Processing Third-person Non-binary Pronouns in Dutch

An EEG study

by

Noortje Akkermans

s1014317

MA degree programme in

Linguistics and Communication Sciences (research)

Nijmegen – August 16, 2023

Supervisors: Helen de Hoop, Maria den Hartog

Assessor: Peter de Swart

Radboud University

Acknowledgements

This thesis stems from an interest to learn about a new and intriguing development in the Dutch language and society. A new pronoun was introduced to the language, but this word that was intended to be useful seems to evoke some problems. While I have focused on and studied different topics and methodologies throughout the rest of my masters, I wanted to switch to the current topic for this thesis as I found it is highly relevant at this time and seems to receive more and more attention. Luckily I could share the curiosity and enthusiasm for this topic with others that could even teach me things along the way. I want to thank my supervisors, Helen and Maria, for their ideas, their knowledge and their enthusiasm. I also want to thank Levi and Tamara for their help with setting up the experiment, data collection and data processing and analyses, the brainstorm sessions, and the fun times not related to the project in between. Finally, I am grateful for my friends, my family, and Joep for their genuine interest and enthusiasm, the inspirational conversations, their support throughout this project, and the occasionally necessary change of scenery. I am happy to present this study on an interesting and important topic that will hopefully continue to receive the attention and research that it deserves, and I hope you enjoy reading it!

Table of contents

Abstract

Recently the pronouns *hen* and *hun* have been introduced into the Dutch language as non-binary pronouns. However, the introduction of these pronouns causes resistance among language users, and gives rise to several grammatical anomalies and interpretation difficulties. The current study investigates whether the newly introduced non-binary pronouns *hen* and *hun* are processed differently from masculine and feminine pronouns, and to what extent participants' experience with, attitude toward, and general habituation to the non-binary pronouns influence how they are processed. An EEG experiment was conducted among native Dutch young adults who read a text in which non-binary pronouns *hen* and *hun* were used. The results indicate a general processing cost for non-binary pronouns that can be related to interpretation difficulties that arise when *hen* is used to refer to a singular non-binary antecedent. While it was expected to find additional processing costs related to syntactic violations that arise when *hen* is used as a subject pronoun in combination with a singular finite verb, the results do not support this. Expectations regarding influences from participants' experience with and attitude towards the non-binary pronouns, or from short-term habituation to the non-binary pronouns on how they were processed were not supported. Possible explanations and interpretations related to relevant literature are discussed.

1. Introduction

Language is always changing. One recent shift has been the use of more inclusive language, for example by using gender-neutral words (e.g., 'partner' instead of 'girlfriend', 'husband') to refer to people whose gender is unknown or to people with a non-binary gender identity (i.e., not (only) male or female). Along with this, the use of non-binary pronouns increased. In English, for example, "singular" *they* has been used generically whenever the gender of a referent is unknown or irrelevant, and this use has become established in the language (see Balhorn, 2004; Noll et al., 2018; Prasad & Morris, 2020). Later on, *they* was also used to refer to people with a non-binary gender identity. However, in many languages, no such non-binary third person pronoun is available. In Dutch, for example, no non-binary third person singular pronouns existed until they were recently introduced to the language. When referring to a person whose gender is evident from the context or the word (e.g. 'sister'), generally the binary personal pronouns *zij* 'she' and *hij* 'he' are used. Other pronouns that can be used to refer to people but are not marked for gender are *het* 'it' in very few cases, for example when referring to a baby, or the demonstrative pronoun *die* 'that (one/person)'. In case a person's gender is unknown, *hij/zij* 'he/she', the demonstrative pronoun *die* or *diegene* 'that person', or the generic masculine pronoun is used. For example, in the sentence *Iemand is zijn tas vergeten* 'Someone has forgotten his bag', the masculine possessive pronoun is used to refer to an antecedent that is unspecified for gender.

A study by Redl et al. (2021) investigated how this generic masculine possessive pronoun is processed. They found that readers show a processing cost in sentences with female continuations after the generic masculine pronoun. When referring to a stereotypically gender-neutral antecedent, the use of the generic masculine possessive pronoun caused a male bias in male participants, but not female participants. Male participants appear to process the pronoun as one referring to a masculine referent. In other words, the use of the Dutch generic masculine pronoun is not always perceived as generic and inclusive. The use of non-binary pronouns might turn out to be more suited for this purpose. Since no such pronoun existed in the Dutch language, the Transgender Network of the Netherlands (TNN) organized an election in 2016 for what the Dutch non-binary personal pronoun should be. This election was won by the personal pronoun *hen* and possessive *hun* (TNN, 2016a, 2016b), and since then, these pronouns have been implemented by some media outlets to refer to people with a non-binary gender identity.

While the non-binary pronouns *hen* and *hun* are being used in the media and were acknowledged by a dictionary of the Dutch language (Van Dale, 2021), they are far from conventionalized and evoke a lot of resistance. An important factor for this could be that the words that were selected as the non-binary pronouns were already used as the third-person plural pronouns. In that sense, the Dutch non-binary pronouns are similar to the English non-binary pronouns *they/them/their*, since for both languages the same pronouns can be used for both third-person singular non-binary referents, as well as third-person plural referents. A big difference, however, is that with "singular" *they* in English a plural verb form is used whereas non-binary *hen* in Dutch takes a singular verb form – see Table 1 below for an example sentence. This can make sentences with the non-binary pronoun *hen* sound ungrammatical, since the grammatical number of *hen* may be perceived as plural, in which case verb agreement

Table 1

Example Sentences with Third-person Pronouns in Dutch

		Third person pronouns	**Non-binary pronouns**
Direct object	Singular	*John vraagt hem/haar om hulp* 'John asks him/her for help'	*John vraagt hen om hulp* 'John asks them for help'
	Plural	*John vraagt hen om hulp* 'John asks them for help'	
Indirect object	Singular	*John geeft hem/haar een cadeau* 'John gives him/her a present'	*John geeft hen een cadeau* 'John gives them a present'
	Plural	*John geeft hun een cadeau* 'John gives them a present'	
Complement of preposition	Singular	*John geeft een cadeau aan hem/haar* 'John gives a present to him/her'	*John geeft een cadeau aan hen* 'John gives a present to them'
	Plural	*John geeft een cadeau aan hen* 'John gives a present to them'	
Subject	Singular	*Hij/Zij wil een huis kopen* 'He/She wants to buy a house'	*Hen wil een huis kopen* 'Them wants to buy a house'
	Plural	*Zij/Ze/Hun willen een huis kopen* 'They want to buy a house'	
Possessive pronoun	Singular	*Zijn/Haar huis staat te koop* 'His/Her house is for sale'	*Hun huis staat te koop* 'Their house is for sale'
	Plural	*Hun huis staat te koop* 'Their house is for sale'	

is violated. Another big difference between *they* in English and *hen* in Dutch is that *they* was already used as a generic pronoun, and this meaning later extended to non-binary reference. *Hen* in Dutch, however, was introduced as a new pronoun, specifically to refer to non-binary antecedents.

Furthermore, the Dutch pronoun *hen* is originally used as the third-person plural object pronoun, and as a complement of a preposition (see Table 1). A third-person plural subject is referred to with the personal pronoun *zij* 'they', its reduced form *ze*, or the third-person plural object pronoun *hun* 'them' (despite a lot of criticism; see de Hoop, 2020; van Bergen et al., 2011). However, for the new meaning of this pronoun, *hen* is used as a subject (and as an object) when referring to a person with a non-binary gender identity.

Additionally, these new pronouns were introduced to the language by prescriptively imposing it, while new pronouns generally emerge naturally out of other words. Heine and Song (2011) discuss three frequent sources of new third-person pronouns, namely demonstratives,

nouns, and intensifiers. These types of words can evolve into third-person pronouns through a process of grammaticalization. Heine and Song describe core parameters that apply to grammaticalization of newly emerged pronouns, based on observations from pronoun emergence in multiple different languages around the world. They discuss their Extension model, which describes four stages of transition from initial meaning to a new, fully conventionalized pronoun. In the initial stage, a word that is the source of a newly emerging pronoun still only has its original meaning. In the second, bridging stage, this word is used in a new context which gives rise to a new meaning next to the pre-existing meaning. In this stage, the new meaning is still optional. In the third stage, what is called the switch stage, the source meaning is fading and the target meaning or function is the only acceptable use in some contexts, creating more of a distinction between the source meaning and the target meaning. Finally, in the fourth stage, the new meaning and function are completely conventionalized as a new word. This model demonstrates that the emergence and grammaticalization of new pronouns is a very slow and gradual process. By prescriptively imposing a new non-binary pronoun, these extension stages are essentially skipped, which means that there was no gradual adaptation or integration of the new meanings of *hen* and *hun* in the language. Pronouns are generally accessed and used very frequently and automatically. However, this sudden, imposed meaning change requires a lot of conscious processing. This might be an explanation of why there is so much resistance against these non-binary pronouns.

Hen being used as a subject in combination with a singular finite verb, as well as the new imposed meaning and use of this pronoun, might explain why the non-binary pronoun *hen* is not as accepted in the Dutch language yet. All these factors are indications and possible explanations of this new pronoun being processed differently from the binary pronouns. The current study will examine whether this can be found in EEG language processing data from young Dutch adults that read a text including both binary and non-binary pronouns.

Aside from *hen/hun*, the pronoun *die* (possessive *diens*) can be used for people with a non-binary gender identity, instead of or in addition to *hen/hun*. As mentioned above, this pronoun is already used as a third-person singular (demonstrative) pronoun that is unmarked for gender. This is an important difference between *hen/hun* and *die/diens* as non-binary pronouns, which might also explain why *die/diens* as non-binary pronouns seem to evoke less resistance and might require less habituation. Additionally, non-binary *hen/hun* seem to be used more specifically to refer to people with a non-binary gender identity, rather than people whose gender is not known or relevant, while *die/diens* are also being used for the latter situation. Therefore, the current study will solely focus on non-binary pronouns *hen/hun* and the potential problems that these cause.

1.1. Non-binary pronoun processing

The processing of non-binary pronouns as compared to binary pronouns has not been studied to a great extent. The first study to cover this topic was one by Foertsch and Gernsbacher (1997). They collected reading times for English sentences in which the binary pronouns or the non-binary pronoun *they* was used to refer to an antecedent earlier in the sentence. In different conditions, the gender of the pronoun (i.e., masculine, feminine, or neutral/non-binary) either matched or mismatched the stereotypical gender of the antecedent (i.e., masculine, feminine,

neutral, or indefinite). Their results indicated that a mismatch of gender between the antecedent and the pronoun resulted in slower reading times, which implies a processing cost. Interestingly, sentences in which the non-binary pronoun was used were read equally fast as sentences in which the binary gender of the pronoun and the antecedent matched. They found an additional effect of definiteness, where *they* was read faster than *he* or *she* when antecedents were indefinite nouns. In a second experiment, antecedents were made more specific (i.e., 'My nurse…' instead of 'A nurse…'). Here, reading times were equal among the different pronouns when the antecedent was stereotypically neutral. For stereotypically masculine antecedents, *he* was read faster than both *she* and *they*. For stereotypically feminine antecedents, both *she* and *they* were read faster than *he*. (1) below shows several sentences taken from the study.[1] Overall, the results of their study demonstrate that the English non-binary pronoun *they* is the most acceptable pronoun to refer to neutral (1a) or indefinite antecedents (1b) as compared to stereotypically masculine (1c) or feminine (1d) antecedents. Additionally, for stereotypically masculine or feminine antecedents, *they* is processed more easily when the antecedent is non-referential (1c, d) as compared to when it is more specific (1e, f).

Noll et al. (2018) investigated the processing of *he* and *they* as generic, or epicene pronouns (i.e., pronouns that could refer to an antecedent of which the gender is not known or not specified) for stereotypically gendered antecedents, and how this changed in fifteen years.

(1) a) A runner should eat lots of pasta the night before a race, even if *they* would rather have steak.
b) Anybody who litters should be fined $50, even if *they* cannot see a trashcan nearby.
c) A truck driver should never drive when sleepy, even if *they* may be struggling to make a delivery on time.
d) A nurse should have an understanding of how a medication works, even if *they* will not have any say in prescribing it.
e) That truck driver should never drive when sleepy, even if *they* may be struggling to make a delivery on time.
f) My nurse should have an understanding of how a medication works, even if *they* will not have any say in prescribing it.

They did this by conducting the same lexical decision experiment twice with fifteen years in between. Participants read sentences and were to respond whether they agreed or disagreed with the statement after each sentence. Critical sentences contained an antecedent in the first clause, and a pronoun in the second clause. Responses and response times were collected. In the earlier study, they found no differences between masculine and feminine antecedents with pronoun *he,* but they did find that the use of *they* facilitated responses to feminine antecedents. In the second study, fifteen years later, they found that responses were quicker for masculine antecedents with *he*, which indicates that the processing and interpretation of epicene *he* changed over time. In

[1] The sentences presented here are shortened. In the original stimuli, these sentences were followed by an additional clause beginning with 'because'.

the later study, *they* did not facilitate or hinder either of the gendered antecedents over the other, but *he* did hinder the processing of feminine antecedents, which it did not in the first study.

