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# Processing of Pronouns With Gender-Inclusive –x in Spanish: An Eye-Tracking Study

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## Abstract

Psycholinguistic research on gender-inclusive language has mainly focused on the processing of stereotyped nouns, while other work has centered on the processing of gender-inclusive morphemes (GIMs). This study focuses on Spanish and, by means of an eye-tracking technique, it examines the early and late processing of pronouns ending with the gender-inclusive morpheme –x, in comparison to those ending with the canonical masculine morpheme –o and the feminine morpheme –a. It also considers emerging trends between –x and extralinguistic factors, such as gender identity, sexual orientation, experience with gender studies, and attitudes towards GIMs. Spanish-speaking university students in Puerto Rico completed a sentence reading task and a questionnaire that collected information pertaining to four extralinguistic factors. Linear mixed-effects models display that processing –x is more costly than –o in all early and late reading measures, but more costly than –a only in some early and late reading measures. Furthermore, the random-effects structure showed an inverse relationship between these differences: the smaller the difference between –x and –o, the larger the difference between –a and –x. Emerging trends with extralinguistic factors suggest future studies should further explore their relationship with gender-inclusive morpheme –x. For a holistic understanding of gender-inclusive Spanish processing at the



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intersection of language and gender, these findings evince the importance of examining GIMs in comparison to both canonical morphemes and measuring both early and late processing.

## Keywords

gender-inclusive language, gender-inclusive morphemes, eye tracking, sentence processing, extralinguistic factors, Spanish

### Highlights

- Previous studies on inclusive language in Spanish focus primarily on the processing of –x in nouns by means of the self-paced reading technique.
- The present eye-tracking study shows that during the early and late stages of processing, pronouns with –x are costlier than pronouns with –o, but they are processed more easily than pronouns with –a during the late stages.
- Pronouns with –x temporarily disrupt sentence processing but do not affect overall sentence comprehension.
- Gender identity, sexual orientation, experience with gender studies, and attitudes towards gender-inclusive morphemes constitute emerging factors that potentially modulate the processing of pronouns with –x.

The present study adopts a psycholinguistic approach to examine how the Spanish gender-inclusive morpheme (GIM) –x affects language processing by means of an eye-tracking technique. In what follows, we provide an overview of gender-inclusive language and the strategies used by different languages to integrate gender-neutral forms. We also explain grammatical gender in Spanish and describe the gender-inclusive alternatives proposed for this language, including a brief discussion of the controversies surrounding their use. In addition, we consider previous studies that describe how the use of gender-inclusive language is associated with various factors, such as gender stereotypes, language attitudes, and other extralinguistic characteristics related to individuals. Then, we explain the current study’s methodology, report the results, discuss the findings in light of previous research, present theoretical implications, and provide general conclusions based on our study objectives.

## Gender-Inclusive Language

Current years have met an increased interest in using gender-neutral terms in language to represent individuals with non-binary gender identities, that is, people who do not identify within the male/female binary. This includes not identifying as male or female, identifying as both male and female, or identifying somewhere in between the binary gender system (McNabb, 2017). Non-binary identities have been recognized as a third gender in indigenous cultures for centuries (McNabb, 2017). Some examples comprise

the two-spirit Native American identity, the hijras in India, and the muxes in Mexico (see [Independent Lens, 2015](#), for a map of cultures around the world that recognize more than two genders). However, in other cultures the acknowledgment and open discussion of non-binary identities, as well as the use of gender-inclusive language, is more recent. Researchers on the topic have discussed both neutral and innovative gender-fair language strategies to achieve inclusion of all identities ([Sczesny et al., 2016](#)). Neutralization proposals comprise epicene or collective nouns or noun phrases that have no grammatical gender marking and are, thus, considered neutral, such as *people* or *humankind* in English, and *individuo* ‘individual’ or *el estudiantado* ‘the student body’ in Spanish. Innovative proposals include lexical, orthographic, and morphological alternatives. Regarding lexical options, for instance, in Swedish, a new pronoun, *hen*, has been introduced with a generic singular meaning ([Vergoossen et al., 2020](#)). In English, new pronouns, such as *ze* and *xe*, have also been proposed ([Bradley et al., 2019](#)), although the use of the singular pronoun *they* seems to be more widely recognized and accepted ([Camilliere et al., 2021](#)). Some orthographic options, which have the written form as their central objective, proposed for different languages include the asterisk in German ([Körner et al., 2022](#); [Zacharski & Ferstl, 2023](#)) and the underscore in Slovene ([Popič & Gorjanc, 2018](#)). In the present study, we focus on a grammatically gendered language, Spanish, and on morphological innovations that have been proposed as gender-fair strategies to achieve language inclusivity. Before we explain the GIMs that have appeared in Spanish, we provide some information on Spanish grammatical gender.

