The Processing of Phi-features in Sentences with Third-person Pronoun: An ERP Study in Turkish*

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ABSTRACT: The relationship between Person and Number features is often addressed in both theoretical and experimental studies. It is noteworthy that the discussion on how these features are processed has evolved over time towards how Person and Number features are structured in constructions with different persons (first person, second person, third person). While some studies state that Person and Number features can only be tested with third-person sentences (Manchini et al., 2011; Mancini et al., 2014), other studies state that these features can be tested with all person pronouns except R-expressions (regular noun phrases) (Ackema & Neeleman, 2019). In the literature, it is noteworthy that the relationship between the processing of Person and Number features has been tested with first- and second-person pronouns and R-expressions, but there is no study testing the issue with third-person pronouns. The aim of this study was to investigate whether there is a difference in the processing of Person and Number features in sentences with third-person pronouns in Turkish using Event-related Brain Potentials (ERPs). In this study, three conditions, namely Grammatical, Person Mismatch and Number Mismatch, were presented visually in words to 33 participants. In the study, a widespread N400 component was observed in both the processing of the Person feature and the processing of the Number feature. It was found that there was no difference between the two features in the corresponding time window. However, in the next time window, a late N400 component was observed in the processing of the Number feature, while a positivity (P600) was observed in the processing of the Person feature. In this time window, there is a difference in the processing of the Person and Number features. In conclusion, this study found that there is

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a difference in the processing of the Person and Number features in sentences with third-person pronouns in Turkish. It is suggested that the P600 finding in the processing of the Person feature reflects the difficulty in processing this feature. It is suggested that the late N400 finding in the processing of the Number feature may be due to the load it imposes on the processing process due to the fact that the morphological appearance of the Number feature in verb conjugation is parallel to nominal pluralisation, and the greater demand on working memory as the resolution of the Number mismatch involves more alternatives than the Person mismatch.

Keywords: syntax, language processing, third person, person, number, ERPs

Üçüncü Kişi Adılı İçeren Tümcelerde Phi-özelliklerin İşlenmesi: Türkçede Bir OİP Çalışması

ÖZ: Kişi ve Sayı özellikleri arasındaki ilişki gerek kuramsal gerekse deneysel çalışmalarda sıklıkla ele alınmaktadır. Bu özelliklerin nasıl işlemlendiği konusundaki tartışmaların zaman içerisinde farklı kişilerle (birinci kişi, ikinci kişi, üçüncü kişi) kurulan yapılardaki Kişi ve Sayı özelliklerinin yapılanışının nasıl olduğuna doğru evrildiği dikkat çekmektedir. Kimi çalışmalarda Kişi ve Sayı özelliklerinin sadece üçüncü kişili yapılarla test edilebileceği belirtilerken (Manchini ve diğ., 2011; Mancini ve diğ, 2014) kimi çalışmalar ise bu özelliklerin R-ifadeleri (düzenli ad öbekleri) dışında bütün kişi adıllarıyla test edilebileceğini (Ackema & Neeleman, 2019) ifade etmektedir. Alanyazına bakıldığında Kişi ve Sayı özelliklerinini işlemlenmesi arasındaki ilişkinini birinci, ikinci kişi adıllarıyla ve R-ifadeleri ile test edildiği ancak üçüncü kişi adıllarıyla konuyu test eden bir çalışmanın bulunmadığı dikkat çekmektedir. Bu çalışmanın amacı, Türkçe'de üçüncü kişi adılları içeren tümcelerde kişi ve sayı özelliklerinin işlenmesinde bir farklılık olup olmadığını Olaya İlişkin Beyin Potansiyelleri (OİP) ile belirlemektir. Çalışmada 33 katılımcıya Dilbilgisel, Kişi uyumsuzluğu ve Sayı uyumsuzluğu olmak üzere üç koşul sözcükler halinde görsel olarak sunulmuştur. Çalışmada gerek Kişi özelliğinin işlemlenmesinde gerekse Sayı özelliğinin işlemlenmesinde geniş yayılımlı N400 bileşeni gözlemlenmiştir. İlgili zaman penceresinde iki özellik arasında farklılık oluşmadığı belirlenmiştir. Buna karşın bir sonraki zaman penceresinde Sayı özelliğinin işlemlenmesinde geç-N400 bileşeni görülürken Kişi özelliğinin işlemlenmesinde pozitiftenin (P600) oluştuğu belirlenmiştir. Bu zaman penceresinde Kişi ve Sayı özelliğinin işlemlenmesinde farklılığın oluştuğu görülmektedir. Sonuç olarak bu çalışmada Türkçede üçüncü kişi adıllı tümcelerde Kişi ve Sayı özelliklerinin işlemlenmesinde farklılığın oluştuğu belirlenmiştir. Kişi özelliğinin işlemlenmesinde P600 bulgusunun bu özelliğin işlemlenmesindeki güçlüğü yansıttığı düşünülmektedir. Sayı özelliğinin işlemlenmesindeki geç-N400 bulgusunun ise eylem çekiminde Sayı özelliğinin biçimbilimsel görünümünün adcıl çoğullaştırma ile paralellik taşıması nedeniyle işlemleme sürecinde yarattığı yükten ve Sayı uyumsuzluğunun

çözümlenmesinin Kişi uyumsuzluğuna göre daha fazla alternatif içermesi nedeniyle çalışma belleğine duyulan daha fazla ihtiyaçtan kaynaklanabileceği düşünülmektedir.

Anahtar sözcükler: sözdizim, dil işlemleme, üçüncü kişi, kişi, sayı, OİP

1 Introduction

There are many studies in the literature on the processing of Person and Number features. In these studies, reaction time (Carminati, 2005; Mancini et al., 2014), observation of the repair process (Aygüneş, 2012; Aygüneş, 2013b), Event-related Potentials (ERPs) (Nevins et al., 2007; Silva-Pereyra & Carreiras, 2007; Zawiszewski & Friederici, 2009; Mancini et al., 2011a; Zawiszewski et al., 2016; Aygüneş, 2013a; Aygüneş et al., 2021; Aristia et al., 2022) and time-frequency analysis (Aygüneş, in press) have been used, and cognitive responses are compared based on sentences produced by the participants containing Person mismatch and Number mismatch. Since the study by Silva-Pereyra & Carreiras (2007), which focused directly on the interaction and hierarchy between Person and Number features using ERPs, the relevance of investigating the relationship between these features has been maintained, and data from different languages have allowed us to gain a better understanding of the structure and processing of Person and Number features within syntax, as well as the features carried by ERPs such as N400, Left Anterior Negativity (LAN), and P600. However, it remains unclear whether the relationship between Person and Number features can be observed in the first/second or third person, and whether its occurrence in different languages supports the current observations. The aim of this study is to investigate the processing of Person and Number features in third-person constructions in Turkish.[1]

[1] It is noteworthy that ERP studies in Turkish are quite limited (For studies on P600 effect in syntax-product interaction in Turkish, see Bekar, 2016; Zora, Heldner, & Schwarz, 2016; Uzun et al, 2021; Düzenli-Öztürk, 2018 for the P600 effect in syntax-meaning interaction and Cedden & Eken, 2012; Aygüneş, 2013, 2021; Yanılmaz & Drury, 2018; Cedden, Eken, & Berberoğlu, 2020; Aygüneş et al., 2021; Cedden, Eken, & Çakar, 2021 for the studies in which N400, P600 and LAN effects were found in syntax- morphosyntax interaction). Increasing the number of studies other than agreement processing will play an important role in making language-specific determinations more successful.

