effects, it is clear that Person mismatch

and Number mismatch significantly differ in terms of the N400 effects. The N400 has a larger amplitude in Person mismatch condition. It demonstrates that the Person and Number features are different, that is, there is a difference in the processing of the two features. Moreover, the processing of the Person feature creates a greater cognitive load. However, the difference observed between Person and Number features does not refer to a topographic difference, but an amplitude difference. The N400 component (Mancini et. al., 2011a; Zawiszewski et. al., 2015) has been reported along with the LAN component (Silva-Pereyra & Carreiras 2007; Nevins et. al., 2007) during the processing of the Person feature. Mancini et. al. (2011a) emphasize that the N400 was observed because the Person feature is a discursive feature, but the LAN was observed because the Number feature is morphological alone. Consequently, the processing of the Person feature establishes a multidimensional relationship between morpho-syntax and discourse. More specifically, N400 is visible, but LAN is actually elicited instead of N400, as there are only morpho-syntactic processes in Number mismatch and no additional connection takes place with discourse. LAN + P600 pattern has also been reported quite systematically during the processing of the Number feature (Angrilli et al., 2002; Coulson et. al., 1998; De Vincenzi et. al., 2003; Hagoort & Brown, 2000a; Kutas & Hillyard, 1983; Mancini et. al., 2011a; Molinaro et. al., 2008b; Molinaro et. al., 2011; Nevins et. al., 2007; Osterhout & Mobley, 1995; Palolahti et. al., 2005; Roehm et. al., 2005; Silva-Pereyra & Carreiras, 2007).

Similar to Zawiszewski et. al. (2015), we have found the N400 component during the processing of the Number feature. One of the possible reasons for this N400 effect can be that the N400 basically reflects a feature-based error identification process. Even though the Person feature is determined as a binary feature in the form of [± participant] and [± speaker], because the Number feature is missing and because the [singular] members are by default, only the plural forms are determined in the form of [+ plural] (Nevins, 2011). Therefore, it can be argued that the N400 in this condition increased amplitude, as N400 was elicited in both conditions and more features needed to be analysed to interpret the Person feature. Another possible reason for N400 effects in both conditions in the study can be the location of the critical word in the experiment. Some studies showed that if the critical word is located at the end of the sentence, N400 effects can be observed because the analysis of the entire sentence also takes place at the end (Hagoort, 2003; Hagoort & Brown, 1999). In this case, it is emphasized that the N400 can reflect the wrap-up effect of the sentence. However, even if the evaluation of the whole sentence has a possible effect on the topographic distribution of this ERP component, it does not appear to mask the difference in the processing of these features. Therefore, the processing of the Person and Number feature differs and more resources are needed to process the Person feature. Even though there is no statistical difference between Person and Person-Number mismatch, there is a difference between Number and Person-Number mismatch. This finding suggests that due to the high cognitive

load of the Person feature, a mismatch in the Person feature has a similar effect to the situation in which a mismatch is created in both features. In conclusion, even though Silva-Pereyra and Carreiras (2007) did not reach a feature hierarchy with a similar experiment pattern in Spanish, the current study suggests a hierarchy in the form of Person>Number and thus supports the Feature Hierarchy Hypothesis.

In the second time window, a P600 component with a positive polarity peak was observed in all conditions, but this positivity did not make a significant difference when the grammatical condition was compared to those where there was a mismatch in a single feature. Similarly, there was no difference in this time window between Person mismatch and Number mismatch (Figure 2). The difference was observed between the Person + Number mismatch and the other conditions. Thus, the source of the difference was the Person-Number mismatch. The positivity in Person-Number mismatch was distributed in the left –posterior region of the scalp, but the topographic appearance of the effect here differed from the P600 peaking in the mid-posterior area and remained in a more limited area (Figure 3). This effect, which was observed only in binary mismatches in the second time window, seems to be compatible with the findings of Silva-Pereira and Carreiras (2007). In their study, a significant difference was found only in cases where binary mismatches occurred in the 500-700 ms time window, but the positivity in the present study was found in the right posterior area of the scalp. Similarly, Barber and Carreiras (2003) reported that the decision making process takes place in binary mismatches faster and without any separate control process. As a result, the processing of the mismatches created in both features here required more cognitive resources than a single mismatch.