Speyer and Schleef (2019) studied how non-native speakers processed non-binary pronouns as compared to binary pronouns. For this, they replicated the first experiment from Foertsch and Gernsbacher (1997). They found that the Austrian non-native speakers of English processed *they* more easily than a binary pronoun when it referred to an indefinite antecedent. Their results are highly similar to those from the native speakers in the original experiment.

Whereas the above mentioned studies concerned the use of "singular" *they* in the English language, a recent study by Vergoossen et al. (2020) investigated this topic in the Swedish language. In Swedish, the pronoun *hen* was promoted as an additional pronoun that could be used to refer to non-binary gender identities and as a generic pronoun, aiming to reduce gender stereotyping in communication. In 2015, *hen* was added to the Swedish dictionary as a generic and non-binary pronoun, in addition to the existing binary pronouns (*han* 'he' and *hon* 'she'). The study by Vergoossen et al. aimed to investigate whether this new non-binary pronoun is processed with greater difficulty than the existing binary pronouns. *Hen* was used in sentences where it referred back to neutral nouns (e.g., 'person'), lexically gendered nouns (e.g., 'sister', 'king'), or stereotypically gendered nouns (e.g., 'cosmetologist', 'construction worker'). The binary pronouns were used in similar sentences, where the gender of the gendered nouns always matched the gender of the pronoun. Processing cost was measured in an eye-tracking experiment by looking at the reading times for the pronoun, the words following the pronoun (the spillover region), and the noun. The results showed no processing cost for non-binary pronouns as compared to binary pronouns. A small processing cost was found in the spillover region following the non-binary pronoun. This processing cost was larger when the non-binary pronoun referred to a neutral noun as compared to when it referred to a gendered noun. Vergoossen et al. very briefly discuss the possibility that the interpretation of *hen* might have influenced the pronoun resolution process. *Hen* in Swedish can be used as a generic pronoun, as well as a pronoun to refer to a person with a non-binary gender identity. It is possible that the non-binary pronouns that refer to neutral nouns create a context in which it is unclear to the reader whether *hen* is used generically, or to specifically indicate that the antecedent is non-binary.

A study by Prasad and Morris (2020) investigated whether the processing of the English non-binary reflexive pronoun *themselves* differed from how the binary reflexive pronouns *himself* and *herself* and the third-person plural reflexive pronoun *themselves* are processed. Sentences used in their experiment are presented in (2) below. They recruited only participants who indicated to be familiar with the non-binary gender identity and the use of gender-neutral pronouns, aiming to investigate how their processing results compare to acceptability ratings and processing results with similar sentences from previous studies. They studied event-related potentials (ERPs) of participants that listened to sentences with the non-binary, binary, and plural reflexive pronouns, and non-referential (2a, b) or referential (2c, d) antecedents with either ambiguous (2a, c) or unambiguous (2b, d) gender. They were specifically looking for a P600 effect, which is a brain response that is associated with processing difficulty, for example due to syntactic violations or structural mismatches (Chen et al., 2021; Luck, 2012; Nieuwland, 2014). For referential unambiguous antecedents, gendered names were used (e.g., John). They found a P600 effect when *themselves* was used to refer to specific antecedents (i.e., 'John', 2d

below), but not when it was used to refer to singular non-referential antecedents (i.e., 'someone', 'every woman') or referential antecedents unspecified for gender (i.e., 'the stranger'). They conclude that the participants were not able to dissociate the gender associated with a name, and therefore still show a processing cost when the non-binary pronoun is used to refer to these types of antecedents, even though they were familiar with the use of non-binary pronouns. However, note that using *themselves* to refer to gendered names specifically suggests that the antecedent has a non-binary gender identity (because otherwise *himself* or *herself* could be used to refer to them), whereas for non-referential antecedents and antecedents unspecified for gender *themselves* is likely interpreted as a generic or epicene pronoun.

(2) a) **Someone** in the group needs to pull **himself/herself** together.
b) **All women** must learn to stand up for **themselves**.
c) **The stranger** poured **himself/herself** a cup of coffee.
d) **John** decided to treat **themselves** to sushi.

Another recent study by Chen et al. (2021) also employed ERPs to study how the non-binary pronoun is processed as compared to the binary pronouns. The participants from this study were also familiar with non-binary gender identities and preferred pronouns. Stimulus sentences contained a gendered name and a matching or mismatching binary pronoun, or singular *they* (mismatch). In a plural condition, *they* referred back to two names (match). The results showed a P600 effect for both mismatch conditions as compared to their control conditions. Interestingly, they also found an Nref effect for the mismatched binary pronouns as compared to the matched binary pronouns, but this was not found for *they*. An Nref effect is usually found when it is unclear what referent a pronoun refers to, for example because the gender of the pronoun does not match the (stereotypical) gender of the antecedent (Chen et al., 2021; Nieuwland, 2014). The absence of an Nref effect for *they* referring to a singular antecedent (mismatch) as compared to *they* referring to a plural antecedent (match) could be an indication that the use of *they* for singular antecedents does not hinder pronoun resolution like a gender mismatch in binary pronouns does. Additionally, the P600 effect found for singular *they* became smaller as participants' age increased. The authors argue that this could be due to more exposure to the non-binary pronouns at older age, as all participants were undergraduates at a school that encourages students to provide their preferred pronouns and teaches students about non-binary gender identities. The older participants have likely been exposed to and taught about non-binary pronouns more as they attended the school for a longer period of time. However, it could be possible that the age differences in this population are not large enough to be able to reliably account for this reduction in processing cost. Overall, this study found that even interlocutors who are familiar with the non-binary pronoun show some processing difficulty. Additionally, a gender mismatch in the binary pronouns elicits an additional referential difficulty that is not found for the non-binary pronoun.

1.2. Present study

The current study aims to investigate the processing of the Dutch non-binary pronouns *hen* (personal pronoun) and *hun* (possessive pronoun), as compared to the binary pronouns *hij* 'he', *hem* 'him' and *zijn* 'his', and *zij* 'she' and *haar* 'her'. At the time of writing, no other EEG studies were found that investigate the processing of Dutch non-binary pronouns.

One of the potential problems in processing the non-binary pronouns, as discussed in the introduction, is the fact that *hen* already exists in Dutch and is used as a third-person plural object pronoun. This implies that *hen* will likely be processed as an object pronoun, and it could therefore be expected that the use of non-binary *hen* as a subject requires more habituation than non-binary *hen* as an object. The current study differentiates the processing of non-binary *hen* as a subject and as an object, as part of the more general aim to investigate how the non-binary pronouns are processed. This difference in grammatical function between an existing use and a new use could be less of an issue for the possessive pronouns. While the use of *hun* as a non-binary possessive pronoun is not standard in Dutch, *hun* does exist as the possessive pronoun for third-person plural referents. Comparing these different non-binary pronouns across grammatical functions sheds light on the influence of change in grammatical function on how the newly introduced pronouns are processed.

Another factor that potentially influences how these new pronouns are processed, is the extent to which readers are familiar with the non-binary pronouns, and their attitude toward them. As was briefly discussed in the introduction, the use of non-binary *hen* and *hun* in, for example, the media evokes some resistance among language users. This is probably due to not being used to the new pronouns, or the feeling that they are ungrammatical, which could be a consequence of the new pronouns being imposed rather than having evolved naturally. Another reason could be a more general negative attitude towards nonconforming gender identities. Therefore, experience with and attitude toward nonconforming gender identities and the non-binary pronouns potentially influence how these pronouns are processed. While the non-binary pronouns may be perceived as incorrect or not standard by some people, they might be more or completely acceptable to people who are frequently exposed to them or who frequently use these pronouns. In order to study whether these factors play a role in how the non-binary pronouns are processed, the following overarching research question was formulated: "How are the Dutch non-binary pronouns *hen* and *hun* processed in the brain?". This question is further divided in the following subquestions:

1. How are the non-binary personal and possessive pronouns processed compared to the binary personal and possessive pronouns?
    a. How is the Dutch non-binary personal pronoun *hen* processed in the brain, as compared to binary personal pronouns?
    b. How is the Dutch non-binary possessive pronoun *hun* processed in the brain, as compared to binary possessive pronouns?
2. To what extent is the non-binary personal pronoun *hen* processed differently as a subject and as an object?
3. To what extent does experience and familiarity with or attitude toward the use of the Dutch non-binary pronouns influence how these are processed in the brain?

In order to study this, ERP data is collected from native Dutch participants while reading a text in which the Dutch masculine, feminine, and non-binary third-person singular pronouns are used in an electroencephalography (EEG) experiment. In this text, both the personal subject and object pronouns and the possessive pronouns are presented, to refer to three characters in a newspaper article.

1.3. Hypotheses

Based on previous ERP studies on pronoun processing and gender associations, the following hypotheses were formulated. The general expectation was that the non-binary pronouns are processed differently from the masculine and feminine pronouns. This could be caused by a number of reasons. First, the use of singular *hen* and *hun* is not standardized in Dutch. *Hen* and *hun* are actively being used as pronouns, but mainly with plural reference, and *hen* as a plural cannot be used as a subject.[2] Non-binary *hen*, however, is used both as a subject and as an object. Second, using *hen* as a singular non-binary subject pronoun leads to an ungrammatical sentence, not only because it is an object form, but also because it combines with a finite verb conjugated in singular form (see Table 1). Finally, the introduction of the Dutch non-binary pronouns was not natural. The new pronouns did not emerge spontaneously and evolved into a standardized form through a grammaticalization process, but were prescriptively imposed. All these factors provide reasons to expect that the new non-binary pronouns will not be processed similarly to the existing binary personal pronouns.

A P600 effect is generally associated with processing or integration difficulty due to syntactic violations or grammatical anomalies. The Dutch non-binary pronouns create ungrammatical sentences as soon as *hen* is used as a subject, because *hen* is originally an object pronoun and the verbs are conjugated in singular form. This is why it was expected that a stronger P600 effect would be found for the subject non-binary pronouns, as well as for the finite verbs that follow the non-binary pronouns. More specifically, it was expected that *hen* as a subject elicits a more positive P600 than *hen* as an object or *hun* as a possessive pronoun, since the latter two are not ungrammatical in Dutch. Additionally, previous studies report a P600 effect when the pronoun does not match the antecedent, in gender (Chen et al., 2021; Nieuwland, 2014) or in number (Chen et al., 2021). Since *hen* is generally used as a plural pronoun, a P600 effect could be evoked when non-binary *hen* is processed as a plural pronoun while referring to a singular antecedent.

Furthermore, it was hypothesized that an N400 effect would be found when participants read the non-binary pronouns. The N400 effect is generally found when a word is unexpected, or when a specific expectation is not met (Frank et al., 2015; Luck, 2012; Nieuwland, 2014; Nieuwland & Van Berkum, 2006). This could be expected for processing non-binary *hen* and *hun* since these pronouns are not yet widely used in this way. Participants may be surprised to read these non-binary pronouns when they may be expecting a binary pronoun. Alternatively, if participants interpret *hen* and *hun* as plural pronouns, instead of singular pronouns, an N400 effect could be expected since the pronoun does not match the mental image of the referent.

[2] *Hun* can in fact be used as a plural subject in Dutch (see de Hoop, 2020; van Bergen et al., 2011), but *hun* was not chosen as a subject non-binary pronoun.

Finally, it was expected that the non-binary pronouns elicit an Nref effect. An Nref effect can be found when additional processing is required to determine what a pronoun is referring to, for example due to a gender mismatch between a pronoun and an antecedent (Chen et al., 2021; Nieuwland, 2014). This Nref effect can specifically be expected for non-binary *hen* as an object, when it is unclear to the reader whether the pronoun refers to a non-binary individual or a group of individuals, since the latter is the more common use for *hen*.

While some processing cost were expected to occur for every participant when reading the non-binary pronouns, it was also hypothesized that personal experience with the Dutch non-binary pronouns or non-binary gender identity could influence how these non-binary pronouns are processed. When participants frequently use the non-binary pronouns themselves, or experience them being used in their immediate social environment, these participants might show a smaller processing cost as compared to participants that are not familiar with them. Prasad and Morris (2020) had a similar hypothesis in their study, but their results suggest that participants with a non-binary gender identity or participants that interacted with people with a non-binary gender identity still showed a processing cost when names that elicited gender associations (e.g., 'John') were co-indexed with the non-binary reflexive pronoun *themselves*. However, when *themselves* was co-indexed with singular antecedents that were non-referential and/or were ambiguous in gender (e.g., 'the stranger', 'every woman', 'someone'), these participants did not show a processing cost. In other words, as long as there are no clear gender indications in the antecedent, the non-binary pronoun *themselves* might not elicit a processing cost. Note that it cannot be concluded from this study whether this is due to the participants having experience with the non-binary gender identity, or whether speakers of English are in general experienced with *they* referring to singular antecedents. Since *they* has long been used generically in English, all speakers of English are experienced with *they* as a singular (generic) pronoun. The current study explores whether familiarity and experience with the new non-binary pronouns in Dutch influences how these are processed, without any potential interference from more general experience with the non-binary pronouns being used as singular generic pronouns.