1.1 Agreement

The process of agreement within syntax can be broadly defined as the congruence of features between two constituents. For example, in the case of subject-verb agreement, the Person, Number and Gender features carried by the verb inflection are uninterpretable, whereas these features on the subject are interpretable. Uninterpretable features in the verb inflection seek interpretable sources that match these features and become interpretable by matching interpretable features on the subject (Chomsky, 2000). The smooth functioning of this mechanism that allows for agreement allows for grammatical sentences based on agreement, while the failure of matching results in constructions lead to ungrammatical sentences (see Aygüneş, 2013a). In addition to the agreement mechanism explaining the licensing of Person, Number and Gender features, there is another approach suggesting that suggests that there are differences in the licensing of Person and Number features. Sigurdsson (2004) argues that the Number feature is licensed within the Inflectional Phrase (IP), whereas the Person feature, due to its discursive properties, additionally interacts with the Speech Participation Phrase (SPP) above the IP. Nevins (2011), on the other hand, develops a feature-based approach and states that Person and Number differ in the number of features they carry. Accordingly, the Person feature is fully determined by the binary feature pattern of Participant and Speaker. However, the Number feature is privatised and only the plural feature is specified. On the other hand, singular features are not specified.

According to the phi-features theory developed by Ackema & Neeleman (2013, 2018, 2019), person pronouns have Person and Number features. However, these features differ in their internal structure. Two factors, Proximity and Distance, are effective in determining the Person feature. However, similar to Nevins' (2011) explanations, it is stated that the Number feature is only plural, and the singular is not a feature. According to this approach, personal pronouns carry at least one of the Person features (Proximity and/or Distance). The first-person singular pronoun carries the feature Proximity, the second-person singular pronoun carries both Proximity and Distance and the third-person pronoun carries the feature distance. Thus, Ackema & Neeleman's explanation differs from the other explanations in that they consider third-person pronouns to be person-feature-bearing pronouns. Finally, Ackema & Neeleman argue that there is a difference between personal pronouns and R-expressions (regular noun phrases). According to them, R-expressions do not have Person features, but only Number features.

In addition to theoretical studies on the organisation of agreement features in syntax, the issue is also discussed in the psycholinguistic literature. Scholars have been interested in the processing of agreement between determiners and nouns within noun phrases, and between subjects and verbs within IP and complement

phrases (CP). Understanding how these features are processed has led researchers to consider the validity of the Feature Hierarchy Hypothesis (Greenberg, 1963), which posits a hierarchical structure of Person > Number > Gender. Aygüneş (2013a)/ Aygüneş et. Al. (2021) Silva-Pereyra & Carreiras (2007), Nevins et al. (2007), Mancini et al. (2011), Aygüneş (2013a), and Zawiszewski et al. (2016), have contributed significantly to these investigations. In the next section, studies on the processing of Person and Number features are discussed in detail.

1.2 Processing of Person and Number features

1.2.1 Processing of Person and Number features in non-ERPs studies

Some of the studies on the processing of Person and Number features are based on reaction time measurements or on observation of the repair process of agreement violations. In addition, one study used the fMRI method.

Carminati (2005) conducted a study in Italian that examined how participants' reaction times were affected by the presence of both Person and Number agreement in sentences with semantic ambiguity. The results showed that when there was ambiguity in both the Person and Number features, reaction times were shorter. This was attributed to the more specified nature of the Person feature, which led to faster resolution of ambiguity when the Person feature was involved. Consequently, Carminati (2005) suggested that Italian has a Person > Number hierarchy due to its higher cognitive salience.

In the studies by Aygüneş (2012) and Aygüneş (2013b) in Turkish, the relationship between Person and Number features was investigated by observing participants' sentence repair strategies in sentences containing agreement violations. The results showed that in sentences where the subject was formed with the first singular person (Ben), there were more repairs based on subject features for Person mismatches (*Ben$_{1SG}$ okul-a git-ti-n$_{2SG}$) and more repairs based on verb inflection for Number mismatches (*Ben$_{1SG}$ okul-a git-ti-k$_{1PL}$). Aygüneş (2012) pointed out that these results suggest that Person features are more closely related to subject features and are licensed in the higher domain of Complement Phrases (CPs), which contain discourse features, whereas Number features are more related to verb inflection and are therefore licensed in the lower domain of Inflection Phrases (IPs). Similarly, in Aygüneş's (2013b) study, this approach was applied to sentences formed in the third-person (*O$_{3SG}$ dün okul-a git-ti-n$_{2SG}$, *O$_{3SG}$ dün okul-a git-ti-ler$_{3PL}$) to test for person and number agreement. The results showed that there was a greater reliance on subject features to repair number agreement mismatches in third-person structures. This led to the conclusion that there is a difference in the processing of person and Number features in first and third-person structures.

Mancini et al. (2014) investigated the relationship between Person and Number features in Italian using reaction time measures in two experiments. In the first experiment, reaction times were measured in sentences with agreement mismatches in first-person structures for Number, Person, and both Number and Person together. The results showed no difference between the three conditions, indicating that there was no difference in the processing of Person and Number features in first-person structures. In the second experiment, similar mismatches were created for third-person structures, and in this case, differentiation was observed in all three conditions. Participants' reaction times were faster for number mismatches. Thus, the study suggests that the processing distinction between Person and Number agreement can only be observed for third-person structures, where there are significant differences in the processing of these features. However, such a distinction does not exist for first-person structures.

The fMRI study by Mancini et al. (2017) showed a greater response for Person compared to Number in the left middle temporal gyrus (LMTG), and while the posterior portion of the LMTG was sensitive to both Person and Number violations, the anterior portion of this region showed a selective response for Person violations.

Table 1. Studies on processing Person and Number features in non-ERPs studies and their key findings

Study	Method	Lang.	Design	Findings	Feature Hierarchy
Carminati (2005)	Reaction time	Italian	N: 3rd P. N + P.:1st and 2nd. P.	Lower response time in Person+Number mismatch condition compared to Number mismatch condition	Person > Number
Aygüneş (2012)	Repair	Turkish	1st P. Sg. Subj.	Person feature associated with Subject, Number feature associated with verb inflection	Person > Number
Aygüneş (2013b)	Repair	Turkish	3rd P. Sg. Subj.	Person feature associated with Subject, Number feature associated with verb inflection	Person > Number

Mancini et al. (2014)	Reaction time	Italian	1st P. Sg. Subj.	No difference in the processing of Person and Number features	Person = Number
			3rd P. Sg. Subj.	Person feature processing is longer than Number feature processing	Person > Number
Mancini et al. (2017)	fMRI	Spanish	3rd Person (R-expression)	Greater response for Person in the LMTG. LMTG for Person and Number Violation. The anterior portion of LMTG for Person Violations.	-

N.: Number feature, N.+P: Number and Person feature, P.: Person, Sg: Singular, Subj.: Subject, Lang: Language.

Looking at these studies, it is clear that there is a significant Person > Number hierarchy between the Person and Number features. However, there are some differences in the findings. For example, Carminati (2005) and Mancini et al. (2014) both examined the Person and Number features in Italian and found differences between them. While Carminati (2005) showed faster responses for the Person mismatch condition, Mancini et al. (2014) found the opposite, indicating slower responses for the Person mismatch condition. Despite the opposite direction of the findings in these two studies, it is suggested that the interpretation between these two features is similar, supporting the assumption of a Person > Number feature hierarchy. Another difference between the studies is related to the person used to construct the experimental sentences. Aygüneş (2012) used first-person pronoun, while Aygüneş (2013b) used third-person pronoun. Despite the different person constructions, both studies showed differences in the Person and Number features. On the other hand, Mancini et al. (2014) reported that there was no differentiation occurred in the first-person pronoun, and the distinction between Person and Number features was only present in third-person.