## Grammatical Gender and GIMs in Spanish

Unlike English, a natural gender language in which gender depends on lexical assignment (e.g., *boy* for males and *girl* for females), or morphological distinction (e.g., *actor* for males and *actress* for females), Spanish is a grammatically gendered language that marks gender on all nouns, by classifying them into two categories that denote masculine or feminine gender. Generally, words that end with the morpheme *-o* mark the masculine gender (e.g., *libro* ‘book’), while words that end with the morpheme *-a* mark the feminine gender (e.g., *silla* ‘chair’). The *-o* = masculine/*-a* = feminine pattern is consistent 99.9% of the time for nouns ending with *-o* and 96.3% of the time for nouns ending with *-a* ([Teschner & Russell, 1984](#)). In Spanish, some nouns also end with *-e*, and 89.4% of these words are masculine. However, two-thirds of the most frequent words that end with *-e* are feminine ([Teschner & Russell, 1984](#)). This indicates that the morpheme *-e* is not a reliable marker for grammatical gender. Proponents of GIMs in Spanish take advantage of the ambiguous nature of the morpheme *-e* to suggest its use as one of the GIM options for words that name (i.e., nouns, determiners, pronouns) and describe (i.e., adjectives) people who identify outside of the feminine/masculine binary. In grammatically gendered languages, contrary to what some critics have stated, GIMs do not seek to abolish the grammatical gender categories of other animate and

inanimate nouns, but rather pursue both gender neutrality as well as the representation of non-binary individuals in language (Vidal-Ortiz & Martínez, 2018). Based on this double function, GIMs can be considered both neutralization and innovative gender-fair language strategies (Sczesny et al., 2016).

In addition to the proposal of the GIM –e, Spanish speakers have suggested other GIMs, which include –x, –u, and –i. As mentioned above, these morphemes can be attached to nouns (*adulte*, *adultx* ‘adult’), pronouns (*elle*, *ellx*), articles (*le*, *lx*, *lu*, *li* ‘the’) and adjectives (*alte* ‘tall,’ *rojx* ‘red,’ *cansadu* ‘tired,’ *harti* ‘fed up’). As explained by Stetie and Zunino (2024), the GIMs that have been proposed are used both to refer specifically to people who identify as non-binary and as a generic form in plural noun phrases. In Spanish, although traditionally the masculine grammatical gender has been used as the generic plural form (Real Academia Española & Asociación de Academias de la Lengua Española, 2010), proponents of the use of gender-inclusive language argue that this is better achieved with GIMs and, therefore, suggest that the –o be replaced with one of them. According to Stetie and Zunino (2024), the use of these morphological innovations even “work better when they are used in plural form and to replace a generic use than when [they] are used to name or refer to individuals who do not perceive themselves within the traditional sex-gender binarism” (p. 450). This notion is further supported by the findings of a Twitter<sup>1</sup> corpus study conducted in Argentina, in which Kalinowski (2020) found that GIMs –x and –e were used more frequently as gender-neutral plural alternatives, while their use in singular contexts as markers of non-binary identities was less frequent. Our study focuses on pronouns with the Spanish GIM –x which, based on the previous linguistic context provided in our experimental sentences, can be interpreted either as a generic plural (a group of individuals regardless of their gender identification) or as a reference to a group of exclusively non-binary individuals.

The letter x was first introduced into Spanish when Medieval Spanish scholars translated the Arabic word *al-shayun*, which can mean ‘the thing,’ ‘unknown thing,’ or ‘unknown something’ (Milian, 2017; Salinas & Lozano, 2021; TED, 2012). Medieval Spanish scholars took the sound “ck” from the Greek letter χ (chi) and replaced it with the Latin letter X so that the “sh” in *al-shayun* could be translated. Since its origins, –x in Spanish has had a history of representing the unknown, therefore providing room for the diverse gender identities in language. Among the Spanish GIMs that have been proposed, –e and –x currently seem to be the most widespread and the most researched (Cabello Pino, 2020; Fábregas, 2022; Michnowicz et al., 2023; Salinas, 2020; Salinas & Lozano, 2017, 2021; Stetie & Zunino, 2022, 2024), while –u, –i, and forms such as the asterisk in Spanish have yet to be examined more carefully. Stetie and Zunino (2024) mention that particularly in Argentina, –e is the most frequently used GIM (p. 447). Salinas and Lozano (2017) study the use of –x specifically in the term *Latinx* among