In addition to familiarity and experience with the non-binary pronouns, it was expected that the potential processing costs for these pronouns decreases as the experiment proceeds since participants would repeatedly be exposed to the non-binary pronouns throughout the experiment. In an ERP study, Nieuwland and van Berkum (2006) studied whether discourse context could overrule a more general, context-independent interpretation. They specifically tested this for the lexical-semantic feature animacy. Participants were presented with short stories in which a person interacted with either another person or an inanimate object. They found N400 effects for inanimate nouns and verbs requiring an animate object in stories in which an inanimate object was treated as animate (animacy violation). Interestingly, however, these effects became weaker as the story unfolded. In fact, when an inanimate object had been treated as animate throughout the story, but was presented with an inanimate property at the end of the story, an N400 effect was found again. These results show that, even though the stories contain an animacy violation that is pragmatically odd, participants adapted to the story-specific context. In the current experiment, participants might show signs of habituation to non-binary *hen* similar to those found by Nieuwland and van Berkum, as they might adapt to *hen* being used to refer to a singular antecedent in the text.

2. Methods

2.1. Participants

For this study, 17 right-handed native speakers of Dutch (11 female, 5 male, 1 other) were recruited through the online participant recruitment system of Radboud University. All participants had normal or corrected to normal vision, and no cognitive, language, or speech disorders. Only participants between 18 and 30 years old were recruited (M = 22.6, SD = 2.9), and none were aware of the study aim prior to participating. All participants were rewarded with €20 or course credits after participation.

2.2. Materials

2.2.1. Written text

Participants were presented with a written Dutch text in which both the non-binary pronouns *hen* and *hun* and the binary pronouns *hij*, *hem*, *zijn* and *zij*, *haar* were used. This text was based on a recent article in the Dutch newspaper *de Volkskrant* (De Weerd, 2023). This newspaper uses the non-binary pronouns *hen* and *hun* to refer to people with a non-binary gender identity. By using a newspaper article, the stimuli used in this study are highly representative of how people would generally encounter the use of (non-binary) pronouns in their day-to-day life.

In the text, three Ukrainian people who moved to Berlin or still live in Kyiv are introduced and they talk about their experiences with the queer community in Kyiv and Berlin, and the influence of the Ukrainian war. The text features three characters.[3] One character was referred to using masculine pronouns, one was referred to using feminine pronouns, and one was referred to using non-binary pronouns, creating three gender conditions. Caution was taken to minimize any potential stereotypical gender associations by using gender-neutral terms (e.g., *queeractivist* instead of *queeractiviste* which specifically denotes a female queer activist), and by only using surnames to refer to the characters in addition to the pronouns. However, the character that is referred to using non-binary pronouns was introduced as a person with a non-binary gender identity to make clear that *hen* and *hun* refer to this person (e.g., *De non-binaire queeractivist Oestemenko …* 'The non-binary queer activist Oestemenko …').

The text consisted of nine paragraphs, each featuring one of the three characters, and thus one of the gender conditions. Each character was featured in three paragraphs in total (see Table 2 below for an overview of the number of stimuli in the different conditions). Each of the gender conditions was presented 30 times throughout the text. The stimuli in each of the gender conditions consisted of 13 personal subject pronouns, 7 personal object pronouns, and 10 possessive pronouns. Among the object pronouns are both direct and indirect objects, as well as pronouns that are the complement of a preposition (see Table 1). In addition to the critical pronouns, the text included 26 finite verbs following the personal subject pronouns in each of the gender conditions. Depending on the text version that participants were presented with, the

[3] The original article was based on real interviews, but the people that are featured in the stimuli for this study will be referred to as characters henceforth.

Table 2

Number of Stimuli and Corresponding Dutch Pronoun for Each Condition

	Subject	**Object**	**Possessive**
Non-binary	13 - *hen*	7 - *hen*	10 - *hun*
Feminine	13 - *ze*[4]	7 - *haar*	10 - *haar*
Masculine	13 - *hij*	7 - *hem*	10 - *zijn*

number of verbs presented in each gender condition slightly varied. In version 1, for example, 10 verbs were presented in the feminine condition, 9 in the non-binary condition, and 7 in the masculine condition. The verbs in each of the gender conditions are considered as three more conditions in addition to the different pronoun conditions. In total, each participant was presented with 116 stimuli in 12 conditions.

Six different versions of the same text were created in order to counterbalance the order of the different gender conditions between participants. See Table 3 below for an overview. Note that the paragraphs were in the same order across the different versions, and only the gender condition changed. The different versions were created by replacing the pronouns with the corresponding pronouns of a different gender condition. The rest of the text was identical between versions. Participants were presented with one of the text versions, making sure each version was presented an equal amount of times.

A short, two sentence introductory paragraph was used in a practice phase before the experimental stimuli were presented. In this practice paragraph, none of the characters nor any of the pronouns that were used as the experimental stimuli were presented. Participants were also presented with a practice question in order to familiarize them with the complete procedure. One version of the full text can be found in Appendix A.

2.2.2. Questionnaire

Participants were presented with a questionnaire at the end of the EEG experiment in order to collect background information and control variables. The questionnaire contained background questions regarding gender identity, age, and language background, as well as knowledge about, experience with, and attitude toward the non-binary gender identity and the Dutch non-binary pronouns. For example, participants were asked whether they knew any people around them with a non-binary gender identity, and whether they had previously encountered the use of non-binary pronouns in texts. Some of these questions were based on the questionnaire used by Prasad and Morris (2020). The contents of the questionnaire are presented in Table B1 in Appendix B.

The questionnaire also included control questions about the text that participants were presented with. Participants were asked whether they knew anyone with one of the surnames that were used in the text or whether they had read the original text before, since this text was heavily based on an existing article in a Dutch newspaper. This information was collected in order to be able to control for possible effects of personal associations with the character names

[4] *Ze* is the reduced form of *zij* ‘she’, and is more natural in this text since *zij* would create more emphasis.

Table 3

Pronoun Genders Per Paragraph in Each Text Version

	Character	Version 1	Version 2	Version 3	Version 4	Version 5	Version 6
P1	Zakrevska	F	M	NB	NB	F	M
P2	Bakhin	M	NB	F	M	NB	F
P3	Bakhin	M	NB	F	M	NB	F
P4	Oestemenko	NB	F	M	F	M	NB
P5	Zakrevska	F	M	NB	NB	F	M
P6	Oestemenko	NB	F	M	F	M	NB
P7	Bakhin	M	NB	F	M	NB	F
P8	Oestemenko	NB	F	M	F	M	NB
P9	Zakrevska	F	M	NB	NB	F	M

Note. Overview of the pronoun genders presented in each of the paragraphs (P1 – P9) for the different text versions, with F referring to feminine pronouns, M to masculine pronouns, and NB to non-binary pronouns. Note that the order of the paragraphs and the character names is constant across versions.

or familiarity with the text on how the text was processed. For example, in case a participant knows someone with one of the names used in the text, it is likely that the participant will have certain associations with that name that may or may not match with the character that has the same name in the text. This could in turn influence how the pronouns that refer to this character are processed by the participant.

The variable of Experience ($\alpha = .73$) was based on responses to five questions from the questionnaire, regarding participants' experience and familiarity with the use of *hen* and *hun* to refer to people with a non-binary gender identity. The variable of Attitude ($\alpha = .83$) was based on two other questions from the questionnaire, measuring participants' attitude toward the use of *hen* and *hun* to refer to people with a non-binary gender identity, and acceptability of the sentence *Hen haalt hun schouders op* 'Them shrugs their shoulders'. See Appendix B for an overview of all the questions in the questionnaire, and a specification of the questions used for the variables of Experience and Attitude.

2.3. Procedure

In order to reduce artifacts from eye movements as much as possible, the text was presented one word at a time using a rapid serial visual presentation (RSVP) paradigm, with each word being presented in the middle of the screen. Text was presented in black on a dark grey

background. Before each sentence, a fixation cross was presented in the middle of the screen, until the participant initiated the sentence with a button press. Each word of a sentence was presented for a duration of 230 to 590 ms, depending on the word length. This duration was computed by adding 20 ms for each character in the word to a base duration of 190 ms, resulting for example in a total duration of 230 ms for two-character words or a total duration of 390 ms for ten-character words. The words were presented with a jittered interstimulus interval of 350 ms on average (between 200 ms and 500 ms, following Khachatryan et al., 2018). After each sentence-final word, a fixation cross was presented until the next sentence was initiated by the participant with a button press.

At the end of each paragraph, a comprehension question was presented (in full, not word by word) on the screen. Participants were able to answer the question using keys on the keyboard corresponding to the answers 'true' and 'false'. The comprehension questions addressed the general message of the paragraph rather than fine details, since these questions were not intended as a measure of memory. After answering the question, a fixation cross was presented during which time participants could move and blink if desired, before sitting still again and initiating the next sentence with a button press.

The experiment was conducted in a soundproof booth, aiming to minimize external noises from distracting participants or influencing their performance during the experiment. Upon arrival, participants were orally instructed about the experiment prior to receiving the written instructions. They were asked to try not to move and to blink as little as possible during the EEG data collection, and were informed that they had the opportunity to blink after each sentence, as long as a fixation cross was presented on screen. Participants were also told that they would be presented with several questions about the text to ensure they kept paying attention during the experiment. After the instructions, participants were presented with a practice paragraph, followed by a practice comprehension question, before initiating the experimental items. Throughout the experiment, the participant was seated inside the booth but had the possibility to communicate with the experimenter through an intercom.

The stimuli were presented using Presentation (Neurobehavioral Systems, Inc.). After completing the EEG experiment, participants filled out the background questionnaire in Qualtrics (Provo, UT, https://www.qualtrics.com).

2.4. EEG recording and data processing

EEG signals were recorded from 32 active actiCAP Ag/AgCI scalp electrodes, and were amplified using an actiCHamp amplifier (Brain Products GmbH, Gilching, Germany). Signals were sampled at a rate of 500 Hz and recorded using BrainVision Recorder. The raw EEG signals were filtered in BrainVision Recorder with a low cutoff filter at 0.016 Hz with a time constant of 10 s and a high cutoff filter at 125 Hz. The electrodes were arranged using an international 10-20 system. Of the 32 electrodes, two were placed on the left and right mastoid and four electrodes were used to record an electro-oculogram (EOG). Horizontal eye movements were measured by two electrodes placed beside the lateral canthi. Vertical eye movements and blinks were measured with two electrodes placed just above the left eyebrow and below the left eye, in line with participants' pupil while looking straight ahead. A ground electrode was placed on the forehead. Electrode impedance was kept below 10 kΩ.

The EEG data was processed using the FieldTrip toolbox (Oostenveld et al., 2011; http://fieldtriptoolbox.org) in MATLAB (The Math Works, Inc.). All 90 pronouns and 26 finite verbs following subject pronouns were treated as stimuli (see also Appendix A). Trials were defined as epochs of 1200 ms, from 200 ms before stimulus onset until 1 second post stimulus onset. Note that the stimulus design allowed for trial overlap, since two stimuli could be presented adjacent or in close proximity to each other within one sentence. The EEG data was re-referenced to the average of the left and right mastoid electrodes. Eye movement artifacts were removed through an independent component analysis for each participant. Trials were low pass filtered with 35 Hz, and baseline-corrected using a time window of -200 ms to 0 ms relative to stimulus onset. Trials were then resampled to 400 Hz, after which trials containing artifacts could automatically be removed using a -100 to 100 μV threshold. Finally, average values of Nref, N400, and P600 ERP components were computed for each condition. Table 4 below gives an overview of the time windows and electrode sites that were used to analyze each component. These regions of interest (ROIs) were chosen based on the study by Nieuwland (2014) which investigated the same three components with regard to referential pronoun processing.

Three participants were excluded from the analyses due to technical difficulties resulting in incomplete EEG recordings. Additionally, preprocessing resulted in the deletion of a total of 66 trials across the remaining fourteen participants. The highest number of trials that was rejected for one participant was 19 out of 116 ($M = 4.7$, $SD = 6.1$). Following trial rejection, no additional participants were excluded. However, for one participant the EEG recordings from the occipital channels were very noisy and were removed from the analysis during preprocessing. This participant was therefore excluded from the P600 component analyses.