1.2.2 ERPs studies on processing of Person and Number features

It is noteworthy that a significant proportion of the studies investigating the cognitive organisation of Person and Number features are ERP studies. While some of these studies focus on investigating potential differences in the

processing of Person and Number features within a language, others shed light on this topic by using experimental sentences that contain both Person and Number features, although they may address different topics.

Nevins et al (2007) conducted a study in Hindi with third-person singular subjects and found P600 effects. They observed differences between conditions containing both Person+Gender mismatches and Number+Gender mismatches that occurred in a late time window of 800-1000 milliseconds (ms). According to their findings, there was a distinction between the two conditions, one containing the Person feature and the other containing the Number feature. Thus, they suggested that the larger amplitude of the P600 for Person+Gender mismatch may indicate that Person processing plays a more critical role relative to Number processing.

Silva-Pareyra and Carreiras (2007) investigated the processing of Person and Number features in Spanish using first- and second-person pronoun. The study included a grammatical condition and three mismatch conditions, including Person mismatch, Number mismatch, and Person+Number mismatch. In the Person+Number mismatch conditions, they observed greater anterior negativity at the P600 and late P600. While the Person+Number mismatch condition showed a greater amplitude of negativity and P600 compared to the other conditions, this study did not find a significant difference between the Person-only and Number-only mismatch conditions. Therefore, the study proposed that Person and Number features may not be distinct features, and that the N400 reflects mismatch detection, while the late P600 component may be related to reanalysis and repair processes.

Zawiszewski et al. (2009) investigated subject-object agreement in Basque using second-person singular sentences. The study included Person mismatch and Person-Number mismatch conditions for both subject and object positions. The results showed N400+P600 components in both subject and object agreement. However, as the focus of the study was not on the relationship between Person and Number features, no specific interpretation of the processing differences between these features was provided. The study suggests that the N400 reflects the processing difficulty of agreement structures, whereas the P600 may be associated with reanalysis and repair processes.

Mancini et al. (2011) were the first study to highlight the importance of the person used to construct the experimental sentences in the study of Person and Number features. They argued that the differences in the organisation of Person and Number features in pronouns such as 'I', 'You' and 'He/She/It' make first- and second-person structures inappropriate for studying the relationship between these features. Instead, they suggested that third-person structures are more appropriate for this purpose. The study, conducted in Spanish with third-person structures (with R-expressions), showed that there were processing differences

between erson and Number features that were reflected in the N400 and P600 components. They concluded that Person features require more cognitive resources, suggesting a hierarchical organisation of Person > Number in R-expressions.

Aygüneş (2013a)/Aygüneş et al. (2021) tested Person and Number features using first- and second-person structures in Turkish, following an experimental design similar to Silva-Pareyra and Carreiras (2007). In contrast to the findings in Spanish, this study reported a differentiation between Person and Number features. The N400 component showed significant differences between all mismatch conditions, with the amplitude of the N400 being greater for Person mismatch compared to Number mismatch, leading to a Person > Number hierarchy. Furthermore, Aygüneş (2013a) highlighted that in these experiments, the critical word (the verb) was located at the end of the sentence, which could have contributed to the formation of the N400, considering that the evaluation of the whole sentence could have occurred simultaneously. However, even if this possibility is valid, it does not eliminate the difference in the processing of Person and Number features, since the location of the critical word (the verb) was the same in both conditions, making the effect applicable to both conditions. Regarding the P600 component, Aygüneş (2013a)/Aygüneş et al. (2021) argued that the Number mismatch did not produce a distinct effect compared to the grammatical condition, whereas the Person mismatch resulted in a distributed P600, suggesting that this P600 might reflect difficulties in reparation and discourse-based processing. On the other hand, Aygüneş et al. argued that the weak cognitive salience of the Number feature suggests that there may be no need for repair and integration that would lead to the formation of a significant P600. Furthermore, the absence of a P600 in the Number mismatch condition was attributed to the location of the critical word at the end of the sentence, where the simultaneous occurrence at the end of the sentence and the evaluation of the whole sentence may have caused a closure negativity that suppressed the P600. This study highlights that the larger amplitude of the N400 for Person mismatch reflects the greater cognitive resources required to process Person features, supporting the hierarchical structure of Person > Number in first- and second-person singular structures.

Zawiszewski et al. (2016) tested Person and Number features in the Basque language using second-person singular structures and included Person mismatch, Number mismatch, and Person+Number mismatch conditions. The results showed that there was no significant difference in the N400 between Person mismatch and Number mismatch, while the P600 component showed a significant difference between Person and Number mismatch, with a larger amplitude of the P600 observed in the Person mismatch and Person+Number mismatch conditions compared to Number mismatch.

Aristia et al. (2022) investigated the processing of Person and Number features in French using first- and second-person structures. They found that the N400 was present in both Person and Number conditions, but the negativity for Person mismatch in the left anterior area was greater than that for Number mismatch, creating a significant difference. However, no P600 effects were observed when processing the corresponding conditions. This suggests that the N400 may be sensitive not only to morphosyntactic but also to syntactic processes, and that the P600 may be more related to controlled processes.

Finally, Aygüneş (in press), in his study using time-frequency analyses with third-person pronouns, found that an increased delta power for processing the Person feature and increased theta power for processing the Number feature, and that there were differences in the processing of Person and Number features in these two frequency bands.

In summary, ERPs studies have made significant contribution to our understanding of the cognitive processing of Person and Number features. A review of the literature focusing on the structuring of Person and Number features within ERPs studies reveals differences in the processing of these features across languages and individuals. These studies predominantly suggest differences in the processing of Person and Number features, and they propose a hierarchical organisation of cognitive processing where Person > Number, as outlined in Table 2.

Table 2. ERPs studies on the processing of Person and Number features

Study	Language	Design	Findings	Feature Hierarchy
Nevins et al. (2007)	Hindi	3rd. Person (R-expression)	Person+Gender Mism.: P600 Number+ Gender Mism.: P600 Gender Mism.: P600	Person > Number
Silva-Pereyra & Carreiras (2007)	Spanish	1st Person and 2nd Person	Person+Number Mism.: Anterior negativity+P600	Person = Number
Zawiszewski and Friederici (2009)	Basque	2nd Person	Person and Person+Number Mism.: When analyzed as a whole, N400+P600	-
Mancini et al. (2011)	Spanish	3rd Person (R-expression)	Person Mism.: N400+P600 Number Mism.: LAN+P600	Person > Number

Aygüneş (2013a/ Aygüneş et al. 2021)	Turkish	1st Person and 2nd Person	Person Mism.: N400 Number Mism.: N400	Person > Number
Zawiszewski et al. (2016)	Basque	2nd Person	Person Mism.: N400+P600 Number Mism.: N400+P600	Person > Number
Aristia et al. (2022)	French	1st Person and 2nd Person	Person Mism.: N400 Number Mism.: N400	Person > Number
Aygüneş (in press)	Turkish	3rd Person (Pronoun)	Person Mism.: increased power in delta power Number Mism.: increased power in theta power	Person > Number

Mism.: Mismatch

Looking at Tables 1 and 2, it is clear that there are notable differences in the processing of Person and Number features. The main findings of these studies support the idea that Person features play a more dominant role in cognitive processing than Number features, suggesting a hierarchical organisation of Person > Number. However, the effect of the Person feature (first/second-person vs third-person and R-expressions vs pronouns) in the sentences used in the experiments on the results is still controversial and further studies are needed to clarify this issue.