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1) Officially known as ‘X’ since July 2023.

the LGBTQIA+<sup>2</sup> community and its dispersion on U.S. campuses and among student-led organizations. In their study, Michnowicz et al. (2023) find that “[t]he use of –x is clearly gaining traction compared to the other innovative forms; the highest reported frequency of –x is from the one participant who self-identified as ‘Other’ (33%), followed by young women (18%) and then young men (14%)” (pp. 117–118). When focusing the analysis on age, the authors state: “Among innovative forms, –x shows the largest jump in reported use, from 2% among older college-educated participants, to 7% for the middle age group, to 17% reported –x among the youngest group, again showing how this form is gaining ground among college-educated speakers” (p. 120). Although –x is not associated with any specific pronunciation and, therefore, only admissible in written texts, “for writing it is usually preferred [over –e, for instance], since [...] it does not require spelling modifications related to the grapheme-phoneme conversion rules that govern the Spanish orthographic system” (Stetie & Zunino, 2022, p. 8). Based on the findings in these previous studies, our eye-tracking study, for which college-level participants were exposed to gender-inclusive language in written form, focuses specifically on the GIM –x.

These innovative GIMs have been labeled direct forms of non-binary Spanish (NBS; López, 2020). Meanwhile, indirect NBS refers to unspecific terms (e.g., *estas son mis amistades* ‘these are my friends,’ *el pueblo puertorriqueño* ‘the Puerto Rican people’), what Stetie and Zunino (2024) and other researchers call neutralization strategies to achieve inclusion of different identities in language. These indirect forms are often used unconsciously by Spanish speakers and their gender-neutral value goes unnoticed (López, 2020). In contrast, the use of direct NBS (by employing GIMs), has generated tensions between Spanish grammarians and Feminist scholars, which are rooted in the linguistic sexism debate<sup>3</sup> that arose in the 1980s (Cabeza Pereiro & Rodríguez Barcia, 2013). This debate is based on different definitions of the word *gender*: while the former group defines gender as a purely functional feature of language that marks grammatical agreement and not biological sex, the latter group defines gender as a social construct inseparable from language. Proponents from one perspective believe that GIMs are not needed because the grammatical masculine generic gender is already inclusive enough, while those from the other perspective argue that GIMs can be used as effective tools to combat androcentrism in Spanish. These opposing positions can evidently impact Spanish speakers’ perception, use, and attitudes towards GIMs. Irrespective of where a Spanish speaker stands regarding the previous debate, GIMs –x and –e provide psycho-

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2) The acronym stands for lesbian, gay, bisexual, transgender, questioning, intersex, and asexual. The plus sign denotes community members who relate to other forms of gender diverse identities and sexualities.

3) For a thorough account of the functional grammar standpoint on this debate, see Roca (2005, 2006). For more information on linguistic sexism and the feminist critique of the Spanish language, see Bengoechea (2008, 2015) and Cabeza Pereiro and Rodríguez Barcia (2013).

linguists with the opportunity to examine the extent to which speakers with a binary grammatical gender system can acquire a third grammatical gender category, one that is said to be inclusive of all gender identities. Previous studies on gender-inclusive language have begun to examine how a variety of factors affect acceptance, use, and processing of different forms of inclusive language.

## Attitudes Towards Gender-Inclusive Language

Related to the debate described above, one group of studies focuses on the perceptions of and attitudes towards gender-inclusive forms. [Ivanová and Kyseľová \(2022\)](#) conducted a qualitative analysis of the answers and comments obtained from an online questionnaire completed by Slovak, Czech, and Polish speakers. The questionnaire focused mainly on comparing (1) the generic masculine form, (2) pair forms (full male and female noun forms or feminine forms), and (3) full male noun forms with female suffixes after a slash or in brackets. The findings displayed arguments reflecting both acceptance and rejection of forms substantiating gender-inclusive language. For instance, some speakers supported the use of the generic masculine as equally representative for both genders, and, hence, neutral, while others validated it as being male-biased and offensive. Speakers also supported the generic masculine more than the other alternatives by referring to its economy, its naturalness, and tradition—“the entrenchment of the generic masculine forms in the language system and the preference to keep the current system unchanged (defending the linguistic status quo)” (p. 413). Moreover, participants tended to associate forms other than the generic masculine with political correctness, feminist ideals, and gender balance (p. 414). To examine the reception of the gender-inclusive underscore in Slovene, [Popič and Gorjanc \(2018\)](#) conducted a corpus analysis of two collections of texts gathered six months apart from different online sources that use this mark, specifically web pages of organizations, members, and supporters of the LGBTQIA+ rights, to see whether its use was prolific, consistent, and extensive. The researchers found that among the LGBTQIA+ community and several other cultural or media outlets, the underscore is very present, it is used consistently, and its use is growing, as exhibited by a significant increase between the two collections of texts in the number of words and tokens including the underscore. With respect to one of the main arguments against the use of the underscore—its complex and difficult use—, the authors state: “the writers who use the underscore use it remarkably consistently as we can hardly find different versions/spellings of words written with an underscore. Thus, one of the main criticisms of the underscore (that it is hard to use) seems to be invalid, at least in our database” (p. 347).