Interestingly, there was no greater positivity in the single feature mismatches than in the grammatical condition. In many studies, the P600 component has been reported for the subject and verb disagreement (Barber & Carreiras, 2005; Hagoort et. al., 1993; Mancini et. al., 2011a; Nevins et. al., 2007; Osterhout & Mobley, 1995; Silva-Pereyra & Carreiras, 2007). P600 in these studies was associated with diagnosis (Barber & Carreiras, 2005; Carreiras et. al., 2004; Molinaro et. al., 2008), morpho-syntactic agreement difficulty (Carreiras et. al., 2004; Friederici et. al., 2002; Kaan et. al., 2000) and discourse-level agreement difficulty (Kaan&Swaab, 2003). However, in all these studies, the critical word was not at the end of the sentence. Lück et. al. (2006) state that if the critical word is at the end of the sentence, the closure negativity that occurs due to the evaluation of the entire sentence can mask the formation of the P600. Given that Turkish is a Subject Object Verb (SOV) language, and the critical word in the experiment is at the end-of-sentence position, it can account for why the P600 effect was not observed in the current study. However, the difference of the positivity following a dual mismatch in the Person and Number features compared with the other conditions suggests that if there is any need for more cognitive resources during sentence processing, the potential masking effect may

exceed and the P600 may occur, yet the masking effect may affect the topography of the P600.

When the findings of this study are taken into consideration, it is seen that the N400 + P600 pattern was observed in all conditions. Furthermore, the Person and Number features cause a statistically significant difference in the N400 component. This difference was due to the larger N400 amplitude triggered by the Person feature. As a result, the current study on Turkish supports the Feature Hierarchy Hypothesis shown as Person>Number in the literature. In other words, the findings of this study show that there is a difference between the processing of Person and Number features, and more cognitive resources are required for the processing of Person features.

Previous research has shown that different Person and Number features should be considered. For instance, although the current experiment design matches the one by Silva-Pereyra and Carreiras (2007), the results of both studies diverge. Silva-Pereyra and Carreiras (2007) do not report any difference in the processing of the Person and Number features; however, the current study reveals such a difference. Moreover, Mancini et. al. (2011a, 2014) claim that the processing of Person and Number features differ only in the case of the third person. Yet, in the current study, similar to Zawiszewski et. al. (2015), we found a difference between Person and Number in the other Person features as well (i.e., 1^{st}, 2^{nd}). As a result, whether processing difference is dependent on the Person features (i.e., 1^{st}, 2^{nd},3^{rd}) and Number features (singular, plural) is still debatable in terms of the Feature Hierarchy Hypothesis.

The ERP studies on Person and Number features report different brain components. For instance, Silva-Pereyra and Carreiras (2007) observed Anterior Negativity + P600 during Person and Number processing. They also did not find any difference in the processing of these features. However, Mancini et. al. (2011a) reported N400 + P600 for the processing of Person and LAN + P600 for the processing of the Number feature. They also reported differences in the processing of the Person and Number features. Zawiszewski et. al. (2015) found N400 + P600 for both the Person and Number processing. They also report that the difference in the processing was manifested only in the P600 component. The current study on Turkish shows that N400 and P600 were present during the processing of Person and Number mismatch. More specifically, the difference between the processing of these features lies in the N400. However, due to the limited number of studies on the processing of Person and Number features and the conflicting findings, it is critical to study other languages to reach a more general conclusion.

5 Conclusions

The following are our conclusions as pertaining to our research questions: A N400+P600 pattern was observed during the processing of Person and Number features in the k-paradigm in Turkish. A greater N400 amplitude was elicited

during the processing of Person features than Number features. This finding shows that there are significant differences between the processing of Person and Number features in Turkish, and the Feature Hierarchy Hypothesis (Person>Number) is valid for Turkish. The findings also support the idea that Person and Number features enter the derivation as distinct probes rather than bundle features.

Author Contributions

M. A. : theoretical framework, EEG recording, data analysis, discussion of ERP and linguistic results, article writing.
I. K. : EEG recording, proofreading.
Ö. A. : supervising theoretical framework, discussion of linguistic results.
T. D. : supervising data analysis, discussion of ERP results.

References

Angrilli, A., Penolazzi, B., Vespignani, F., De Vincenzi, M., Job, R., Ciccarelli, L., Palomba, D., Stegagno, L. (2002). Cortical brain responses to semantic incongruity and syntactic violation in Italian language: An event related potential study. *Neuroscience Letters*, *322*(1), 5-8.

Aydın, Ö. (2007). Türkçede üçüncü kişi buyrum yapıları, *Ankara Üniversitesi Dil ve Tarih-Coğrafya Fakültesi Dergisi*, *47*(1), 151-163.