There are debates in the literature about the processing differences of Person and Number features within first, second, and third-person structures. The main aim of this study is to investigate whether there are processing differences between Person and Number features in third-person pronoun in Turkish using ERPs. Furthermore, the study aims to identify which ERP components are elicited in third-person structures and to discuss their functions. The main focus of this research is to determine whether there are different cognitive processing patterns between Person and Number features in third-person structures in Turkish.

2 Method

2.1 Participants

The study included 33 participants (18 females [age range: 20-27, mean: 23], 15 males [age range: 20-26, mean: 24]). All participants were right-handed (for hand preference questionnaire; Nalçacı et al.,2002) and had normal or corrected-to-normal vision. They had completed or were continuing their undergraduate education. This study was approved by the Ethics Committee for Clinical Research at Istanbul University, Istanbul Medical Faculty (approval number: 8928).

2.2 Design

The aim of the study was to investigate the processing of Person and Number features using third-person structures, similar to the approach of Mancini et al. (2011). However, unlike Mancini et al. (2011), this study used the third-person pronoun 'O (S/he)' instead of R-expressions in the subject position. Ackema & Neeleman (2019) state that R-expressions, unlike third-person pronouns, do not have person features, but only Number features. In parallel with this approach, they state that experiments with third-person pronouns are necessary to test the relationship between Person and Number features.

Accordingly, three conditions were created in the study: Grammatical condition (pro_{3SG} … V_{3SG}), Person mismatch condition (*pro_{3SG} … V_{2SG}), and Number mismatch condition (*pro_{3SG} … V_{3PL}). In all conditions, the subjects were represented by the third-person singular pronoun "O". To prevent the pronoun "O" from being interpreted as an object followed by a transitive verb (e.g., o okul ‘that school’), a time adverb "şimdi" (now) was placed between the subject position and the object. For verb inflection, the progressive aspect marker “-(I)yor” was added to all verbs. In the grammatical condition, the copula marker “-Ø” was used for verb inflection. It should be noted that there is no phonological equivalent of copula marker in Turkish. In the Person mismatch condition, the second-person singular marker “-sIn” was used for verb inflection. The reason for preferring the second-person over the first-person in the Person mismatch condition is that the first-person plural has two different forms, including inclusive and exclusive. (Ackema & Neeleman, 2019). Therefore, an attempt was made to create a more valid comparison by favouring the second-person in the Person mismatch condition. In the Number mismatch condition, the third-person plural marker "-lAr" was used.[2] Therefore a z-paradigm (Good & Yu, 2005) used

[2] Accordingly, in the framework of Ackema & Neeleman, 2019, the feature distributions in the conditions are as follows:

for the agreement manipulation (Table 3). Each condition was represented by 50 sentences. To equate grammatical and non-grammatical sentences, filler sentences (*N*=50) similar to the grammatical condition were added, but these were not included in the analysis.

Table 3. Experiment sentences

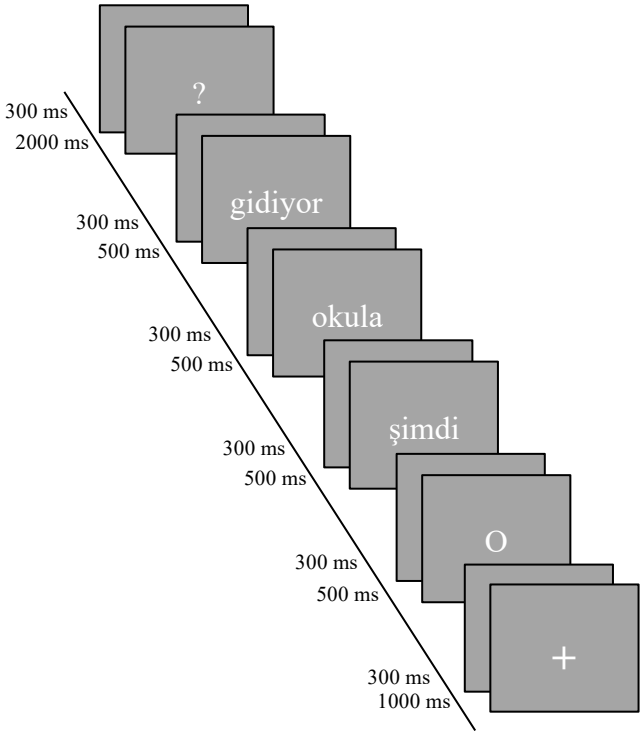
Example				Condition	N
O	şimdi	okul-a	gid-iyor-Ø.	Grammatical	50
S/he (3Sg)	now	school-Dat	go-Tense-3Sg		
*O	şimdi	okul-a	gid-iyor-sun	Person Mismatch	50
S/he (3Sg)	now	school-Dat	go-Tense-2Sg		
*O	şimdi	okul-a	gid-iyor-lar	Number mismatch	50
S/he (3Sg)	now	school-Dat	go-Tense-3Pl		

2.3 Procedure

EEG recordings were performed in a Faraday cage, which provides an electromagnetically isolated and soundproof environment. Stimuli were presented visually as word stimuli. The distance between the participant and the screen was 115 cm. During stimulus presentation, a fixation cross (+) was displayed on the screen for 1000 ms, followed by the presentation of each word for 500 ms, with a blank screen interval of 300 ms between words. After the presentation of the complete sentence, a question mark (?) was displayed on the screen for 2000 ms, during which time participants were instructed to press the right mouse button if the sentence was grammatically correct and the left mouse button if it was not. The screen colour was set to grey, and the text was presented in white (Figure 1).

Grammatical: Pronoun [NMB: __, PRS: DIST]... V [NMB: __, PRS: DIST]
Person Mismatch: Pronoun [NMB: __, PRS: DIST]... V [NMB: __, PRS: PROX-DIST]
Number Mismatch: Pronoun [NMB: __, PRS: DIST]... V [NMB: PL, PRS: DIST]

Figure 1. Stimulus presentation



2.4 EEG Recording and ERP Analysis

EEG recording and ERPs analysis followed the basic pre-processing steps as described in Aygüneş (2013a) and Aygüneş et al. (2021). For EEG recording, 32 channels were placed according to the international 10/20 system. Referencing was performed by taking the average of the electrodes placed on both ears. Participants' eye movements were monitored using electrodes placed on the outer canthus and nasion of the right eye. EEG data were digitised at a sampling rate of 500 Hertz (Hz). Throughout the study, electrode impedances on the scalp were kept below 6 kΩ, and the resistance of the reference and EOG electrodes was kept below 3 kΩ.

In the ERPs analysis phase, muscle and eye artifacts were removed from the EEG data using Independent Component Analysis, and low-pass and high-pass

filters of 0.01 Hz - 15 Hz were applied. The critical word to be analysed in the study was a verb, and the analysed epochs covered a time window of 200 ms before and 800 ms after the presentation of the critical word. Four-time windows (0-150 ms, 150-300 ms, 300-500 ms, and 500-800 ms) were determined based on overall averages, and analyses were performed based on the average amplitudes in these time windows.