[Gustafsson Sendén et al. \(2015\)](#) examined how attitudes and behavior toward the newly introduced Swedish gender-neutral pronoun *hen* changed over time. They administered questionnaires from 2012 (the year in which the pronoun *hen* was introduced) to 2015 in university and community settings in Sweden to obtain data on attitudes

and usage of *hen*, and they considered the influence of factors, such as sexism, political orientation, gender identity, interest in gender issues, and age. They found that time was a significant predictor of attitudes, even when controlling for other predictors. Sexism, political right affiliation, and a strong gender identity were associated with negative attitudes, while younger people, women, students, and those who were interested in gender issues had more positive attitudes towards *hen*. Similar effects were found for usage of *hen*, but the overall effects were smaller than those for attitudes. The researchers concluded that attitudes changed faster than behavior, and that although the use of innovative gender-neutral pronouns might be met with resistance at first, attitudes and use can shift over time.

Moving back to Spanish, perceptions of inclusive language were examined by Michnowicz et al. (2023) through an online questionnaire of reported familiarity, opinions, and use of different GIMs among Spanish speakers residing in North Carolina. Overall, the findings show that women report more familiarity with GIMs than men, particularly those in the middle-aged group. Moreover, women have the most positive opinions of the GIMs. Although most participants did not report using any of the innovative morphological forms, those who did reported using *-x* and *-@* more frequently in writing, and *-e* more often in speech. The authors point out that among the three linguistic contexts considered, a Det-N phrase, a Quant-Det-N phrase, and the word *Latin-s*, the last was the context in which *-x* was more frequently used. It is worth noting that this study included one young non-binary participant who was familiar with GIMs, had positive opinions of them, and reported using them, particularly *-x*. Attitudes towards gender-inclusive language comprise one of the variables considered in the present study.

## Processing of Gender-Inclusive Language

In addition to studying language attitudes, previous research has examined the way in which different gender-inclusive language strategies are processed and the extent to which they can mitigate biases (Lindqvist et al., 2019; Renström et al., 2024; Stetie & Zunino, 2022, 2024; Vergoossen et al., 2020; Zarwanitzer, 2019). Vergoossen et al. (2020) conducted an eye-tracking study to examine the processing of the innovative gender-inclusive pronoun *hen*. Participants read pairs of sentences, in which the first sentence included a role noun and the second sentence included a pronoun; both were either gendered (masculine, feminine) or neutral. The authors examined reading time at the noun in the first sentence, at the pronoun in the second sentence, and at the spillover region following the pronoun. A processing cost for the pronoun *hen* only appeared in the spillover region, where reading time was longer when *hen* referred to neutral nouns than when it referred to gendered nouns. However, the reading time was similar when *hen* followed a masculine gendered noun or a feminine gendered noun. Vergoossen et al. (2020) conclude, thus, that as a gender-inclusive pronoun, *hen* is not difficult to

process. The influence of two participant characteristics on the processing of *hen* were considered, but neither self-reported previous experience with *hen* nor personal attitudes modulated the processing of *hen* versus the gendered pronouns.

In a study conducted in English and Swedish, Lindqvist et al. (2019) compared how paired pronouns (e.g., *he/she*), traditional neutral pronouns (e.g., singular *they*) and new gender-neutral pronouns (e.g., *ze* in English and *hen* in Swedish) influenced biases in recruitment situations. The results from both languages displayed that paired forms and new gender-neutral pronouns eliminated male bias, while traditional gender-neutral words like singular *they* evoked male biases. The authors conclude that innovative gender-neutral pronouns are optimal for gender inclusivity. In a follow-up study, Renström et al. (2024) tested the extent to which different gender-fair strategies could evoke associations with normative and non-normative gender expressions using the same paradigm from their previous study. In Swedish, paired pronouns evoked gender normative biases, while *hen* did not. Conversely, the English data showed that both *ze* and *they* elicited lower gender normative biases than paired pronouns. The gender normative bias for *ze* was even lower for participants who were familiar with this new pronoun. In cases where the use of *ze* and *they* were explicitly stated as non-binary, their normative bias was eliminated. Therefore, gender-neutral pronouns elicit non-normative gender associations when they are new words that are well known by language users.