Aygüneş, M. (2012). Türkçede uyum özelliklerinin onarım tabanlı incelenmesi. *Mersin University Journal of Linguistics and Literature*, 1-19.

Aygüneş, M. (2013a). *Türkçede uyum özelliklerinin Olaya İlişkin Beyin Potansiyelleri (OİP) çerçevesinde incelenmesi*, Unpublished doctoral dissertation. Ankara University.

Aygüneş, M. (2013b). Türkçede üçüncü kişide kişi ve sayı özelliklerinin özelliklerinin onarım tabanlı incelenmesi. *Turkish Studies*, 255-268.

Baker, M. C. (2008). *The syntax of agreement and concord.* Cambridge: Cambridge University Press.

Baker, M. C. (2011). When agreement is for number and gender but not person. *Natural Language & Linguistic Theory, 29*(4), 875-915.

Banguoğlu, T. (1974/1986). *Türkçenin grameri*. Ankara: Türk Tarih Kurumu Basımevi.

Barber, H., & Carreiras, M. (2003). Integrating gender and number information in Spanish word pairs: An ERP study. *Cortex*, *39*(3), 465-482.

Barber, H. A. & Carreiras, M. (2005). Grammatical gender and number agreement in Spanish: An ERP comparison. *Journal of Cognitive Neuroscience, 17*(1), 137-153.

Béjar, S. (2000a). Structural markedness in formal features: Deriving interpretability. *Revue québecoise de linguistique 28*(1), 47-72.

Béjar, S. (2000b). *Locality, cyclicity and markedness in Georgian verbal morphology*. GLOW 23, Vitoria, Spain.

Béjar, S. & Rezác, M. (2003). Person licensing and the derivation of PCC effects. In Ana-Teresa Pérez-Leroux & Yves Roberge (Ed.), *Romance linguistics: Theory and acquisition* (pp. 49-61). Amsterdam: John Benjamins.

Bianchi, V. (2006). On the syntax of personal arguments. *Lingua,116*(12), 2023-2067.

Bornkessel, I., Mcelree, B., Schlesewsky, M. & Friederici, A.D. (2004). Multidimensional contribution to garden-path strength: Dissociating phrase structure from case marking. *Journal of Memory and Language, 51*(4), 495–522.

Burkhardt, P., Fanselow, G. & Schlesewsky, M. (2007). Effects of (in)transitivity on structure building. *Brain Research 1163*, 100-110.

Carreiras, M., Salillas, E., & Barber, H. A. (2004). Event related potentials elicited during parsing of ambiguous relative clauses in Spanish. *Cognitive Brain Research, 20*(1), 98-105.

Carminati, M.N. (2005). Processing reflexes of hierarchy (person>number>gender) and implications for linguistic theory. *Lingua,115*(3), 259–285.

Chomsky, N. (1995). *The Minimalist program.* Cambridge, Mass.: MIT Press.

Chomsky, N. (2000). Minimalist inquiries: The framework. In Roger Martin, David Michaels, & Juan Uriagereka (Ed.), *Step by step: Essays on minimalist syntax in honor of Howard Lasnik*, (pp. 89-155). Cambridge, MA: MIT Press.

Chomsky, N. (2004). Beyond explanatory adequacy. In A. Belletti (Eds.), *Structures and beyond*, (pp.104-131). Oxford: Oxford University Press.

Choudhary, K., Schlesewsky, M., Roehm, D., & Bornkessel-Schlesewsky, I. (2009). The N400 as a correlate of interpretively-relevant linguistic rules: Evidence from Hindi. *Neuropsychologia, 47*(13), 3012-3022.

Coulson, S., King, J. W., & Kutas, M. (1998). Expect the unexpected: Event related brain response to morphosyntactic violations. *Language and Cognitive Processes, 13*(1), 21–58.

De Vincenzi, M., Job, R., Di Matteo, R., Angrilli, A., Penolazzi, B., Ciccarelli, L. (2003). Differences in the perception and time course of syntactic and semantic violations. *Brain and Language, 85*(2), 280-296.

Díaz, B., Sebastián-Gallés, N., Erdocia, K., Mueller, J. & 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*(3), 357–373.

Ergin, M. (1992). *Edebiyat ve Eğitim Fakültelerinin Türk Dili ve Edebiyatı Bölümleri için Türk Dil Bilgisi*. İstanbul: Özal Matbaası.