2.5. Statistical analysis

An ROI analysis was performed with linear mixed-effects models, to compare the processing of the different pronouns for each predefined ROI (see Table 4) in R (R Core Team, 2022). Standardized values of the average ERP amplitudes per trial were used. The factors Pronoun Gender (Female, Male, Non-binary) and Grammatical Function (Subject, Object, Possessive) were added as fixed effects, as well as their interaction. In order to analyze habituation, a factor

Table 4

ERP Components Analyzed

ERP Component	Time Window	Electrode Sites
Nref	250-1000ms (sustained negative shift)	F3, Fz, FC1, C3, FC5 (left-frontal)
N400	300-500ms (negative, peak around 400ms)	F3, Fz, FC1, FC2, C3, Cz, C4, CP1, CP2, P3, Pz, P4 (central)
P600	500-1000ms (positive shift)	CP5, P3, Pz, Oz, O1, P7 (left-posterior)

Sentence Number representing the progress within the experiment was added, as well as its interaction with Pronoun Gender since it was expected that participants would show habituation to the non-binary pronouns but not to the binary pronouns since the latter don't require habituation. Standardized values of Experience (with non-binary pronouns) and Attitude (towards non-binary pronouns) were also added as fixed effects. Participant and Text Version were added as random effects. The best fitting model was selected using the backward stepwise model selection strategy, starting with the full model, and then systematically removing any factors that did not contribute to the model fit. In these analyses, masculine pronouns were treated as the reference category for Pronoun Gender, and subject pronouns were treated as the reference category for Grammatical Function on the intercept of the models. In order to analyze any significant interaction effects, post hoc tests were executed by analyzing simple effects with estimated marginal means with a multivariate *t* adjustment.

To analyze the processing of the finite verbs following the critical subject pronouns, an additional ROI analysis with linear mixed-effect models was performed to the standardized values of the average ERP amplitudes per trial. These analysis included the factors Pronoun Gender and Sentence Number, as well as their interaction, as fixed effects. Standardized values of Experience and Attitude were also added as fixed effects, and Participant and Text Version were added as random effects. The same backward stepwise selection strategy was applied to select the best fitting model. In these analyses, the masculine pronoun gender was treated as the reference category. In order to analyze any significant interaction effects, post hoc tests were executed by analyzing simple effects with estimated marginal means with a Tukey adjustment.

Since this study collected a limited amount of reliable data, fitting the full models turned out to be impossible. The best fitting models for the ROI analysis of the pronouns included the interaction between Pronoun Gender and Grammatical Function, the interaction between Pronoun Gender and Sentence Number, and standardized scores of Experience and Attitude as fixed effects, and Participant as random intercept. For the verb stimuli, the best fitting models for the Nref and N400 components included Pronoun Gender, Sentence Number and standardized values of Experience as fixed effects and Participant as random intercept. For the P600 component, the best fitting model only included Pronoun Gender and standardized values of Attitude as fixed effects, and no random intercepts since this resulted in a singular fit. This could possibly be explained by the exclusion of one participant for this particular analysis, or the limited amount of data that was collected from the verb stimuli in general.

3. Results

3.1. Behavioral results

3.1.1. Control and background questions

None of the participants had read the original text that the stimuli were based on before, nor did any of the participants know anyone with one of the surnames of the characters in the text. All fourteen participants were familiar with the gender identity 'non-binary'. No participants indicated that they prefer to be referred to with non-binary pronouns. When asked to indicate

their proficiency levels in other languages that they knew on a scale of 1 (beginner) to 7 (native speaker), all participants indicated to know the English language with a proficiency level of at least 4 (M = 5.7). Most participants also gave English as their answer when asked about other languages in which they occasionally hear or read (N = 12, 85.7%), or use (N = 9, 64.3%) non-binary pronouns. One participant indicated to also use non-binary pronouns in French. Finally, self-reported difficulty with reading sentences with non-binary *hen* and *hun* was significantly higher at the start of the experiment (M = 4.5, SD = 1.5) than at the end of the experiment (M = 2.9, SD = 1.4), $t(13) = 4.1$, $p = .001$.

3.1.2. Experience questions

All fourteen participants were familiar with the fact that *hen* and *hun* can be used to refer to people with a non-binary gender identity, prior to participating. Less than half (N = 6, 42.9%) of the participants indicated to have read a text that used *hen* and *hun* to refer to people with a non-binary gender identity before. Most participants (N = 10, 71.4%) indicated to know at least one person that prefers others to use non-binary pronouns to refer to them. Further, when asked how often participants use, hear, and read non-binary *hen* and *hun* in their daily lives on a scale of 1 (never) to 5 (very often), participants mainly indicated to (almost) never use the pronouns (M = 2.1, SD = 1.0), and almost never or occasionally hear (M = 2.4, SD = 0.9) and read the pronouns (M = 2.6, SD = 0.8).

3.1.3. Attitude questions

The acceptability ratings (1 to 7) of the sentence *Hen haalt hun schouders op* 'Them shrugs their shoulders' were diverse, with the range of responses covering the entire scale (M = 4.4, SD = 2.1). General attitudes toward *hen* and *hun* as non-binary pronouns (1 to 7) were also quite divided, with responses ranging from 2 to 7, but overall more positive (M = 5.4, SD = 1.7).

3.2. EEG results

This section reports the results from each of the ROI analyses for the pronoun and verb stimuli, as well as post hoc pairwise comparisons. An overview of the output for each of the models can be found in Appendix C.

3.2.1. Nref results pronoun stimuli

There was a significant main effect of Pronoun Gender (β = -0.35, SE = 0.16, t = -2.24, p = .026), where Nref amplitudes were generally more negative in the non-binary gender condition compared to the masculine gender condition. Further, there was a significant interaction effect between Pronoun Gender and Grammatical Function (β = 0.53, SE = 0.18, t = 2.96, p = .003), where the difference in Nref amplitude between object and subject pronouns was different in the non-binary gender condition compared to the masculine gender condition. Post hoc pairwise comparisons indicated that object pronouns significantly differed from subject pronouns in the non-binary gender condition ($t(1208) = 3.61$, p = .004) but not in the masculine gender condition. The difference between possessive pronouns and object pronouns in the non-binary

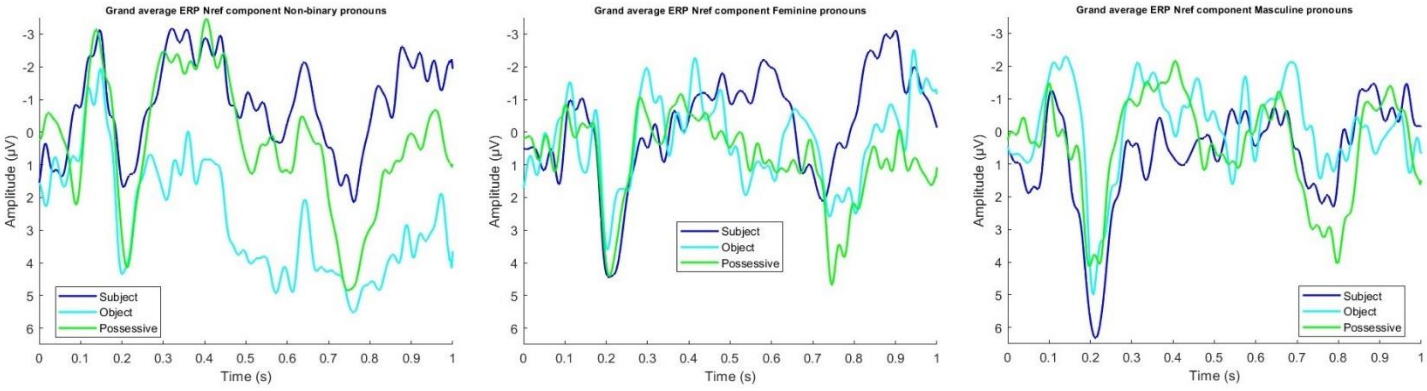
gender condition (t(1209) = -2.47, p = .128), as well as the differences between the non-binary and masculine gender conditions (t(1208) = 2.54, p = .108) and the feminine and non-binary conditions (t(1208) = -2.29, p = .197) for object pronouns, also yielded high t-values but did not reach statistical significance (p > .05). As can be seen in Figure 1 below, the Nref was generally more negative in the non-binary condition compared to masculine and feminine conditions, but only for the subject and possessive pronouns. This implies that non-binary subject and possessive pronouns are harder to process than the binary subject and possessive pronouns. Further, the Nref was more negative for non-binary subject and possessive pronouns than for non-binary object pronouns, indicating that non-binary subject and possessive pronouns evoked more processing difficulty than non-binary object pronouns.

3.2.2. N400 results pronoun stimuli

There was a significant main effect of Pronoun Gender (β = -0.33, SE = 0.15, t = -2.13, p = .034), where N400 amplitudes were generally more negative in the non-binary gender condition compared to the masculine condition. Further, there was a significant interaction effect between Pronoun Gender and Grammatical Function (β = 0.65, SE = 0.18, t = 3.65, p < .001), where the difference in N400 amplitude between object and subject pronouns was different in the non-binary gender condition compared to the masculine gender condition. Post hoc pairwise comparisons indicated that for the non-binary gender condition object pronouns significantly differed from subject pronouns (t(1208) = 4.08, p < .001), and possessive pronouns significantly differed from object pronouns (t(1209) = -3.59, p = .004). These differences were not found for the masculine gender condition. Pairwise comparisons also indicated that the feminine gender condition significantly differed from the non-binary gender condition for object pronouns (t(1209) = -3.06, p = .024). The differences between the non-binary and the masculine gender conditions for object pronouns (t(1209) = 2.70, p = .069) as well as for subject pronouns

Figure 1

Grand Average ERPs for the Nref Component of the Pronoun Stimuli in Each of the Gender Conditions



Note. From left to right, plots present the non-binary, feminine and masculine gender conditions respectively. Grammatical function is represented by dark blue for subject, cyan for object and green for possessive pronouns. Horizontal axes represent time in seconds relative to the onset of the pronoun stimuli. Vertical axes represent grand average ERP amplitudes in microvolt.

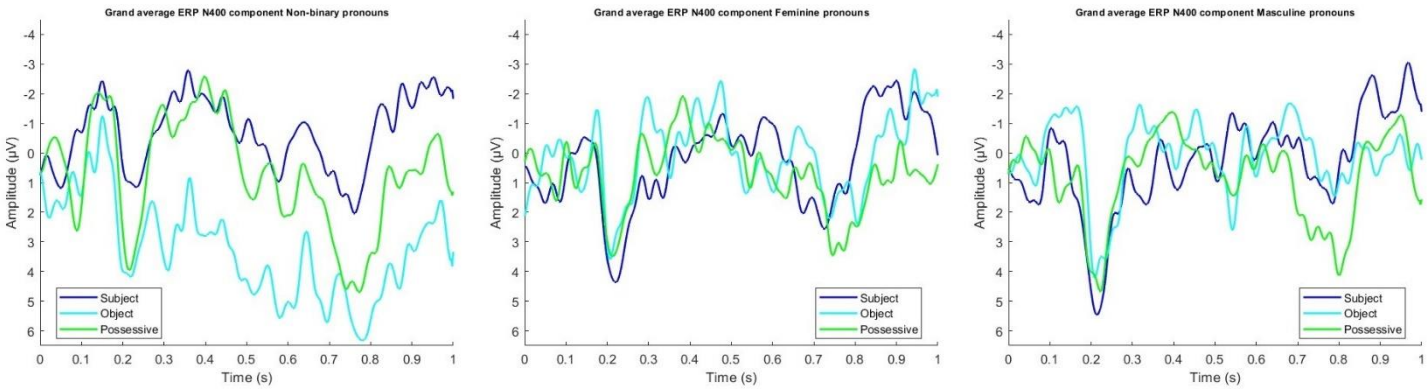
(t(1209) = -2.45, p = .135) also yielded high t-values but did not reach statistical significance (p > .05). As can be seen in Figure 2 below, N400 amplitudes were generally more negative in the non-binary condition compared to the masculine and feminine conditions, but only for the subject and possessive pronouns. The N400 for the non-binary object pronouns is more positive compared to masculine and feminine object pronouns. This implies that non-binary subject and possessive pronouns are harder to process than the binary subject and possessive pronouns, and that the non-binary object pronouns are easier to process than the binary object pronouns.