In Spanish, studies have examined the processing of GIMs, but not all of them have taken biases into consideration. Zarwanitzer (2019) studied how –x and –e were processed in Spanish nouns, in contrast to nouns with –o (e.g., *amigos*, *amigxs*, *amigues*, ‘friends’) and how the processing of these three morphemes differed amongst young adults and older adults (37–71 years old). By means of a self-paced reading task, participants read a carrier sentence followed by an experimental sentence that contained a noun ending in one of the three morphemes (e.g., *Hoy cumple años María. Invitó a sus amigos/amigxs/amigues a tomar el té* ‘Today is María’s birthday. She invited her friends over for tea’). The author found significantly longer total reading time for experimental sentences that included nouns with –x and –e, in comparison to those that included nouns with –o, which had the shortest reading time. This result was consistent across both age groups, leading Zarwanitzer to conclude that reading nouns with GIMs –x and –e requires greater levels of language processing than the masculine generic –o. Stetie and Zunino’s (2022) study tested the generic mental representations of the morphemes –o, –x, and –e in stereotyped role names in Spanish. Participants completed a comprehension task in which they read a sentence that included either high or low male stereotypical subject nouns and, then, answered a multiple-choice question about the reference of the noun phrase in the subject position. The researchers measured total reading time of the sentence and total response time to the question. They also examined participants’ responses to the multiple-choice questions. The authors found that the use of the masculine –o evoked more male than mixed group representations,

an effect that was moderated by the stereotypicality of the role names. In other words, nouns with high male stereotypicality (e.g., *carpinteros* ‘carpenters’) were significantly more associated with groups of males than with mixed-gender groups. In contrast, GIMs –x and –e elicited more references to mixed groups. They found no significant reading time differences between sentences with generic –o and those with GIMs –x and –e. Regarding response time, participants took significantly longer to respond to questions when the preceding sentence included –o versus when the preceding sentence included –x and –e, and there were no significant response time differences between the two GIMs. These findings evince that the so-called generic –o morpheme is biased towards male representations in contrast to GIMs, which illustrate mixed groups of men, women, and gender diverse individuals. Moreover, unlike [Zarwanitzer \(2019\)](#), [Stetie and Zunino \(2022\)](#) did not find evidence for a higher processing cost for GIMs –x and –e, when compared to the generic –o morpheme. The present study examines the processing cost of the GIM –x in Spanish pronouns by means of an eye-tracking technique. To our knowledge, it constitutes the first study to use eye tracking to examine gender-inclusive language in Spanish.

## Processing of Gender Stereotypes

The role played by gender stereotypes in language processing, considered by [Stetie and Zunino \(2022\)](#), has been further examined in several eye-tracking and self-paced reading studies. For example, [Khan and Daneman \(2011\)](#) used eye tracking to examine the effect of the –*man* suffix on excluding female referents (e.g., congressman). Participants read a five-sentence paragraph that included a neutral context in the first three sentences, and a gender stereotyped noun in the fourth sentence that either ended in –*man* (e.g., spokesman) or –*person* (e.g., spokesperson) and was followed by a reflexive pronoun (e.g., himself or herself). After the reading task, participants answered a questionnaire that measured the gender stereotypes of the nouns included in the study. Results showed a strong male association for the –*man* suffix. In other words, participants displayed longer fixation durations when a word with the –*man* suffix was followed by the reflexive pronoun *herself*. Similarly, in [Reali et al.’s \(2015\)](#) study, after participants completed the eye-tracking task, they answered questions related to sexism and the roles of men and women in society. The results showed a correlation between participants’ eye movements and their gender stereotype beliefs. The more stereotypically masculine a noun was, the shorter the fixation durations were on the masculine pronoun. In [Messer and Kennison’s \(2018\)](#) study, participants answered the Bem Sex Role Inventory (Bem, 1974), a questionnaire that considers attitudes towards masculinity and femininity. Male participants who obtained higher femininity scores had shorter fixation durations when reading the pronoun *he* followed by a female metaphor. Coming back to Spanish, [Stetie and Zunino \(2024\)](#) used a self-paced reading task to evaluate the influence of role names with stereotypical male or female bias on the processing of Det-N phrases with the

GIM -e. They considered three interest zones—the noun phrase with the GIM -e, the three-word spillover region, and the wrap-up region (final word of the sentence)—, as well as total reading time of the sentence. The authors found evidence of a semantic bias effect only on the first spillover word, in which the male-biased condition was processed faster than the female-biased condition. They do not consider the processing difficulty to be linked to the GIM -e, but rather to the lower frequency of occurrence of female-biased role names with GIMs (p. 461). In sum, these studies suggest that gender stereotypes are activated during reading and the conventional notions of gender play a role during language processing. This is taken into account in the present study.