To observe the effect of lateralisation in the statistical analysis, four regions of interest were defined: left frontal (F3, F7, FC3, FT7), right frontal (F4, F8, FC4, FT8), left parietal (CP3, TP7, P3, P7) and right parietal (CP4, TP8, P4, P8). Analysis was performed by averaging electrodes within each region of interest. SPSS statistical software, version 26.0 (SPSS Inc., Chicago, Ill., USA) was used for statistical analysis. A three-factor repeated measures ANOVA analysis was used: Condition (3 levels: Grammatical, Person Mismatch, Number Mismatch), Anterior-Posterior (AP) distribution (2 levels: Anterior, Posterior), and Lateralisation (Lat) (2 levels: Left, Right). When the degrees of freedom in the numerator were greater than 1, the Greenhouse-Geisser correction (Greenhouse-Geisser, 1959) was applied, and the Bonferroni correction (Bonferroni, 1936) was used for p-values.

3 Results

This section presents the results of time-locked electrophysiological responses to the critical word, the verb. In this context, time-locked responses to verb presentation in time windows of 0-150 ms, 150-300 ms, 300-500 ms and 500-800 ms are analysed.

3.1 0-150 ms

In the first time window, a significant difference was observed in the main effect of AP distribution, $F(1,32)= 19.868$, $p < .001$. However, no significant differences were found in the main effect of Condition, $F(2, 64) = 1.624$, $p > .05$, the main effect of Lateralisation, $F(1, 32) = 2.636$, $p > .05$, the AP × Lateralisation interaction, $F(1, 32) = 0.217$, $p > .05$, the Condition × Lateralisation interaction, $F(1.666, 53.313) = 1.607$, $p > .05$, the Condition × AP interaction, $F(2, 64) = 1.400$, $p > .05$, and the Condition × AP × Lateralisation interaction, $F(2, 64) = 1.323$, $p > .05$. Thus, no significant differences between conditions were observed in the first time window.

3.2 150-300 ms

In the second time window, a significant difference was found in the main effect of AP distribution, F (1,32) = 12.685, p < .001. However, no significant differences were found in the main effect of Condition, F (2,64) = 0.333, p > .05, main effect of Lateralization, F (1,32) = 4.185, p < .05, AP × Lateralization interaction, F (1,32) = 1. 500, p > .05, Condition × Lateralization interaction, F (2,64) = 0.229, p > .05, Condition × AP interaction, F (2,64) = 2.239, p > .05, and Condition × AP × Lateralization interaction, F (2,64) = 0.347, p > .05. Similar to the first time window, no statistically significant differences between conditions were found in the second time window.

3.3 300-500 ms

In the third time window, no significant differences were observed in the Condition × Lateralization interaction, F (2,64) = 0.409, p > .05, and the AP × Lateralization interaction, F (1,32) = 3.256, p > .05. However, a significant difference was found for the main effect of Lateralization, F (1,32) = 2.636, p < .001, the main effect of AP distribution, F (1,32) = 54.358, p < .001, the main effect of Condition, F (2,64) = 12.924, p < .001, the Condition × AP interaction, F (2,64) = 5.210, p < .01, and the Condition × AP × Lateralization interaction, F (2,64) = 3.185, p < .05. Thus, there were significant differences in the main effects of Condition, the Condition × AP interaction, and the Condition × AP × Lateralization interaction.

When the main effect of condition was compared pairwise, it was found that Person Mismatch (M = 1.245, SD = 0.395) and Number Mismatch (M = 1.259, SD = 0.373) produced a significantly greater negativity (p < .001) than the Grammatical condition. However, there was no significant difference between Person Mismatch and Number Mismatch.

Table 4. Pairwise comparison of Conditions in the 300-500 ms time window

Grammatical vs Person Mismatch				
df	*F*	*p*	*MSE*	ηp^2
(1,32)	21.575	<.001	1.846	.403
Grammatical vs Number Mismatch				
df	*F*	*p*	*MSE*	ηp^2
(1,32)	16.793	<.001	2.312	.344
Person Mismatch vs Number Mismatch				
df	*F*	*p*	*MSE*	ηp^2
(1,32)	0.003	n.s.	1.928	.001

n.s.: Not statistically significant
Bonferroni correction applied to p-values.

For the effect produced by the Condition × AP interaction, when conditions were compared pairwise in both the anterior and posterior regions of the surface, the results were as follows: In the anterior region, Person Mismatch (M = 0.102, SD = 0.420) and Number Mismatch (M = -0.134, SD = 0.376) produced significantly greater negativity compared to the Grammatical condition (M = 0.847, SD = 0.0.385) ($p < .01$). However, no significant difference was found between Person Mismatch and Number Mismatch. In the posterior region, Person Mismatch (M = 2.387, SD = 0.445) and Number Mismatch (M = 2.652, SD = 0.562) produced significantly greater negativity compared to the Grammatical condition (M = 3.841, SD = 0.415) ($p < .001$). However, no significant difference was observed between Person Mismatch and Number Mismatch. These results indicate that in both the anterior and posterior regions, there is a statistically significant difference in the negativity produced by Person Mismatch and Number Mismatch compared to the Grammatical condition, while no significant difference was observed between Person Mismatch and Number Mismatch in either region.

Table 5. Pairwise comparison of conditions in Condition×AP interaction in the 300-500 ms time window

		Grammatical vs Person Mismatch			
	df	*F*	*p*	*MSE*	ηp^2
Anterior	(1,32)	10.481	<.01	1.744	.247
Posterior	(1,32)	23.470	<.001	2.969	.423
		Grammatical vs Number Mismatch			
	df	*F*	*p*	*MSE*	ηp^2
Anterior	(1,32)	10.796	<.01	2.937	.252
Posterior	(1,32)	17.363	<.001	2.687	.352
		Person Mismatch vs Number Mismatch			
	df	*F*	*p*	*MSE*	ηp^2
Anterior	(1,32)	1.160	n.s.	1.586	.035
Posterior	(1,32)	0.831	n.s.	2.771	.025

n.s.: Not statistically significant
Bonferroni correction applied to p-values.

The effect of the interaction Condition × AP distribution × Lateralization interaction yielded the following results when conditions were compared pairwise in each region of interest: In the left frontal region, both Person Mismatch (M = -0.353, SD = 2.971) and Number Mismatch (M = -0.544, SD = 2.511) elicited significantly ($p < .01$) greater negativity compared to the Grammatical condition (M = 0.577, SD = 2.643), whereas no difference was

observed between Person Mismatch and Number Mismatch. Similarly, in the right frontal region, Person Mismatch (M = 0.557, SD = 2.250) and Number Mismatch (M = 0.277, SD = 2.292) elicited significantly ($p < .05$) greater negativity compared to the Grammatical condition (M = 1.116, SD = 2.062), but there was no difference between Person and Number Mismatch. The posterior region of both the left and right hemispheres showed a similar pattern. In the left posterior region, Number Mismatch (M = 2.664, SD = 2.357) and Person Mismatch (M = 2.342, SD = 2.447) elicited significantly ($p < .001$) greater negativity compared to the Grammatical condition (M = 3.793, SD = 2.374), with no difference observed between Person Mismatch and Number Mismatch. Similarly, in the right posterior region, Number Mismatch (M = 2.639, SD = 3.164) and Person Mismatch (M = 2.433, SD = 3.013) elicited significantly ($p < .001$) greater negativity compared to the Grammatical condition (M = 3.888, SD = 2.809), with no difference observed between Person and Number Mismatches. In summary, the results indicate that in each region of interest, there was a significant increase in negativity for both Person and Number Mismatches compared to the Grammatical condition. However, there was no significant difference between Person and Number Mismatches in any of the regions (Table 6).