3.2.3. P600 results pronoun stimuli

The analysis did not show any significant main effects for the P600 component. There was a significant interaction effect between Pronoun Gender and Grammatical Function (β = -0.47, SE = 0.19, t = -2.51, p = .012), where the difference in P600 amplitude between object and subject pronouns was different in the feminine gender condition compared to the masculine gender condition. Post hoc pairwise comparisons indicated that the feminine gender condition significantly differed from the non-binary gender condition for object pronouns (t(1122) = -3.39, p = .008). The differences between object pronouns and subject pronouns in the non-binary gender condition (t(1122) = 2.69, p = .073) and in the feminine gender condition (t(1122) = -2.21, p = .229), as well as the difference between possessive pronouns and object pronouns in the feminine gender condition (t(1123) = 2.11, p = .284), also yielded high t-values but did not reach statistical significance (p > .05). As can be seen from Figure 3 below, P600 amplitude was more negative for feminine object pronouns compared to masculine and non-binary object pronouns, as well as feminine subject and possessive pronouns. This implies that feminine object pronouns are syntactically easier to process, both compared to non-binary and masculine object pronouns as well as the other feminine pronouns. The figure also shows that the P600 amplitude was more positive for non-binary object pronouns compared to non-binary subject

Figure 2

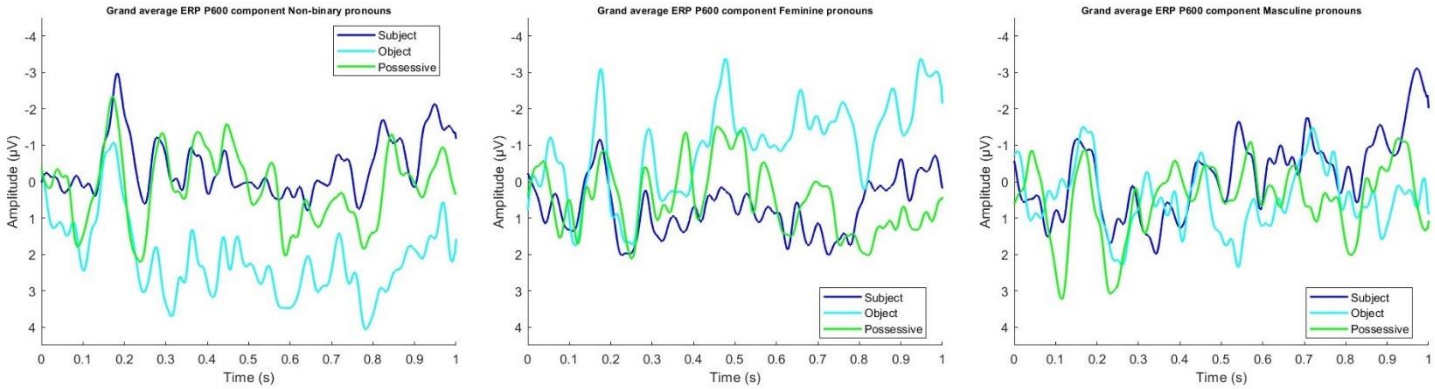
Grand Average ERPs for the N400 Component of the Pronoun Stimuli in Each of the Gender Conditions



Note. From left to right, plots present the non-binary, feminine and masculine gender conditions respectively. Grammatical function is represented by dark blue for subject, cyan for object and green for possessive pronouns. Horizontal axes represent time in seconds relative to the onset of the pronoun stimuli. Vertical axes represent grand average ERP amplitudes in microvolt.

Figure 3

Grand Average ERPs for Pronoun Stimuli P600 Component in all Gender Conditions



Note. From left to right, plots present the non-binary, feminine and masculine gender conditions respectively. Grammatical function is represented by dark blue for subject, cyan for object and green for possessive pronouns. Horizontal axes represent time in seconds relative to the onset of the pronoun stimuli. Vertical axes represent grand average ERP amplitudes in microvolt.

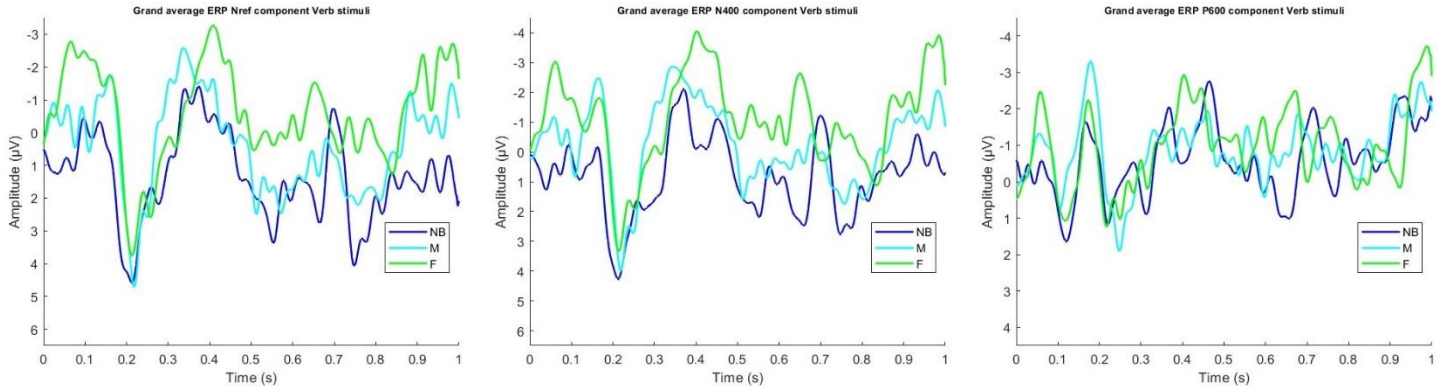
pronouns, implying that non-binary object pronouns are syntactically more difficult to process than non-binary subject pronouns.

3.2.4. Results verb stimuli

For the verb stimuli, no significant effects were found for the N400 and P600 analyses. In the Nref analysis, a main effect of Sentence Number was found (β = -0.005, *SE* = 0.002, *t* = -2.08, *p* = .038), implying that Nref amplitudes became more negative as the experiment progressed, contrary to what was expected. Figure 4 below presents the Nref, N400 and P600 amplitudes for the verb stimuli in each of the Pronoun Gender conditions.

Figure 4

Grand Average ERPs for Verb Stimuli ROI Components



Note. From left to right, plots present the Nref, N400 and P600 components respectively. Gender conditions are represented by NB for non-binary (dark blue), M for masculine (cyan), and F for feminine pronouns (green). Horizontal axes represent time in seconds relative to the onset of the verb stimuli. Vertical axes represent grand average ERP amplitudes in microvolt.

4. Discussion

In this study, an EEG experiment was conducted among native Dutch young adults who read a text that included the non-binary pronouns *hen* and *hun*. The aim of this experiment was to study how these recently introduced non-binary pronouns are processed compared to masculine and feminine pronouns. To this end, Nref, N400, and P600 components for the non-binary pronouns, as well as the finite verbs following non-binary subject pronouns, were compared to the same components for the masculine and feminine pronouns and the finite verbs following these subject pronouns.

4.1. Non-binary versus binary pronouns

The overall expectation was that the non-binary pronouns are processed differently from the masculine and the feminine pronouns. More specifically, it was expected that ERP effects would be found in all three ROIs for the non-binary pronouns as compared to the binary pronouns, indicating processing difficulty when reading non-binary *hen* and *hun*.

The results show both an Nref effect and an N400 effect for non-binary pronouns compared to binary pronouns, implying that the non-binary pronouns elicit a processing difficulty. This is in line with what was expected and with results from several studies that found processing costs for non-binary pronouns (Chen et al., 2021; Foertsch & Gernsbacher, 1997; Prasad & Morris, 2020; Vergoossen et al., 2020). One could argue, however, that in three of these studies processing costs were only found for gendered referents, whereas the current study found this effect for referents that were ambiguous in gender. Foertsch and Gernsbacher found a processing cost for gendered nouns but not for neutral or indefinite nouns, and Prasad and Morris only found a processing cost for gendered names but not for non-referential antecedents and antecedents ambiguous in gender. In Chen et al. non-binary pronouns only referred to gendered names, and they found a P600 effect for singular *they* as well as for a gender mismatch between a binary pronoun and a gendered name indicating a similar integration difficulty for these two contexts. In these studies, the non-binary pronouns referring to gendered antecedents create a context where the pronoun can only be interpreted as one with non-binary reference. In sentences with ambiguous, neutral, or non-referential antecedents no processing costs were found, which is likely due to singular *they* being a widely accepted generic pronoun in the English language (Balhorn, 2004; Noll et al., 2018). This explanation is supported by the Nref results from Chen et al., which show that a gender mismatch between a binary pronoun and a gendered name hinders pronoun resolution, but the use of singular *they* to refer to a gendered name does not. There is less of a processing cost, because there is an alternative correct interpretation readily accessible for these sentences. This is an important difference with the current study, that should be taken into account when interpreting the different results. In the current study, the non-binary pronouns evoke only non-binary reference since non-binary *hen* in Dutch cannot be used for generic reference and was specifically introduced to the language to refer to individuals with a non-binary gender identity. The current study shows that the non-binary pronouns in Dutch evoke a processing cost that is also found in English sentences where singular *they* specifically denotes a non-binary referent (Chen et al., 2021; Prasad & Morris, 2020; Vergoossen et al., 2020).

However, Vergoossen et al. (2020) report an opposite finding. They found a processing cost for the Swedish non-binary pronoun *hen*, but this processing cost was larger when it referred to neutral nouns than when it referred to gendered nouns. Vergoossen et al. briefly discuss that this finding could be explained by the fact that *hen* can also be used generically, like with singular *they* in English. What is interesting with this study by Vergoossen et al., is that the non-binary pronoun that was investigated (Swedish *hen*) was only recently introduced to the language as a new pronoun, like the Dutch non-binary pronoun. However, unlike the Dutch non-binary pronoun, Swedish *hen* was introduced as a new pronoun for non-binary as well as generic reference. The larger processing cost that Vergoossen et al. found for the neutral referents could be explained by the fact that in these sentences the interpretation and processing of Swedish *hen* is complicated even further by creating a context where it could be interpreted in two different ways. In sentences where Swedish *hen* was used to refer to gendered antecedents, the processing cost is decreased as it can only be interpreted as a non-binary pronoun rather than both a non-binary pronoun and a generic pronoun for neutral nouns. In other words, it is likely that the results from Vergoossen et al. reflect more general integration difficulties with the new pronoun that are amplified in contexts where there are multiple possible interpretations, whereas the opposite seems to be true in English since these same contexts create an additional and more accessible interpretation for singular *they* (i.e., a generic interpretation). This ties in with the current results for non-binary *hen* in Dutch, suggesting that the combination of the non-binary pronouns being relatively new to the language (like Swedish *hen* in Vergoossen et al.) and the fact that this pronoun could only be interpreted as a non-binary pronoun (like in the gendered antecedent conditions in Chen et al., 2021, Foertsch and Gernsbacher, 1997, and Prasad and Morris, 2020) causes a processing cost related to interpretation difficulties and the pronoun not yet being integrated into the language.

While the current study found Nref and N400 effects for non-binary pronouns compared to binary pronouns in line with what was expected, no P600 effect was found. Since P600 effects are generally found for processing difficulties related to syntactic violations and grammatical anomalies (Chen et al., 2021; Luck, 2012; Nieuwland, 2014), it is remarkable that the non-binary pronouns in the current study do not seem to evoke such effects. All the more so considering results from Prasad and Morris (2020) and Chen et al. (2021), that present a P600 effect for the non-binary pronoun in English. In addition to expectations regarding the pronouns themselves, it was expected that the finite verbs following a non-binary subject pronoun would elicit a greater P600 as compared to the same verbs following a masculine or a feminine subject pronoun. No effects of Pronoun Gender were found in any of the ROI analyses for the verb stimuli either. One possible explanation is that the processing cost for non-binary pronouns in general is not caused by syntactic integration difficulties from ungrammatical constructions (i.e., *hen* being used as a subject in combination with a singular finite verb). While the non-binary subject pronoun and the finite verb following it do result in grammatical anomalies, the non-binary object and possessive pronouns do not. This could explain why no P600 effect was found for the non-binary pronouns across grammatical functions, and suggests that the processing cost that was found for the non-binary pronouns is caused by the fact that these pronouns are not fully integrated into the language and cause interpretation difficulties.

4.2. Non-binary subject pronouns versus non-binary object pronouns

In addition to examining the difference between non-binary and binary pronouns in general, another aim of this study was to investigate whether non-binary *hen* is processed differently as an object and as a subject. It was expected that P600 amplitudes would be more positive for *hen* as a subject as compared to *hen* as an object, since *hen* already exists in Dutch as a plural object pronoun but not as a subject pronoun.

The results do not support this expectation. Although not significant, the non-binary object pronouns even elicited more a positive P600 than the non-binary subject pronouns. However, the results did show a significant difference in both Nref and N400 amplitudes between non-binary object pronouns and non-binary subject pronouns. The subject pronouns elicited more negative Nref and N400 amplitudes than the object pronouns, indicating that the non-binary subject pronouns evoked more processing difficulties with regard to pronoun resolution and integration. These results are in line with what was expected, since they indicate that the non-binary subject pronouns do seem to be harder to process than the non-binary object pronouns. However, since this difference was not found for the P600 amplitudes of the different pronoun functions, nor for any of the analyses for the verb stimuli, the current results cannot confirm the hypothesis that the non-binary subject pronoun *hen* elicits a processing cost related to grammatical anomalies.

While this could imply that the Dutch non-binary pronouns only cause processing costs related to integration and interpretation difficulty, it is important to note several other surprising results. Results from the post hoc analyses show a trend across ROIs where ERP amplitudes were in general more negative for binary object pronouns compared to non-binary object pronouns. These differences even reached significance for feminine object pronouns compared to non-binary object pronouns in the N400 and P600 analyses. Technically, these results would suggest an N400 effect indicating that feminine object pronouns evoke more processing difficulty than non-binary object pronouns, and a P600 effect indicating that non-binary object pronouns evoke more processing difficulty related to grammatical anomalies than feminine object pronouns. These results are not in line with what would be expected, as the binary pronouns should not evoke any processing cost at all and the non-binary object pronouns do not violate syntactic rules (*hen* is an existing object pronoun in Dutch). The results further show unexpected trends for the feminine pronouns in the P600 analyses, where the P600 amplitudes are more positive for possessive pronouns than for subject pronouns, which in turn are more positive than those for object pronouns. While these trends did not reach significance, in combination with the unexpected P600 effect that was found for the feminine object pronouns as compared to the non-binary object pronouns they do suggest some unwanted interference from the object pronouns in the P600 component. This could possibly be caused by the stimuli used in the experiment. While the naturalistic stimuli are one of the strengths of the current study, they also have the important downside that the different grammatical functions were not presented an equal number of times. From the three grammatical function conditions, the object pronouns were represented by the lowest amount of stimuli (7 stimuli for each gender condition, in contrast to 10 possessive pronouns and 13 subject pronouns in each gender condition). This, in combination with the relatively low number of participants included in the final analyses, should be taken into account when interpreting these results.