Many of the studies reviewed in this Introduction have recognized the importance of considering the influence that extralinguistic factors may have on the use and the processing of gender-inclusive language forms. Overall, these studies have considered sociodemographic characteristics, such as sex, age, educational level, region of origin, gender identity, sexual orientation, and political affiliation, as well as traits relating to the experience that individuals may have with gender-inclusive language (i.e., interest in gender studies). In some, but not all occasions, these extralinguistic factors have influenced not only the attitudes that speakers display towards gender-inclusive language, but also in their language use, particularly their comprehension of these gender-neutral forms. Furthermore, these extralinguistic factors are inevitably sometimes correlated. For example, [Michnowicz et al. \(2023\)](#) removed the region of origin from the data analyses in their study due to excessive collinearity with other factors. [Pesce and Etchezahar \(2019\)](#) found a relationship between gender, attitudes towards gender-inclusive language, and rate of gender-inclusive use, by which women had higher positive evaluations and also reported using gender-inclusive language more frequently than men. Therefore, these extralinguistic factors must be examined carefully. The novelty of these gender-inclusive forms coupled with the varied findings of previous studies encourage the need to continue to examine the effect of extralinguistic factors, as we do in the present study.

## The Current Study

As mentioned above, by means of eye tracking, this study examines the processing of Spanish pronouns with the GIM -x. The main research question is: How does the linguistic processing of -x differ (or not) from that of the traditional grammatical gender morphemes -o and -a? On the one hand, we hypothesized that, based on the grammatical innovation or novelty of GIMs and on certain previous studies ([Zarwanitzer, 2019](#)), the linguistic processing of -x could be more costly than the linguistic processing required for -o and -a, thus reading pronouns ending with -x would result in longer fixation durations. However, on the other hand, based on results found in other sentence processing studies ([Stetie & Zunino, 2024](#); [Vergoossen et al., 2020](#)), it could be that pronouns with -x would not result in any increased processing costs. We are also interested in considering the effect that extralinguistic factors, such as gender identity, sexual

orientation, experience with gender studies, and attitudes towards GIMs, may have on the linguistic processing of pronouns with *-x*. We predicted that certain tendencies would arise with respect to the linguistic processing of *-x* and the extralinguistic factors. Specifically, we expected participants who identify as non-binary (gender identity) and LGBTQIA+ (sexual orientation), who have experience with gender studies and positive attitudes towards GIMs, to tend to process pronouns with *-x* more easily than other participants. Although there are varied findings, this prediction is in line with previous studies according to which extralinguistic factors play a role in participants' perceptions and use of gender-inclusive language (Gustafsson Sendén et al., 2015; Michnowicz et al., 2023; Popič & Gorjanc, 2018, but cf. Stetie & Zunino, 2022; Vergoossen et al., 2020). Previous studies have obtained collinearity or overlap between the extralinguistic factors (e.g., Michnowicz et al., 2023; Pesce & Etchezahar, 2019) and, thus, we expected that some of the factors in our study, such as experience with gender studies and attitudes towards GIMs, would be correlated.

## Method

### Participants

Fifty-one<sup>4</sup> undergraduate students were recruited from a metropolitan university of San Juan, Puerto Rico. Participation was voluntary and confidential. The average age of participants was 21.3 ( $SD = 1.4$ ). Most of the participants were born, raised, and lived in different cities across the metropolitan area of Puerto Rico. Regarding gender identity, 44 identified with a binary gender (15 masculine and 29 feminine), and 7 identified as non-binary. With respect to sexual orientation, 25 identified as heterosexual, while 26 identified as LGBTQIA+.<sup>5</sup> Regarding experience with gender studies, 25 did not have experience (i.e., had not taken courses, webinars, workshops, etc. or completed independent reading on the topic) and 26 did. In terms of attitude towards GIMs, 27 had a positive attitude, while 24 had a mixed attitude (i.e., not completely positive or completely negative). On average, the full sample obtained a GIMs attitude score of 6.9 ( $SD = 2.2$ ) on a 0–9 scale (further explained in the Questionnaire on Extralinguistic factors section). Most of

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4) Given the multiple parameters needed to conduct an a priori power analysis for mixed-effects models (Brysbaert & Stevens, 2018), a power analysis was not conducted because pilot testing of the study to obtain the necessary parameters was not possible in our context. Although our sample size is most likely underpowered, it is close to the median sample size reported by a recent methodological review on eye-tracking studies (King et al., 2019).