Friederici, A. D., & Mecklinger, A. (1996). Syntactic parsing as revealed by brain processes:First-pass and second-pass parsing processes. *Journal of Psycholinguistic Research, 25*(1), 157-176.

Friederici, A. D., Hahne, A., & Saddy, D. (2002). Distinct neurophysiological patterns reflecting aspects of syntactic complexity and syntactic repair. *Journal of Psycholinguistic Research, 31*(1), 45-63.

Frisch, S., & Schlesewsky, M. (2001). The N400 indicates problems of thematic hierarchizing. *Neuroreport, 12*(15), 3391–3394.

Greenberg, J.H. (1963). Some universal of grammar with particular reference to the order of meaningful elements. In J. H. Greenberg, (Eds.), *The universals of language*, (pp.73-113). MIT Press, Cambridge, MA.

Good, J. and Yu, A. C. (2005). *Morphosyntax of two Turkish subject prominal paradigms. Clitic and affix combinations.* In Lorie Heggie and Francisco Ordonez, (Ed.), *Theorical perspectives*, (pp. 315-341). Amsterdam: Benjamins.

Hagoort, P., Brown, C. M., & Groothusen, J. (1993). The syntactic positive shift (SPS) as an ERP measure of syntactic processing. *Language and Cognitive Processes, 8*(4), 439-483.

Hagoort, P., Brown, C.M. (1999). Gender electrified: ERP evidence on the syntactic nature of gender processing. *Journal of Psycholinguistic Research,28*(6), 715–728.

Hagoort, P., & Brown, C. (2000a). ERP effects of listening to speech: Semantic ERP effects. *Neuropsychologia, 38*(11), 1518-1530.

Hagoort, P., & Brown, C. (2000b). ERP effects of listening to speech compared to reading: The P600/SPS to syntactic violations in spoken sentence and rapid serial visual presentation. *Neuropsychologia, 38*(11), 1531–1549.

Hagoort, P., Wassenaar, M., ve Brown, C. (2003). Real-time semantic compensation in patients with agrammatic comprehension: Electrophysiological evidence for multiple-route plasticity. *Proceedings of the National Academy of Sciences of the United States of America, 100*(7), 4340–4345.

Harley, H. & Ritter, E. (2002). Person and number in pronouns: A feature-geometric analysis, *Language, 78*(3), 482-526.

Kaan, E., Harris, A., Gibson, E., & Holcomb, P.J. (2000). The P600 as an index of syntactic integration difficulty. *Language and Cognitive Processes, 15*(2), 159-201.

Kaan, E., & Swaab, T.Y., (2003). Repair, revision, and complexity in syntactic analysis: An electrophysiological differentiation. *Journal of Cognitive Neuroscience. 15*(1), 98-110.

Kabak, B. (2007). Turkish suspended affixation. *Linguistics 45*(2),311-347.

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

Kluender, R., & Kutas, M. (1993b). Subjacency as a processing phenomenon. *Language and Cognitive Processes, 8*(4), 573–633.

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

Kornfilt, J. (1984). *Case marking, agreement and empty categories in Turkish*. Doctoral dissertation. Harvard University.

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

Kutas, M., & Hillyard, S. A. (1980b). Reading between the lines: Event related brain Potentials during natural speech processing. *Brain and Language, 11*, 354–273.

Kutas, M., & Hillyard, S. A. (1983). Event related brain potentials to grammatical errors and semantic anomalies. *Memory and Cognition, 11*(5), 539-550.

Kutas, M., Van Petten, C., Besson, M. (1988). Event related potential asymmetries during the reading of sentences. *Electroencephalography and Clinical Neurophysiology, 69*, 218–233.

Linn, M.S., & Rosen, S. (2003). *The functional projections of subject splits.* In W.E. Griffin (Eds.), The Role of Agreement in Natural Language: TLS 5 Proceedings (pp. 135-146) Texas Linguistic Forum, 53.

Lück, M., Hahne, A., & Clahsen, H. (2006). Brain potentials to morphologically complex words during listening. *Brain Research, 1077*(1), 144-52.

Mancini, S., Molinaro, N., Rizzi, L. & Carreiras, M. (2011a). A person is not a number: Discourse involvement in subject–verb agreement computation. *Brain Research, 1412*(2), 64-76.

Mancini, S., Molinaro, N., Rizzi, L. & Carreiras, M. (2011b). When persons disagree: An ERP study of unagreement in Spanish. *Psychophysiology, 48*(10),1361-1371.