Table 6. Pairwise comparison of conditions in Condition×AP×Lat interaction in the 300-500 ms time window

		Grammatical vs Person Mismatch			
	df	*F*	*p*	*MSE*	ηp^2
Left Anterior	(1,32)	11.552	<.01	2.470	.265
Right Anterior	(1,32)	4.942	<.05	2.084	.134
Left Posterior	(1,32)	19.494	<.001	3.563	.379
Right Posterior	(1,32)	21.336	<.001	3.276	.400
		Grammatical vs Number Mismatch			
	df	*F*	*p*	*MSE*	ηp^2
Left Anterior	(1,32)	12.177	<.01	3.407	.276
Right Anterior	(1,32)	6.822	<.05	3.408	.176
Left Posterior	(1,32)	15.466	<.001	2.718	.326
Right Posterior	(1,32)	14.852	<.001	3.468	.317
		Person Mismatch vs Number Mismatch			
	df	*F*	*p*	*MSE*	ηp^2
Left Anterior	(1,32)	0.618	n.s.	1.955	.019
Right Anterior	(1,32)	1.681	n.s.	2.547	.050
Left Posterior	(1,32)	0.996	n.s.	3.439	.030
Right Posterior	(1,32)	0.479	n.s.	2.928	.015

n.s.: Not statistically significant
Bonferroni correction applied to p-values.

Overall, in the third time window, both Person Mismatch and Number Mismatch elicited greater negativity than the Grammatical condition, and this difference was statistically significant. However, there was no significant difference between the two forms of mismatch, namely Person Mismatch and Number Mismatch.

3.4 500-800 ms

In the last time window, there was no statistically significant main effect of lateralization ($F(1,32) = 0.99$, $p > .05$), Condition × AP Distribution interaction ($F(2,64) = 1.834$, $p > .05$), and Condition × Lateralization interaction ($F(2,64) = 0.208$, $p > .05$). However, a statistically significant main effect was observed for AP Distribution ($F(1,32) = 74.625$, $p < .001$), Lateralization × AP Distribution interaction ($F(1,32) = 9.201$, $p < .01$), Condition ($F(1,555,49.755) = 9.033$, $p < .001$), and Condition × AP Distribution × Lateralization interaction ($F(2,64) = 3.213$, $p < .05$).

When conditions were compared in pairs for the main effect of condition, Number Mismatch ($M = 1.697$, $SD = 0.367$) elicited significantly greater negativity than Grammatical Mismatch ($M = 2.628$, $SD = 0.353$) ($p < .05$), and Number Mismatch also elicited significantly greater negativity than Person Mismatch ($M = 2.738$, $SD = 0.359$) ($p < .001$). However, there was no significant difference between the Grammatical condition and Person Mismatch (Table 7).

Table 7. Pairwise comparison of conditions in the 500-800 ms time window

Grammatical vs Person Mismatch				
df	*F*	*p*	*MSE*	ηp^2
(1,32)	0.127	n.s.	3.153	.004
Grammatical vs Number Mismatch				
df	*F*	*p*	*MSE*	ηp^2
(1,32)	9.510	<.05	3.123	.229
Person Mismatch vs Number Mismatch				
df	*F*	*p*	*MSE*	ηp^2
(1,32)	32.134	<.001	1.151	.501

n.s.: Not statistically significant
Bonferroni correction applied to p-values.

The effect of the interaction Condition × AP × Lateralisation was examined and the following results were obtained for each region of interest: In the left frontal region, Number Mismatch ($M = -0.185$, $SD = 2.277$) resulted in significantly greater negativity compared to the Grammatical condition ($M = -0.773$, $SD = 2.083$) ($p < .05$) and Person Mismatch ($M = 0.906$, $SD = 2.474$) ($p < .001$).

However, there was no significant difference between Person Mismatch and the Grammatical condition. In the right frontal region, Number Mismatch (M = -0.615, SD = 2.248) produced significantly more negativity than Person Mismatch (M = 1.698, SD = 2.368) ($p < .001$). However, there was no difference between Number Mismatch and the Grammatical condition (M = 1.203, SD = 2.029) and between Person Mismatch and the Grammatical condition. In the left posterior region of the scalp, Number Mismatch (M = 3.383, SD = 2.569) produced significantly greater negativity compared to the Grammatical condition (M = 4.474, SD = 2.481) ($p < .05$) and Person Mismatch (M = 4.467, SD = 2.211) ($p < .001$). However, there was no significant difference between Person Mismatch and the Grammatical condition. Finally, in the right posterior region, Number Mismatch (M = 2.903, SD = 3.386) produced significantly greater negativity compared to the Grammatical condition (M = 4.061, SD = 3.136) ($p < .05$) and Person Mismatch (M = 3.881, SD = 3.158) ($p < .01$). However, there was no significant difference between Person Mismatch and the Grammatical condition. Overall, in the third time window (500-800 ms), both Number Mismatch and Person Mismatch produced greater negativity compared to the Grammatical condition, and this difference was statistically significant. However, there was no significant difference between the two types of mismatches. (Table 8).

Table 8. Pairwise comparison of conditions in the 500-800 ms time window in each domain of interest in the Condition×AP×LAT interaction

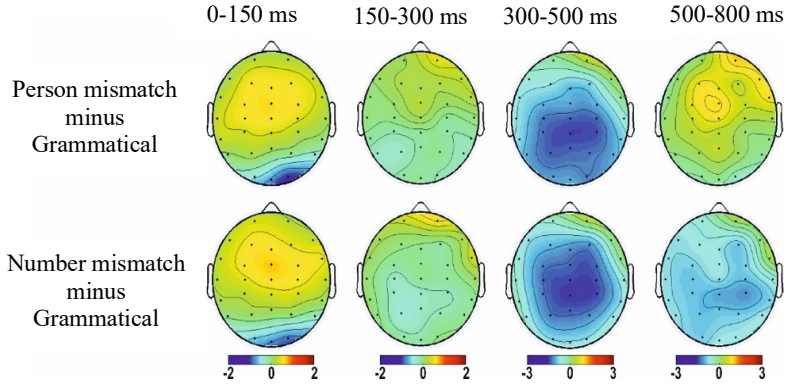
	Grammatical vs Person Mismatch				
	df	*F*	*p*	*MSE*	ηp^2
Left Anterior	(1,32)	0.134	n.s.	4.313	.004
Right Anterior	(1,32)	2.170	n.s.	8.081	.064
Left Posterior	(1,32)	0.000	n.s.	3.648	.000
Right Posterior	(1,32)	0.217	n.s.	4.936	.007
	Grammatical vs Number Mismatch				
	df	*F*	*p*	*MSE*	ηp^2
Left Anterior	(1,32)	6.464	<.05	4.688	.168
Right Anterior	(1,32)	3.041	n.s.	3.751	.087
Left Posterior	(1,32)	9.255	<.05	4.240	.224
Right Posterior	(1,32)	9.243	<.05	4.788	.224
	Person Mismatch vs Number Mismatch				
	df	*F*	*p*	*MSE*	ηp^2
Left Anterior	(1,32)	17.778	.001	2.207	.357
Right Anterior	(1,32)	26.161	.001	1.479	.450
Left Posterior	(1,32)	21.275	.001	1.821	.399
Right Posterior	(1,32)	14.404	.01	2.192	.310

n.s.: Not statistically significant
Bonferroni correction applied to p-values.