5) Previous studies also obtain a similar imbalance regarding gender identity among their participants. For instance, Michnowicz et al. (2023) included a sample consisting of 62% female participants, 38% male participants, and 0.3% non-binary participants. Stetie and Zunino (2024) included a sample of 63% women, 23% men, 3% nonbinary participants and 11% of participants who did not report their gender identities. It is frequently the case that women tend to participate more than men in psycholinguistic experiments (Stetie & Zunino, 2024, p. 455). It is also difficult to achieve high rates of participation from underrepresented groups, such as non-binary individuals.

our participants (i.e., 72%) reported that they agreed with the use of GIMs, while 18% of them stated that they perhaps agreed with their use, and 10% of them disagreed with the use of GIMs. A descriptive, qualitative analysis of the participants' attitudes along with their remarks and clarifications is provided in Román Irizarry (2021).

## Materials

### Sentence Processing Task

We used a two-clause structure for our experimental sentences in the reading task. The first clause introduced a number determiner followed by a gender-neutral or gender-ambiguous noun (e.g., *estudiante* 'student'), which served as a gender-neutral subject. Recall that, in terms of the grammatical gender marking, nouns ending with the morpheme –e are not reliably masculine or feminine (Teschner & Russell, 1984). The second clause introduced a pronoun<sup>6</sup> that belonged to one of the three conditions under study: one ending with masculine –o, one ending with feminine –a, or one ending with non-binary –x. Table 1 contains an example of the three conditions or versions of an experimental item.

**Table 1**

*Example of One Item of the Experimental Sentences*

Condition	Experimental Sentence
–o	Ochenta estudiantes asistieron a la asamblea; no todos votaron a favor de la moción propuesta.
–a	Ochenta estudiantes asistieron a la asamblea; no todas votaron a favor de la moción propuesta.
–x	Ochenta estudiantes asistieron a la asamblea; no todxs votaron a favor de la moción propuesta.
Translation	'Eighty students attended the assembly; not all voted in favor of the proposed motion.'
Question	¿Asistieron cuarenta estudiantes a la asamblea? [Expected response: No] 'Did forty students attend the assembly?'

We also included distractor sentences (see examples in Table 2) to expose participants to other sentence structures, so that the experimental sentences would not stand out. Because participants were told that they were taking part in a study on gender-inclusive

6) All pronouns included in this study fell under the 'pronoun' definition given by the *Real Academia Española* 'Royal Spanish Academy': This institution defines pronouns as "A class of words whose elements take the place of nouns or noun phrases and are used to refer to people, animals, or things without naming them" (Real Academia Española, 2024).

language (without referring to any specific GIM), some of the distractor sentences included forms of gender-inclusive language other than the GIM *-x*; other sentences that did not have gender-inclusive language played with elements of role noun bias. The sole purpose of the distractor sentences was to expose participants to other forms of gender-inclusive language, so that their attention would not be particularly attracted to the experimental conditions with GIM *-x*. Given that these distractor sentences included more complex manipulations such as gender stereotype and grammatical gender agreement in Det-N phrases, we do not analyze them in this paper, which focuses on the processing of GIMs in pronouns that refer to gender-neutral antecedents.

**Table 2**

*Examples of the Distractor Sentences*

Distractor Sentence	Question
Mientras pasaban las horas, les niñas esperaban en el patio a que les recogieran sus padres. 'As the hours passed, the <sub>neg</sub> children <sub>neg</sub> waited in the yard for their parents to pick them up.'	¿Esperaban a sus padres mientras pasaban los meses? 'Were they waiting for their parents as the months passed?' Expected response [No]
Los y las maestras se opusieron al cierre de la escuela de la comunidad. 'The <sub>mas</sub> and the <sub>em</sub> teachers <sub>em</sub> opposed the closing of the community school.'	¿Se opusieron al cierre de la escuela de la comunidad? 'Did they oppose the closing of the community school?' Expected response [Yes]
La cirujana se paralizó al ver que traían a su hijo a la sala de operaciones. 'The surgeon froze upon seeing her son brought into the operating room.'	¿Traían a su hijo a la sala de espera? 'Was her son brought into the waiting room?' Expected response [No]