Overall, these results suggest a processing cost for non-binary subject pronouns compared to non-binary object pronouns related to pronoun resolution and interpretation difficulty. This could be explained by the fact that *hen* exists as a third-person plural object pronoun, but is also used in a new context, as a third-person singular subject pronoun when referring to non-binary antecedents. By contrast, the results do not support the expectation that non-binary subject pronouns evoke a processing cost that is related to the syntactic violations of *hen* being used as a subject in combination with a singular finite verb. Most importantly, however, these results should be interpreted with caution. Future studies should collect more data in order to further examine which factors underlie the differences between non-binary and binary pronoun processing in Dutch.

4.3. Experience and attitude

The current study further aimed to examine whether readers' experience with the non-binary pronouns, or attitude toward the use of *hen* and *hun* to refer to people with a non-binary gender identity, would influence how these pronouns are processed. It was expected that a higher level of experience with non-binary *hen* and *hun* would result in lower processing costs.

The results show no significant effect of Experience or Attitude in any of the ROI analyses, indicating that neither participants' self-reported experience with non-binary *hen* and *hun* nor their attitudes toward these pronouns influenced the amount of processing difficulty. These results are in line with results from Prasad and Morris (2020), which showed that participants with a non-binary gender identity and participants that frequently use or are exposed to non-binary pronouns still showed a processing cost when reading non-binary pronouns referring to names that elicit gender associations. Note that participants in the study by Prasad and Morris did not show a processing cost when non-binary pronouns referred to antecedents that were ambiguous in gender. The current study only included referents with surnames that could not evoke gender associations with the readers, making these stimuli more comparable to the ambiguous gender referents in the Prasad and Morris study. A big difference, however, is that the non-binary reflexive pronoun used in Prasad and Morris (*themselves*) is an established generic pronoun in English whereas *hen* and *hun* in Dutch are not. This explains why Prasad and Morris did not find processing costs in sentences like 'The stranger poured themselves a cup of coffee'. This is a correct sentence for all proficient English speakers (Foertsch & Gernsbacher, 1997), regardless of their experience with non-binary gender identities and non-binary pronouns. In the current study, the non-binary pronouns could only be interpreted with non-binary reference, just like in the sentences where *themselves* referred to gendered names in the Prasad and Morris study. As is evident from the current results, these sentences elicit processing difficulties regardless of participants' experience with the non-binary pronouns, in line with the results from Prasad and Morris.

Still, it was initially hypothesized that more experience with non-binary pronouns and a more positive attitude towards these pronouns would result in a decrease of processing difficulty. These hypotheses were not confirmed. It could be argued that the measures that were taken for experience and attitude could be more elaborate. The variable Experience included five measures of which one only had two response options. The variable Attitude included only two measures, of which one very general measure of overall attitude toward non-binary *hen*

and *hun* and one measure of acceptability of these pronouns in a sentence. Based on this, it is plausible that these variables did not measure experience and attitude as accurately as what was aimed for. In future studies, more elaborate and accurate measures of experience and attitude should be created in order to see whether the current finding that experience and attitude do not influence the processing of non-binary pronouns can be replicated.

4.4. Habituation

Based on results from Nieuwland and van Berkum (2006) regarding adaptation to animacy violations in stories, it was expected that participants in the current study would show habituation to the non-binary pronouns in the form of a decrease in processing cost as they were exposed to the pronouns more throughout the experiment.

The results show no main effects from Sentence Number nor any significant interaction effects between Sentence Number and Pronoun Gender for the pronoun stimuli. This indicates that more exposure to the pronouns throughout the text did not influence how the pronouns in any of the gender conditions were processed. This contradicts results that were found for inanimate objects that are treated as though they were animate in a story (Nieuwland and Van Berkum, 2006). While this animacy violation initially evoked an N400 effect, the effect decreased as the story unfolded indicating habituation and adaptation to the story-specific context. However, this habituation effect was not found for *hen* and *hun* referring to singular non-binary antecedents in the current study.

Remarkably, the results do show an Nref effect of Sentence Number for the verb stimuli. Overall, Nref amplitudes became more negative as the experiment progressed, which implies that the processing difficulty for finite verbs following subject pronouns increased as participants were exposed to these verbs more. Not only does this finding contradict what was initially expected for the verbs in the non-binary gender condition, it is highly unexpected for the verbs in the binary gender conditions. Whereas the singular finite verbs following non-binary subject pronouns create an ungrammatical sentence, the same verbs following binary subject pronouns are not unexpected or ungrammatical in any way. Since the final ROI analysis models for the verb stimuli did not include an interaction between sentence number and pronoun gender, it is unknown whether or not this effect appeared in all three gender conditions equally. It is possible that this effect is very strong for the non-binary condition but not as evident for the binary gender conditions. In that case, this unexpected effect could be explained as increased difficulty with pronoun resolution or sentence interpretation toward the end of the text due to unexpected singular verbs following *hen*. The effect of sentence number on verb processing was only found in the Nref analysis. This suggests that additional processing was required to determine the correct reference of the pronouns upon encountering the finite verbs toward the end of the text, similar to how an Nref effect occurs when pronoun resolution is complicated by, for example, a gender mismatch between pronoun and referent (Chen et al., 2021; Nieuwland, 2014). Even though non-binary the non-binary pronoun was presented multiple times in combination with singular verbs which would make this combination less unexpected toward the end of the text, the second to last paragraph includes three occurrences of possessive pronoun *hun* to refer to a plural antecedent (see paragraph 8 of the stimulus text in Appendix A). This could lead to increased unclarity regarding pronoun reference, since *hen* and *hun* could

refer to both a singular non-binary antecedent as well as a plural antecedent. Encountering the singular verbs following non-binary *hen* in this paragraph would therefore require additional processing to resolve pronoun reference, resulting in an Nref effect.

Interestingly, participants' self-reported difficulty with reading sentences with non-binary pronouns was significantly lower for the end of the text compared to the difficulty scores for the beginning of the text. In other words, while the EEG results indicate that processing difficulty for non-binary pronouns did not decrease – or even increased – throughout the experiment, the behavioral results suggest participants experienced the opposite. This could possibly be explained by the length of the text in the current experiment. While the non-binary pronouns were presented relatively frequently throughout the text, there were only three short paragraphs where readers encountered these pronouns. This amount of exposure is possibly insufficient to evoke habituation effects in subconscious processing as more exposure might be necessary for these new pronouns to be integrated into everyday language processing (compare pronoun grammaticalization, Heine & Song, 2011). However, this amount of exposure might be enough for readers to become habituated to the idea and use of the non-binary pronouns which could be reflected in the self-reported reading difficulty scores. Although it should be noted that these self-reported scores are highly sensitive to participants' personal attitudes and possibly even desired responses, making these scores in general less reliable as a measure of processing difficulty compared to EEG data representing unconscious language processing. Future studies could investigate whether the amount of exposure indeed influences habituation effects, by increasing the amount of non-binary pronoun occurrences that participants are exposed to within the experiment.

Alternatively, assuming that non-binary *hen* and *hun* will continue to be used to refer to individuals with a non-binary gender identity, future studies could investigate whether the current results can be replicated several years from now. The non-binary pronouns are still relatively new and have not been fully integrated into the language which explains why participants show sustained processing difficulties upon encountering these pronouns. However, as Noll et al. (2018) showed for generic *he* and *they* in English, processing of non-binary *hen* and *hun* might change over time as they are used more and possibly are considered more acceptable than they are currently. Chen et al. (2021) present similar results, where older students at a school where non-binary pronouns are actively being used show a smaller processing cost as compared to younger students from the same school who had not yet been exposed to the non-binary pronouns as much. Based on these results, it could be expected that more long-term exposure to non-binary *hen* and *hun* will result in a decrease in processing difficulty as a result of habituation.

4.5. Participant gender and age

While the current study did not aim to investigate possible influences from participants' gender identities on how they process non-binary *hen* and *hun*, it is important to discuss findings from Redl et al. (2021) that suggest that participant gender can in fact influence pronoun processing. Redl et al. found that the Dutch generic masculine possessive pronoun is interpreted differently depending on participants' gender. This generic pronoun, when used to refer to a stereotypically gender-neutral antecedent, caused a male bias in male participants but not female participants,

suggesting that male participants processed and interpreted the generic pronoun differently from female participants. However, an important difference between the generic pronouns in the Redl et al. study and the non-binary pronouns in the current study is that the generic pronoun can be used and interpreted as a gendered (masculine) pronoun whereas the non-binary pronouns cannot. In other words, the generic pronoun could evoke a gender association which could explain a gender bias, while the non-binary pronouns cannot evoke such an association or bias. This is why the possible influence from participant gender on non-binary pronoun processing was not investigated in the current study. Still, the results from Redl et al. reveal an interesting factor that should be considered in future non-binary pronoun processing research.

Another factor that might influence non-binary pronoun processing is participants' age. Chen et al. (2021) show that an increase in age resulted in a decrease in processing difficulty for singular *they* in their study. As discussed in the previous section, this age effect is likely related to the amount of exposure and adaptation to the use of singular *they* for non-binary reference. These results suggest that older participants were exposed to the non-binary pronouns more, which in turn resulted in a decrease in processing difficulty. This is why the current study controlled for participant gender by only recruiting participants between the ages of 18 and 30 years old. It could be expected that participants older than 30 years have been exposed to non-binary *hen* and *hun* less than younger participants since these non-binary pronouns are so new to the language. Future studies should examine whether differences can be found between older and younger participants in how they process the non-binary pronouns, and whether this could be related to the amount of exposure.

4.6. Conclusion

The current study presents some initial results regarding the processing of the non-binary pronouns that were relatively recently introduced to the Dutch language. These results indicate a general processing cost for non-binary pronouns that can be related to the interpretation difficulties that arise when *hen* is used to refer to a singular non-binary antecedent. While it was expected to find additional processing costs related to the syntactic violations that arise when *hen* is used as a subject pronoun in combination with a singular finite verb, the results do not support this. Expectations regarding influences from participants' experience with and attitude towards the non-binary pronouns, or from short-term habituation to the non-binary pronouns on how they were processed were not supported. Overall, it should be noted that results presented in the current study should be interpreted with caution. In a continuation of this study more data should be collected to examine whether the processing cost caused by interpretation difficulties that were found can be replicated. Future research should further investigate how the non-binary pronouns *hen* and *hun* are processed, and whether and how different factors can influence this, to gain a better understanding of how these newly introduced pronouns are processed.

References

Balhorn, M. (2004). The Rise of Epicene They. *Journal of English Linguistics*, *32*(2), 79–104. https://doi.org/10.1177/0075424204265824

Chen, P., Leventhal, O., Camilliere, S., Izes, A., & Grodner, D. J. (2021). *Singular they in transition: ERP evidence and individual differences* [Paper presentation]. 34th Annual CUNY Conference On Human Sentence Processing. https://works.swarthmore.edu/fac-psychology/1152

de Hoop, H. (2020). Het verlies van een persoonlijk voornaamwoord: Waarom hun straks geen *hun* meer zeggen. *Nederlandse Taalkunde*, *25*(2), 355–362. https://doi.org/10.5117/NEDTAA2020.2-3.018.DEHO

de Weerd, F. (2023, January 30). *Queers in Kyiv teleurgesteld in hun westerse vrienden: 'Duitsers gingen mij uitleggen hoe het écht zat in Oekraïne'.* De Volkskrant. https://www.volkskrant.nl/cultuur-media/queers-in-kyiv-teleurgesteld-in-hun-westerse-vrienden-duitsers-gingen-mij-uitleggen-hoe-echt-het-zat-in-oekraine~bc3e7258/

Foertsch, J., & Gernsbacher, M. A. (1997). In Search of Gender Neutrality: Is Singular *They* a Cognitively Efficient Substitute for Generic *He*? *Psychological Science*, *8*(2), 106–111. https://doi.org/10.1111/j.1467-9280.1997.tb00691.x

Frank, S. L., Otten, L. J., Galli, G., & Vigliocco, G. (2015). The ERP response to the amount of information conveyed by words in sentences. *Brain and Language*, *140*, 1–11. https://doi.org/10.1016/j.bandl.2014.10.006

Heine, B., & Song, K.-A. (2011). On the grammaticalization of personal pronouns. *Journal of Linguistics*, *47*(3), 587–630. https://doi.org/10.1017/S0022226711000016

Khachatryan, E., Brouwer, H., Staljanssens, W., Carrette, E., Meurs, A., Boon, P., Van Roost, D., & Van Hulle, M. M. (2018). A new insight into sentence comprehension: The impact of word associations in sentence processing as shown by invasive EEG recording. *Neuropsychologia, 108,* 103-116. https://doi.org/10.1016/j.neuropsychologia.2017.12.002