In the Condition × AP × Lateralization interaction, there is a significant difference between Person Mismatch and Number Mismatch in the regions of interest, with Number Mismatch showing greater negativity. However, a similar effect is observed between Person Mismatch and the Grammatical condition, except in the right frontal region, where Number Mismatch shows greater negativity compared to the Grammatical condition.

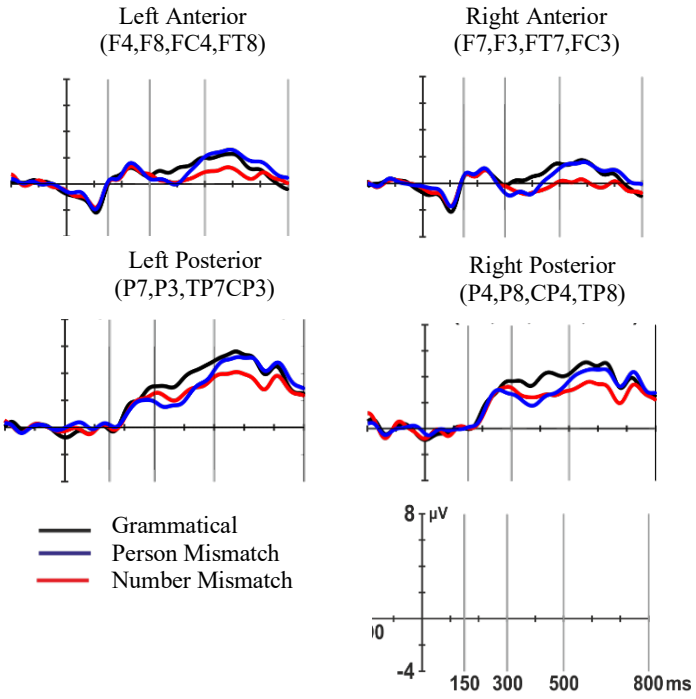
Looking at the results across all time windows, in the 0-150 ms time window only the Grammatical and Person Mismatch conditions differed significantly from each other, while in the 150-300 ms time window no difference was observed between the conditions. In the 300-500 ms time window, a widespread N400 was found in the Number Mismatch and Person Mismatch conditions, this effect was significantly different from the Grammatical condition, while no significant difference was found between the two mismatches. In the last time window, a late N400 effect is observed for Number Mismatch, whereas a positive effect (P600) emerges for Person Mismatch, with a significant difference between the two types of mismatches. The difference topographies obtained by subtracting the Grammatical condition from the Person Mismatch and Number Mismatch conditions are shown below:

Figure 2. Difference scalp topographies related to conditions



The ERP responses, time-locked to the presentation of the stimuli, for each condition are as follows:

Figure 3. Effect of conditions on the presentation of the verb as time-locked



4 Discussion

4.1 Processing of Person and Number Features

The cognitive organisation of Person and Number features in language is one of the topics that has been addressed in the literature, particularly in the context of ERPs. A significant proportion of these studies suggest that Person and Number features are distinct features and further propose a feature hierarchy in the feature of Person > Number (Nevins et al., 2007; Mancini et al., 2011a; Aygüneş et al., 2021; Zawiszewski et al., 2016; Aristia et al., 2022; Aygüneş, M., in press). It is also noteworthy that similar observations have been made in studies outside the ERPs paradigm (Carminati, 2005; Aygüneş, 2012; Aygüneş, 2013b; Mancini et al., 2014). While a significant portion of the literature supports the Person > Number hierarchy assumption, indicating a processing difference between Person and Number features and the need for more cognitive resources to process Person features, there are also studies that argue against the existence of a

hierarchical structure between these features (Silva-Pereyra & Carreiras, 2007; Mancini et al., 2014).

The choice of subject in the experimental design (first/second-person vs. third person) seems to be crucial in shaping these two different views, i.e., whether a difference emerges between the processing of Person and Number features. At this point, in contrast to the approach in the literature that Person and Number features can only be tested using the third person, there are approaches that state that the relationship between these features can also be tested using first/second pronouns. According to the first view, the processing difference between Person and Number features can only be observed in structures produced with the third person, in contrast to the first and second person, due to the different structure of Person and Number features in the third-person (Mancini et al., 2011a; Mancini et al., 2014). It is argued that the full representation of the Number mismatch in third-person structures fully reflects the Number feature, whereas in first- and second-person structures the Number feature is essentially contaminated by the Person feature, preventing the formation of a full Number mismatch. This situation has been suggested to interfere with the observation of the Person > Number hierarchy in first- and second-person experiments. However, despite this view, it is worth noting that studies testing the relationship between Person and Number features in first- and second-person experimental designs have also reported the Person > Number hierarchy (Zawiszewski et al., 2016; Aygüneş et al., 2021; Aristia et al., 2022). These studies undermine the view that only structures created with the third-person are appropriate for testing the processing of Person and Number features.

Based on their phi-features theory, Ackema & Neeleman (2019) state that the relationship between Person and Number features can be tested with first/second-person pronouns in addition to the third person, but when the third-person is formed with noun phrases, they become problematic because they have no Person features, and the most appropriate structures for the third-person are those formed with third-person pronouns. In the current literature, studies in Turkish (Aygüneş, 2012; Aygüneş, 2013a/b; Aygüneş, 2021; Aygüneş et al., 2021), Basque (Zawiszewski et al., 2016) and French (Aristia et al., 2022) have consistently shown that differences in the processing of Person and Number features can be observed in first-second pronouns.

However, there is still a gap in the literature when it comes to analysing the relationship between Person and Number features. Ackema & Neeleman (2019) state that the subject has not been tested with third-person pronoun, and Mancini et al. (2011) used R-expressions, and since these expressions do not have Person features, studies testing the subject with third-person pronouns are needed. This study, which is the first to test the topic with third-person pronouns, shows that there are differences in the processing of Person and Number features for third-

person pronoun, as there are for first- and second-person pronouns. In this study, while N400+P600 was observed in the processing of the Person feature, N400+late N400 were observed in the processing of the Number feature. In the literature there are different explanations for the structuring of Person and Number features. Sigurdsson (2004) states that the Number feature consists of 'Singular' and 'Plural' and the Person feature consists of 'Speaker' and 'Address'. However, he states that there are differences in the licensing of these two features and that the Number feature remains within the boundaries of the IP, while the Person feature must interact with the CP in order to be licensed. Nevins (2011) states that the Person feature is determined according to the 'Participant' and 'Speaker' features, while the Number feature is privative and consists only of the 'Plural' feature without the Singular value of that feature. In another feature-based approach, Ackema & Neeleman (2013, 2018, 2019) similarly state that the Number feature includes only the 'Plural' feature, but the Person feature is determined according to the 'Proximity' and 'Distance' features. What all these explanations have in common is that they lead us to the view that the Person feature is more cognitively demanding than the Number feature. As a result, similar to other studies conducted with first- and second-person pronouns, this study found that there was a difference between Person and Number features when tested with third-person pronouns. This difference is thought to be due to the cognitive salience of the Person feature, in line with theoretical explanations in the literature.