Mancini, S., Postiglione, F., Laudanna, A. & Rizzi, L. (2014). On the person-number distinction: Subject-verb agreement processing in Italian. *Lingua, 146*, 28-38.

Mecklinger, A., Schriefers, H., Steinhauer, K., & Friederici, A. D., (1995). Processing relative clauses varying on syntactic and semantic dimensions: An analysis with Event related potentials. *Memory & Cognition, 23*, 477-494.

Molinaro, N., Barber, H. A. & Carreiras, M. (2011). Grammatical agreement processing in reading: ERP findings and future directions. *Cortex, 47*(8), 908-930.

Molinaro, N., Vespignani, F., & Job, R. (2008a). A deeper reanalysis of a superficial feature: An ERP study on agreement violations. *Brain Research, 1228*, 161-176.

Molinaro, N., Kim, A., Vespignani, F., & Job, R. (2008b). Anaphoric agreement violation: An ERP analysis of its interpretation. *Cognition, 106*(2), 963-974.

Münte, T. F., Heinze, H. J., Matzke, M., Wieringa, B. M., & Johannes, S. (1998). Brain potentials and syntactic violations revisited: no evidence for specificity of the syntactic positive shift. *Neuropsychologia, 36*(3), 217-26.

Münte, T. F., Matzke, M., & Johannes S. (1997). Brain activity associated with syntactic incongruencies in words and pseudo-words. *Journal of Cognitive Neuroscience, 9*(3), 300-311.

Neville, H. J., Nicol, J. L., Barss, A., Forster, K. I., & Garrett, M. F. (1991). Syntactically based sentence processing classes: Evidence from Event related brain potentials. *Journal of Cognitive Neuroscience, 3*, 151-165.

Nevins, A. (2011). Multiple agree with clitics: Person complementarity vs. omnivorous number. *Natural Language ve Linguistic Theory, 29*, 939-971.

Nevins, A., Dillon, B., Malhotra, S., & Phillips, C. (2007). The role of feature-number and feature-type in processing Hindi verb agreement violations. *Brain Research, 1164*, 81-94.

Osterhout, L. & Mobley, L. A., (1995). Event related brain potentials elicited by failure to agree. *Journal of Memory and Language 34*, 739–773.

Osterhout, L., Holcomb, P.J. & Swinney, D.A. (1994). Brain potentials elicited by gardenpath sentences: Evidence of the application of verb information during parsing. *Journal of Experimental Psychology Learning Memory and Cognition, 20*(4), 786-803.

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

Palolahti, M., Leinob, S., Jokelab, M., Koprab, K., & Paavilainen, P. (2005). Event related potentials suggest early interaction between syntax and semantics during on-line sentence comprehension. *Neuroscience Letters, 38*(3), 222-227.

Preminger, O., (2011). Asymmetries between person and number in syntax: a commentary on Baker's SCOPA. *Natural Language & Linguistic Theory 29*(4), *917-937.*

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.

Rezác, M. (2003). The fine structure of cyclic Agree. *Syntax 6*.156–82.

Sezer, F. E. (2001) *Finite inflection in Turkish.* In E. Taylan, (Eds.), *The verb in Turkish.* (pp. 1-45). Amsterdam: John Benjamins.

Shlonsky, U. (1989). *The hierarchical representation of subject-verb agreement*. Haifa: University of Haifa.

Sigurðsson, H. A. (2004). The syntax of person, tense and speech features. *Italian Journal of Linguistics, 16*, 219-251.

Silva-Pereyra, J. F. & Carreiras, M. (2007). An ERP study of agreement features in Spanish. *Brain Research, 1185*(14), 201-211.

Silverstein, M. (1985). Hierarchy of features and ergativity. In Muysken, P., van Riemsdijk, H. (Ed.), *Features and Projections*, (pp.163-232). Foris, Dordrecht.

Yu, A. C. and Good, J. C. (2000). Morphosyntax of two Turkish subject prominal pradigms, In *North East Linguistics Society* (Vol. 30, No. 2, p. 24).

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.

Zawiszewski, A., Santesteban, M. & Laka, I. (2015). Phi-features reloaded: An ERP study on person and number agreement processing. *Applied Psycholinguistics*. *37*(3), 601-626.

Zwicky, A. & Pullum, G. (1983). *Cliticization vs inflection: English n't*. Language *59*, 502-513.