Luck, S. J. (2012). Event-related potentials. In H. Cooper, P. M. Camic, D. L. Long, A. T. Panter, D. Rindskopf, & K. J. Sher (Eds.), *APA handbook of research methods in psychology, Vol 1: Foundations, planning, measures, and psychometrics.* (pp. 523–546). American Psychological Association. https://doi.org/10.1037/13619-028

Nieuwland, M. S. (2014). "Who's he?" Event-related brain potentials and unbound pronouns. *Journal of Memory and Language*, *76*, 1–28. https://doi.org/10.1016/j.jml.2014.06.002

Nieuwland, M. S., & Van Berkum, J. J. A. (2006). When Peanuts Fall in Love: N400 Evidence for the Power of Discourse. *Journal of Cognitive Neuroscience*, *18*(7), 1098–1111. https://doi.org/10.1162/jocn.2006.18.7.1098

Noll, J., Lowry, M., & Bryant, J. (2018). Changes Over Time in the Comprehension of He and They as Epicene Pronouns. *Journal of Psycholinguistic Research*, *47*(5), 1057–1068. https://doi.org/10.1007/s10936-018-9577-4

Oostenveld, R., Fries, P., Maris, E., & Schoffelen, J.-M. (2011). FieldTrip: Open Source Software for Advanced Analysis of MEG, EEG, and Invasive Electrophysiological Data. *Computational Intelligence and Neuroscience*, *2011*, 1–9. https://doi.org/10.1155/2011/156869

Prasad, G., & Morris, J. (2020). *The P600 for singular "they": How the brain reacts when John decides to treat themselves to sushi.* [Preprint]. PsyArXiv. https://doi.org/10.31234/osf.io/hwzke

R Core Team (2022). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/

Redl, T., Frank, S. L., De Swart, P. & de Hoop, H. (2021). The male bias of a generically intended personal pronoun in language processing. *PhD thesis*.

Speyer, L. G., & Schleef, E. (2019). Processing 'Gender-neutral' Pronouns: A Self-paced Reading Study of Learners of English. *Applied Linguistics*, *40*(5), 793–815. https://doi.org/10.1093/applin/amy022

TNN. (2016a, May 9). *Verkiezing van het non-binaire voornaamwoord*. Transgender Netwerk Nederland. Retrieved February 20, 2023, from https://www.transgendernetwerk.nl/verkiezing-non-binaire-voornaamwoord/

TNN. (2016b, June 10). *Zo maak je na toiletten ook taal genderneutraal.* Transgender Netwerk Nederland. Retrieved February 20, 2023, from https://www.transgendernetwerk.nl/non-binair-voornaamwoord-uitslag/

van Bergen, G., Stoop, W., Vogels, J., & de Hoop, H. (2011). Leve hun! Waarom hun nog steeds hun zeggen. *Nederlandse Taalkunde*, *16*(1), 2–29. https://doi.org/10.5117/NEDTAA2011.1.LEVE468

Van Dale. (May 12, 2021). *Welk genderneutraal persoonlijk voornaamwoord gebruik je?* Retrieved February 20, 2023, from https://www.vandale.nl/genderneutraal-persoonlijk-voornaamwoord

Vergoossen, H. P., Pärnamets, P., Renström, E. A., & Gustafsson Sendén, M. (2020). Are New Gender-Neutral Pronouns Difficult to Process in Reading? The Case of Hen in SWEDISH. *Frontiers in Psychology*, *11*, 574356. https://doi.org/10.3389/fpsyg.2020.574356

Appendix A – Stimulus Materials

This appendix presents version 1 of the written text that was presented word by word in the EEG experiment, including the short introductory paragraph and subsequent practice question. The pronoun stimuli are marked in bold, and the verb stimuli are underlined. The gender of the character that is featured in a paragraph is presented next to the paragraph number, with the labels F for female, M for male, and NB for non-binary. The other versions of the text were created by only changing the gender of the critical pronouns in each paragraph (see Table 3 in Methods). Following each paragraph, a statement is presented in italics, for which participants had to indicate whether it was correct or incorrect.

Intro – Oekraïense en westerse queers vonden elkaar jarenlang in de Berlijnse techno-clubscene. Hoe kan het dat de liefde is bekoeld, net nu het door de oorlog zo hard nodig is?

PracticeQ – De tekst gaat over westerse queers in Berlijn en Oekraïne.

1 [F] – Zakrevska zit gespannen in **haar** minimalistisch ingerichte woonkamer in Berlijn. De 30-jarige Oekraïense techno-dj kiest **haar** woorden voorzichtig. Het is alsof **ze** aftast hoe eerlijk **ze** kan zijn tegen de Nederlandse journalist tegenover **haar** aan **haar** koffietafel. **Ze** vertelt dat **ze** hier alleen is omdat **ze** vanuit Berlijn het meeste kan doen voor **haar** familie en **haar** land. 'Maar het liefst wil ik hier helemaal niet zijn', zegt **ze** met een stem vol ingehouden woede. Sinds de Russische invasie zijn veel Oekraïners uit de queerscene naar Berlijn gevlucht, de stad die bekendstaat om zijn clubcultuur, het hoge aantal lhbti'ers en linkse activisten.

Q1 – Zakrevska woont momenteel in Berlijn, maar wil daar het liefst helemaal niet zijn.

2 [M] – De 28-jarige Bakhin uit Oekraïne zit samen met **zijn** Duitse vriend in Berlijn aan de keukentafel. Als de journalist **hem** een aantal vragen stelt over het Oekraïense queerleven, vertelt **hij** dat er in een queerclub in Kyiv, genaamd K41, naast **zijn** landgenoten ook veel Berlijners te vinden waren. 'Op een gegeven moment hoorde je bijna alleen nog maar Duits om je heen. Steeds meer Oekraïners gingen ook weekendjes naar Berlijn, het was fantastisch', vertelt **hij**. Mensen sloten er relaties en vriendschappen, ook met **hem**. **Hij** heeft **zijn** vriend daar bijvoorbeeld leren kennen.

Q2 – K41 is een queerclub in Kyiv waar ook altijd veel Berlijners kwamen.

3 [M] – Volgens Bakhin is K41 een van **zijn** lievelingsclubs, al wist je nooit zeker of je binnenkwam. Geen bewaker heeft **hem** gelukkig ooit geweigerd. Om binnen te komen, moest je je vooraf aanmelden. Bakhin herinnert zich de eerste keer dat **hij** ging nog goed, zegt **hij**. Op **zijn** telefoon laat **hij** een foto zien waarop **hij** met **zijn** vriend over straat loopt met alleen wat kinky ondergoed aan en daarover een lange jas. 'Daardoor ben ik op je gevallen', grapt **zijn** vriend tegen **hem**. Bakhin zegt over de

club: ‘Hoe vernieuwend het was, merkte je zelfs in de darkroom. Dat was geen vieze gesloten kamer, maar het was smaakvol, en iedereen vroeg overal consent, toestemming, voor.’

Q3 – K41, de queerclub waar Bakhin vaak kwam, was heel ouderwets met een vieze, gesloten dark room.

4 [NB] – Toen de oorlogsdreiging toenam, bleven de techno-toeristen komen. De 28-jarige non-binaire queeractivist Oestemenko werkte toen in K41. **Hen** weet nog dat het **hen** opviel dat niet alle bezoekers door leken te hebben wat er speelde. Om die reden nam Oestemenko **hun** spuitbus en spraypainte **hen** begin februari de woorden ‘your dancefloor is Putins battleground’ op de betonnen muren rondom het pand. Oestemenko sliep de eerste dagen na de invasie in de schuilkelder. **Hun** intentie was, zoals die van zovelen, om in **hun** thuisland te blijven en te helpen waar **hen** kon. ‘Ik kwam bij een kinderziekenhuis aan en werd weggestuurd omdat ze al te veel eten hadden’, vertelt Oestemenko. Toen begon het bij **hen** te dagen dat **hen** misschien beter kon helpen vanuit het buitenland. **Hen** besloot naar Berlijn te gaan en daar benefiet-evenementen te gaan organiseren om **hun** land te dienen. Dit leek **hen** een betere manier om zich nuttig te maken.

Q4 – Oestemenko heeft toen de oorlog in Oekraïne begonnen was, de tekst ‘your dancefloor is Putin’s battleground’ op de muur gespoten.

5 [F] – Dj Zakrevska besloot om gelijke redenen naar Berlijn te vertrekken. **Ze** vertelt dat Berlijnse queers **haar** in het begin massaal hulp aanboden. Via **haar** sociale media boden ze **haar** slaapplaatsen aan en beloofden **haar** dat ze zouden helpen met het vinden van een woning en werk. ‘Het was een warm bad van steun’, vertelt **ze**. Na enkele weken volgde echter een dip. Het gebeurde om de haverklap dat Duitsers **haar** gingen uitleggen hoe het écht zat in Oekraïne. Zo vertelt Zakrevska dat **haar** Duitse buurman **haar** uitlegde dat Oekraïne de drones uit Turkije niet moest aannemen, omdat daar ook Koerden mee waren omgebracht. **Ze** kan niet begrijpen dat sommige mensen niet inzien dat dit het verkeerde moment is om **haar** zoiets te vertellen. **Ze** is niet de enige die merkte dat er grenzen zaten aan de West-Europese solidariteit.

Q5 – Zakrevska verteld dat de Berlijnse queers van het begin af aan geen enkele hulp aanboden.

6 [NB] – Het lijkt er soms op dat links deze oorlog ingewikkeld vindt te combineren met een andere strijd, overpeinst Oestemenko. **Hen** was vroeger ook anarchist en voor **hen** is het niet raar dat queeractivisten zich in principe altijd tegenover de staat, het leger en de politie plaatsen. Dat was **hun** eigen houding vroeger ook. **Hun** mening is nu echter dat als je bestaan wordt bedreigd, je soms bondgenootschappen moet sluiten met eerdere vijanden. Linkse vrienden van **hen** posten verhalen met teksten als ‘stop talking about Ukraine, we need to talk about Iran’. **Hen** balt **hun** vuisten. ‘Het is alsof sommige mensen het te complex vinden om meer dan één goed doel te steunen’, zegt

hen. ‘Hoeveel steunbetuigingen we ook uitspreken over Iran, het lijkt niet genoeg om achter Oekraïne te gaan staan. En dat terwijl deze oorlog precies gaat over alles waar queeractivisten in theorie voor vechten’, rondt **hen** uiteindelijk **hun** betoog af.

Q6 – Linkse activisten lijken het moeilijk te vinden om meer dan één goed doel tegelijk te ondersteunen.

7 [M] – Volgens Bahkin is **hij** een van de weinigen die de verwondering en woede niet deelt. **Hij** zegt: ‘De verwachtingen waren misschien wat te hoog.’ **Hij** vertelt dat **hij** met **zijn** vriend op vakantie in Sri Lanka was toen Rusland **zijn** land binnenviel in februari 2022. Op dat moment vond er in Sri Lanka een grote humanitaire crisis plaats. Dat had impact op **hem**, maar **hij** gaf er geen gevolg aan. Daarom is het voor **hem** niet verrassend dat anderen niet alles omgooien voor **zijn** land. ‘Ik denk dat sommige Oekraïners hadden verwacht dat de Duitsers op een regenboogeenhoorn met wapens zouden komen aanvliegen’, zegt **hij**. Voor **hem** is dit niet meer dan een illusie.

Q7 – Bakhin is niet verbaasd over het feit dat de Duitsers minder betrokken zijn bij de oorlog in Oekraïne dan de mensen uit Oekraïne.

8 [NB] – Natuurlijk kun je ervoor kiezen om je verwachtingen over westerse vrienden wat bij te stellen, zegt Oestemenko weifelend. **Hen** zou er graag voor kiezen het gewoon extra te waarderen als **hen** iemand tegenkomt die **hun** land wil helpen. Maar dan denkt **hen** aan de lhbti'ers in het Oekraïense leger, die alles opgeven en hun geaardheid soms zelfs verbergen om te worden geaccepteerd door andere militairen, en neemt de woede het weer over. Het doet **hen** duidelijk veel. **Hen** haalt **hun** schouders op. In oorlogstijd laten mensen hun ware gezicht zien en in het geval van links progressief Berlijn is dat niet fraai, volgens **hen**. ‘Veel van de Berlijnse ‘activisten’ hebben nog nooit ergens voor hoeven vechten. Hun activisme is niet meer dan een lifestyle.’

Q8 – Oestemenko vindt dat links progressief Berlijn zich heel solidair, actief en strijdbaar opstelt en meevecht met Oekraïne.

9 [F] – Zakrevska is het daar roerend mee eens. ‘Natuurlijk kun je niet van iedereen verwachten dat ze met ons ten strijde trekken. Maar dit...’ **Ze** schudt **haar** hoofd. **Ze** kijkt vermoeid, maar dan breekt er een klein lachje door op **haar** gezicht. ‘Ik ben het nog niet verloren hoor. Zondag draai ik weer in K41. Overdag, vanwege de avondklok. Mijn outfit ligt al klaar’, zegt **ze**, en wijst naar een glitterende lap stof op **haar** nachtkastje.