4.2 ERPs Related to Person and Number Features

When examining the ERP components associated with the processing of Person and Number features in the literature, it is clear that the components observed can vary. In studies using first- and second-person singular and plural forms, the N400 component has been observed (Aygüneş, 2013a; Aygüneş et al., 2021; Aristia et al., 2022), or in some cases an early negativity followed by a P600 component has been reported (Silva-Pereyra & Carreiras, 2007). In second-person singular structures, an N400+P600 pattern has been observed (Zawiszewski & Friederici, 2009; Zawiszewski et al., 2016). In the third person, a P600 component has been reported (Nevins et al., 2007), and a pattern of N400+P600 for Person agreement and LAN+P600 for Number agreement has been reported (Mancini et al., 2011a).

In this study, the third-person pronoun was used (e.g., O_{3Sg} şimdi okula gid-iyor-$Ø_{3Sg}$). In the Person Mismatch condition, subjects were presented with the third-person singular form, but the verb was inflected with the second-person singular marker (e.g., *O_{3Sg} şimdi okula gid-iyor-sun_{2Sg}). In the Number Mismatch condition, subjects were presented with the third-person singular form

and the verb was inflected with the third-person plural marker (e.g., *O_{3Sg} şimdi okula gid-iyor-lar$_{3PL}$). In all conditions, the subjects were kept constant, while the agreement discrepancies were created in the verb inflection compared to the grammatical condition. The results of the study showed that in the 300-500 ms time window, both Person and Number features elicited an N400 component, but no differentiation between the two features was observed in terms of processing. However, in the 500-800 ms time window, a late N400 component was observed for Number processing, whereas this negativity disappeared for Person feature processing, and a broadly distributed P600 compound emerged. This time window indicated a distinction between Person and Number feature processing, with greater negativity observed for Number feature processing and positivity for Person feature processing.

4.3 N400

Numerous studies have shown that the N400 component is sensitive not only to semantic processes but also to morphosyntactic processes (Osterhout, 1997; Choudhary et al., 2009; Mancini et al., 2011a; Aygüneş et al., 2021; Zawiszewski & Friederici, 2009; Tanner & Van Hell, 2014; Zawiszewski et al., 2016; Aristia et al., 2022). The N400 findings observed in both Person and Number mismatch conditions in this study support the notion that this component is sensitive to morphosyntactic processes. However, studies reporting the Person > Number hierarchy and observing the N400 component have suggested that greater negativity is elicited in Person agreement compared to Number agreement, indicating the processing difficulty associated with the Person feature (Aygüneş, 2013a; Aygüneş et al., 2021; Aristia et al., 2022). On the other hand, Zawiszewski et al. (2016), in their study with second-person pronouns in Basque, report that there is no difference in the processing of Person and Number features in the N400 time window and that the difference is due to the P600. Ackema & Neeleman (2019) argue that the absence of a qualitative difference between Person and Number mismatches is an expected situation when using pronouns. The findings regarding the N400 in this study are parallel to those of Zawiszewski et al. (2016). No qualitative or quantitative differences in the processing of Person and Number features were observed in the N400 time window.

Instead, differentiation occurred in a later time window, with Number mismatches producing greater negativity (late N400) than Person mismatches. A possible reason for this could be the origin of the plural marker '-lAr' in the Number mismatch condition, which is morphologically ambiguous and may activate both Number and Person features during its processing, adding to the processing load (Kornfilt, 1996). This suffix in verb inflection is also parallel to

nominal pluralisation (e.g., book-lar, 'book-s'). All these situations may have caused the Number mismatch condition created by the suffix '-lAr' to activate different analysis processes and require more resources in working memory.

Furthermore, the third-person plural suffix -lAr is optional in verb conjugation. In other words, when the subject is in the third-person plural ("Onlar"), the presence or absence of the -lAr suffix in the verb conjugation is not subject to grammaticality. For the Number Mismatch condition ("*O$_{3SG}$ şimdi okula gid-iyor-lar$_{3PL}$"), possible Grammatical structures are 1) "O$_{3SG}$ şimdi okula gid-iyor-Ø$_{3SG}$", 2) "Onlar$_{3PL}$ şimdi okula gid-iyor-lar$_{3PL}$" and 3) "Onlar$_{3PL}$ şimdi okula gid-iyor-Ø$_{3SG}$". In contrast, for the Person mismatch condition ("*O$_{3SG}$ şimdi okula gid-iyor-sun$_{2PL}$") the possible grammatical structures are 1) "O$_{3SG}$ şimdi okula gid-iyor-Ø$_{3SG}$" and 2) "Sen$_{2PL}$ şimdi okula gid-iyor-sun$_{2PL}$". Thus, while the Person mismatch condition has two grammatical alternatives depending on the subject and the affix on the verb, the Number mismatch condition has three grammatical alternatives. This may have contributed to the greater negativity observed in the late time window for Number agreement due to the greater load on working memory, as the resolution of Number feature inconsistencies requires the processing of more alternative forms. Although the LAN component is usually associated with working memory (Kluender & Kutas, 1993a; King & Kutas, 1995; Weckerly & Kutas, 1999; Friederici, 2002), the N400 has also been related to working memory capacity but not semantic knowledge, suggesting that the N400 primarily reflects late working memory operations (Salisbury, 2004).

Finally, Aygüneş (2013b) showed that Number mismatches in sentences formed with first-person pronouns were repaired at similar rates depending on the subject and verb conjugation, whereas Number mismatches with third-person pronouns were repaired more often depending on the subject. The different nature of third-person compared to other Person features may also contribute to the larger N400 amplitude observed during Number agreement processing.

4.4 P600

In the literature, P600 has been linked to syntactic processing. With regard to syntactic processing, it has been reported that this component is observed during syntactic violations (Gouvea et al., 2010), during the interpretation of syntactic garden-path sentences (Osterhout & Holcomb, 1992; Kaan & Swaab, 2003) and during complex syntactic structures (Friederici et al., 2002). In the present study, a widespread positivity (P600) was observed for Person mismatches, while a late N400 was observed for Number mismatches in the same time window. It is suggested that this positivity for Person mismatch is mainly due to the fact that Person mismatch is more costly to repair than Number mismatch.

Aygüneş (2013a)/Aygüneş et al. (2021) found that there was a processing difference between Person and Number features in terms of the N400 in the first and second person, while this difference did not appear in the P600. On the other hand, in the present study with third-person pronoun, there was no difference between the two features in terms of the N400, while a late N400 occurred in the late time window for Number mismatch, in contrast to the occurrence of the P600 for Person mismatch. Thus, while first/second-person pronouns and third-person pronouns show similarity in terms of revealing the difference in the processing between Person and Number features, some differences are observed in terms of the components of the ERPs.

5 Conclusion

This study investigated the processing of Person and Number features in Turkish using ERPs with third-person pronouns. The results showed that there is a differentiation in the processing of Person and Number features in the brain, suggesting that these features are processed discretely rather than as a unified whole. Specifically, the main difference between the two features was observed in the late time window, with the emergence of a late N400 during Number feature processing and positivity (P600) during Person feature processing. This study shows that the feature hierarchy is also observed in sentences with third-person pronoun. Regarding the components of the ERPs, studies have supported the idea that the N400 component may be sensitive not only to semantic processing, but also to morphosyntactic processing and operations related to working memory.

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Conflict of Interest Statement: The author declares that there are no financial or academic conflicts of interest between himself or with other institutions, organizations or individuals that could affect this study.
Data Use: EEG data of 33 participants were used in this study.
Ethical Approval/Participant Consent: Istanbul University approval dated 03.01.2014 and numbered 28 was obtained from the Ethics Committee for Clinical Research. Participants were informed about the research and informed consent was obtained from the participants.
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