Q9 – Dj Zakrevska gaat zondagnacht weer draaien in K41.

Appendix B – Contents of Questionnaire

This appendix presents the contents of the questionnaire that participants were presented with after the EEG experiment, in addition to three demographic questions regarding age, gender, and native language. The questions are translated to English here, but were originally presented in Dutch. Next to each question, the response options are presented.

Experience and Attitude

Responses to six questions from the questionnaire were initially taken together as a measure of overall experience with non-binary *hen* and *hun* in Dutch (questions 5, 6, 10, 11, 12 and 13, see Table B1). Note that question 4 measures whether participants are familiar with the non-binary gender identity, but does not regard familiarity with the Dutch non-binary pronouns. Additionally, questions 16 and 17 measure experience with non-binary pronouns, but specifically about experience with such pronouns in other languages. This is why it was decided to not include these measures in the variable of Experience with *hen* and *hun* as non-binary pronouns in Dutch. Cronbach's alpha was calculated for the six experience questions, but this resulted in a poor level of coherence ($\alpha = .54$). Removing question 6, regarding participants' experience with texts that use non-binary *hen* and *hun*, resulted in a sufficient level of coherence ($\alpha = .73$) for measuring Experience.

Responses to two other questions from the questionnaire were taken together as a measure of attitude towards non-binary pronouns in Dutch. These are questions 14 and 15 (see Table B1). Cronbach's alpha indicated a good level of coherence ($\alpha = .83$) for measuring Attitude.

Table B1

Contents of Post-experiment Questionnaire

	Question	**Response options**
1.	What other languages [besides Dutch] do you speak and how proficient are you in each of them?	7-point scale: 1 = beginner 7 = native speaker
2.	The text you have read is based on a newspaper article that appeared in the Volkskrant at the end of January this year. Did you read this article?	o Yes o No o I am not sure o I did see it but I did not read it
3.	In the text you just read, three people were interviewed. Do you personally know anyone with any of their surnames? The surnames were 'Zakrevska', 'Bakhin', and 'Oestemenko'.	o Yes, I know someone with the surname … o No

4.	In the text that you read the pronoun ‘hen’ and the possessive pronoun ‘hun’ referred to a non-binary person. Are you familiar with the gender ‘non-binary’?	o Yes o No
5.	Before this experiment, were you familiar with the fact that ‘hen’ and ‘hun’ can refer to a non-binary person?	o Yes o No
6.	Have you ever read a text before that referred to non-binary persons in this way?	o Yes o No
7.	How difficult did you find it to read the sentences with the non-binary pronouns in the text? In the beginning of the text I found these sentences....	7-point scale: 1 = very easy 7 = very difficult
8.	How difficult did you find it to read the sentences with the non-binary pronouns in the text? Toward the end of the text I found these sentences....	7-point scale: 1 = very easy 7 = very difficult
9.	With which personal pronouns would you like to be referred to?	o Hij/hem/zijn o Zij/haar/haar o Die/die/diens o Hen/hen/hun o Other, namely … o I prefer not to say
10.	How many people do you know who would like to be referred to by a non-binary pronoun?	o Nobody o One or more people I rarely or never talk to o One or more people I occasionally talk to o One or more people I regularly talk to
11.	How often do you use hen/hun as non-binary pronouns in everyday conversations?	5-point scale: 1 = never 5 = very often
12.	How often do you hear hen/hun being used as non-binary pronouns?	5-point scale: 1 = never 5 = very often
13.	How often do you read that hen/hun are used as non-binary pronouns?	5-point scale: 1 = never 5 = very often
14.	How acceptable do you find the following sentence? “Hen haalt hun schouders op” (“Them shrugs their shoulders”)	7-point scale: 1 = poor Dutch 7 = proper Dutch

15.	What is your attitude toward referring to non-binary persons with ‘hen/hun’? My attitude is… Would you please explain?	7-point scale: 1 = negative 7 = positive
16.	Do you speak one or more languages besides Dutch in which you occasionally **hear or read** non-binary or gender-neutral pronouns?	o No o Yes, namely …
17.	Do you speak one or more languages besides Dutch in which you occasionally **use** non-binary or gender-neutral pronouns?	o No o Yes, namely …

Appendix C – Output From Statistical Analyses

This appendix presents the fixed effects output from each of the ROI analyses on the pronoun stimuli (Table C1) and the verb stimuli (Table C3), as well as the output from the post hoc pairwise comparisons for the pronoun stimuli (Table C2). Pronoun gender (*pro_gender*) conditions are represented by *nb* for non-binary, *f* for feminine and *m* for masculine pronouns. Grammatical function (*gram_fun*) conditions are represented by *obj* for object, *subj* for subject and *pos* for possessive pronouns. Standardized scores are indicated with *z*. Statistically significant effects are highlighted in blue. Several high *t*-values from comparisons that did not reach significance in the post hoc analyses are highlighted in yellow.

Table C1

Output Pronoun Stimuli Analyses

		Estimate	**SE**	***t*-value**	***p*-value**
Nref	(Intercept)	1.667e-01	1.180e-01	1.413	0.15819
	pro_gender_nb	-3.516e-01	1.573e-01	-2.235	0.02558
	pro_gender_f	-2.116e-01	1.626e-01	-1.301	0.19338
	gram_fun_obj	-7.229e-02	1.278e-01	-0.566	0.57160
	gram_fun_pos	-3.559e-02	1.153e-01	-0.309	0.75761
	sentence_nr	-4.332e-03	2.526e-03	-1.715	0.08659
	experience_z	-7.348e-05	3.799e-02	-0.002	0.99848
	attitude_z	-6.815e-02	3.771e-02	-1.807	0.09145
	pro_gender_nb:gram_fun_obj	5.335e-01	1.804e-01	2.958	0.00316
	pro_gender_f:gram_fun_obj	1.570e-01	1.799e-01	0.872	0.38316
	pro_gender_nb:gram_fun_pos	1.643e-01	1.627e-01	1.010	0.31277
	pro_gender_f:gram_fun_pos	1.903e-01	1.624e-01	1.172	0.24160
	pro_gender_nb:sentence_nr	5.749e-03	3.468e-03	1.658	0.09766
	pro_gender_f:sentence_nr	2.811e-03	3.564e-03	0.789	0.43052
N400	(Intercept)	2.683e-01	1.150e-01	2.333	0.019918
	pro_gender_nb	-3.287e-01	1.545e-01	-2.128	0.033545
	pro_gender_f	-2.036e-01	1.595e-01	-1.276	0.202115
	gram_fun_obj	-1.391e-01	1.255e-01	-1.108	0.268042
	gram_fun_pos	-1.284e-01	1.133e-01	-1.134	0.257045
	sentence_nr	-3.881e-03	2.479e-03	-1.566	0.117688
	experience_z	2.483e-02	3.451e-02	0.719	0.483242
	attitude_z	-5.993e-02	3.428e-02	-1.748	0.101074
	pro_gender_nb:gram_fun_obj	6.465e-01	1.772e-01	3.648	0.000276
	pro_gender_f:gram_fun_obj	2.530e-02	1.768e-01	0.143	0.886198
	pro_gender_nb:gram_fun_pos	1.605e-01	1.598e-01	1.004	0.315635
	pro_gender_f:gram_fun_pos	6.056e-02	1.596e-01	0.380	0.704331

	pro_gender_nb:sentence_nr	2.111e-03	3.405e-03	0.620	0.535357
	pro_gender_f:sentence_nr	3.891e-03	3.494e-03	1.114	0.265612
P600	(Intercept)	-3.902e-02	1.276e-01	-0.306	0.7599
	pro_gender_nb	2.938e-02	1.661e-01	0.177	0.8596
	pro_gender_f	1.870e-01	1.701e-01	1.099	0.2718
	gram_fun_obj	1.758e-01	1.328e-01	1.324	0.1858
	gram_fun_pos	1.100e-01	1.203e-01	0.914	0.3607
	sentence_nr	-1.853e-03	2.704e-03	-0.685	0.4933
	experience_z	2.555e-02	4.386e-02	0.583	0.5699
	attitude_z	-6.735e-02	4.468e-02	-1.508	0.1547
	pro_gender_nb:gram_fun_obj	1.826e-01	1.878e-01	0.972	0.3311
	pro_gender_f:gram_fun_obj	-4.675e-01	1.866e-01	-2.505	0.0124
	pro_gender_nb:gram_fun_pos	-9.488e-03	1.698e-01	-0.056	0.9554
	pro_gender_f:gram_fun_pos	-1.071e-01	1.695e-01	-0.632	0.5276
	pro_gender_nb:sentence_nr	8.118e-04	3.662e-03	0.222	0.8246
	pro_gender_f:sentence_nr	2.298e-04	3.743e-03	0.061	0.9510

Table C2

Output Post Hoc Analyses Pronoun Stimuli

	gram_fun	**pro_gender**	**Contrast**	**Estimate**	**SE**	**df**	***t*-value**	***p*-value**
Nref	subj	.	nb - m	-0.163581	0.108	1209	-1.513	0.6944
	subj	.	f - nb	0.043929	0.107	1208	0.411	0.9999
	obj	.	nb - m	0.369959	0.146	1208	2.541	0.1076
	obj	.	f - nb	-0.332629	0.146	1208	-2.285	0.1968
	pos	.	nb - m	0.000743	0.123	1210	0.006	1.0000
	pos	.	f - nb	0.069903	0.123	1209	0.569	0.9987
	.	m	obj - subj	-0.072288	0.128	1208	-0.563	0.9988
	.	m	pos - obj	0.036698	0.135	1208	0.272	1.0000
	.	nb	obj - subj	0.461253	0.128	1208	3.605	0.0035
	.	nb	pos - obj	-0.332518	0.135	1209	-2.468	0.1279
	.	f	obj - subj	0.084695	0.127	1209	0.665	0.9961
	.	f	pos - obj	0.070014	0.135	1209	0.520	0.9993
N400	subj	.	nb - m	-0.2597	0.106	1209	-2.445	0.1354
	subj	.	f - nb	0.1834	0.105	1208	1.746	0.5239
	obj	.	nb - m	0.3868	0.143	1209	2.704	0.0690
	obj	.	f - nb	-0.4378	0.143	1209	-3.062	0.0244
	pos	.	nb - m	-0.0992	0.121	1210	-0.823	0.9848
	pos	.	f - nb	0.0835	0.121	1209	0.692	0.9949

	.	m	obj - subj	-0.1391	0.126	1209	-1.103	0.9215
	.	m	pos - obj	0.0106	0.132	1208	0.080	1.0000
	.	nb	obj - subj	0.5074	0.126	1208	4.037	0.0007
	.	nb	pos - obj	-0.4754	0.132	1209	-3.592	0.0037
	.	f	obj - subj	-0.1138	0.125	1209	-0.909	0.9725
	.	f	pos - obj	0.0459	0.132	1209	0.347	1.0000
P600	subj	.	nb - m	0.055	0.113	1123	0.495	0.9995
	subj	.	f - nb	0.1386	0.111	1122	1.244	0.8611
	obj	.	nb - m	0.2386	0.152	1122	1.575	0.6507
	obj	.	f - nb	-0.5115	0.151	1122	-3.389	0.0082
	pos	.	nb - m	0.0465	0.128	1124	0.363	1.0000
	pos	.	f - nb	0.0410	0.128	1123	0.320	1.0000
	.	m	obj - subj	0.1758	0.133	1122	1.317	0.8210
	.	m	pos - obj	-0.0657	0.140	1122	-0.469	0.9997
	.	nb	obj - subj	0.3584	0.133	1122	2.685	0.0729
	.	nb	pos - obj	-0.2578	0.141	1123	-1.835	0.4607
	.	f	obj - subj	-0.2917	0.132	1122	-2.213	0.2290
	.	f	pos - obj	0.2947	0.140	1123	2.109	0.2839

Table C3

Output Verb Stimuli Analyses

		Estimate	**SE**	***t*-value**	***p*-value**
Nref	(Intercept)	0.199121	0.121872	1.634	0.1038
	pro_gender_nb	0.092384	0.123649	0.747	0.4555
	pro_gender_f	-0.108198	0.122813	-0.881	0.3789
	sentence_nr	-0.004970	0.002388	-2.081	0.0382
	experience_z	0.093056	0.055932	1.664	0.1166
N400	(Intercept)	0.030748	0.127779	0.241	0.8101
	pro_gender_nb	0.133626	0.131457	1.016	0.3101
	pro_gender_f	-0.060446	0.130607	-0.463	0.6438
	sentence_nr	-0.004861	0.002540	-1.914	0.0565
	experience_z	0.103735	0.055358	1.874	0.0801
P600	(Intercept)	-0.13492	0.09044	-1.492	0.1367
	pro_gender_nb	0.07527	0.12676	0.594	0.5530
	pro_gender_f	-0.01252	0.12643	-0.099	0.9212
	attitude_z	-0.09317	0.05298	-1.759	0.0796