## Norming Study on the Sentence Processing Materials

A norming study was conducted to determine the possible gender bias of the gender-neutral or gender-ambiguous nouns in the first clause of the experimental sentences. The 62 participants who completed the norming study were not the same as those who completed the eye-tracking study. However, they complied with the same inclusion criteria and were from the same college-level pool of participants. The norming participants' mean age was 21.1 ( $SD = 1.4$ ). With respect to gender identity, 37 identified as feminine, 18 as masculine, 5 as non-binary, and 2 as gender-fluid. In terms of sexual orientation, 40 were heterosexual and 22 identified as LGBTQIA+. Participants were asked to rate the 30 gender-neutral nouns (ending with *-e*) included in the eye-tracking study on an 11-point Likert-style scale. Each noun appeared above the scale. The middle of the scale was 0 and it increased to 5 on either side. The words *masculino* 'masculine' and *femenino* 'feminine'

appeared on both edges of the scale. For half of the nouns, “masculine” appeared on the left side, and for the other half “feminine” was on the left side, in order to avoid any pattern or strategy development during the task. Participants were asked to rate each noun according to the stereotype they believed it represented in society. The closer the rating was to 5 on either side, the greater the association with each gender, while 0 indicated the word was not associated with any particular gender. After rating the noun, participants were asked if they knew the meaning of the word.

Ratings of 0 or 1 were counted as neutral ratings, while ratings of 2–5 were counted as either masculine-bias ratings or feminine-bias ratings. Three proportions were calculated for each noun based on the amount of participant ratings they received as either neutral, masculine, or feminine. Only nouns obtaining a neutral rating of at least 51% (half plus one) were included in the data analyses of the sentence comprehension task. Of the 30 nouns included in the experimental items, four did not obtain a neutral rating of at least 51%: *dirigente* ‘coach’ (35%), *delincuente* ‘delinquent’ (27%), *traficante* ‘drug dealer’ (31%), *gobernante* ‘governor’ (27%). Although these four nouns are gender-neutral regarding their grammatical morpheme –e, they are male-biased based on the norming study results. Given the effect of role noun bias on language processing that has been documented in previous research (e.g., Stetie & Zunino, 2022, 2024), experimental sentences with those four nouns were removed so that the gender bias was controlled as much as possible in the sentences. We were interested in examining the processing of GIM –x in sentential contexts with no gender bias or, at least, with the most gender-neutral antecedents as possible.

## Design

In this sentence processing eye-tracking study, participants read 10 experimental sentences for each condition, for a total of 30 experimental sentences. The critical region was the pronoun in the second clause, and always appeared in word position 8. Because each experimental item had three conditions, the experimental sentences were manually counterbalanced or divided into three lists to ensure participants only read one version of each experimental item. The 30 distractor sentences were the same across all three lists. Within each list, five item blocks were created, each containing six sentences (three experimental and three distractor). The blocks as well as the experimental items included in each block were presented in a random order to each participant with the constraint that no more than three experimental sentences appeared in a row. This pseudorandomization process resulted in the sentences being presented to each participant in a different order, yet the items belonging to each condition were evenly distributed for the duration of the experiment. The questions for the experimental and distractor sentences were controlled so that half had a ‘Yes’ response and the other half had a ‘No’ response.

## Questionnaire on Extralinguistic Factors

This questionnaire, which was created in Google Forms, included 20 questions. Questions 1–6 asked participants which college and program they belonged to (to ensure they were all college students), their age, the town and country in which they were born, the town and country in which they were raised, and their current town of residence. Questions 7–9 asked about gender identity, sexual orientation, and experience with gender studies. Experience with gender studies counted as “yes” if participants had either taken a university level course where gender theory was discussed or done independent reading on gender theory, and “no” if they had not. Questions 10–13 asked participants in which places or contexts they had been exposed to GIMs, including forms with gender-neutral morphemes as well as other strategies that included the representation of women<sup>7</sup> (e.g., *tod@s*, *todos y todas*, *todos/as* ‘all’). Questions 14–20 were used as an estimate of participants’ attitudes towards the use of GIMs: positive, negative, or mixed. In these questions, participants were asked if they agreed with the use of GIMs, which ones they preferred to use, and why. They were also presented with several quotes or scenarios and asked if they agreed with what was stated and if they would use the same gender-inclusive language that was presented in the examples. If a participant’s response to each of these questions was positive (more in line with feminist scholars), they would receive a score of 1; if their response to these questions was negative (more in line with Spanish grammarians), they would receive a score of 0; if their response appeared to contain mixed feelings, as interpreted by the first author, the participant received a score of 0.5. In the end, the scores of Questions 14–20<sup>8</sup> were added to calculate each participants’ attitude score towards GIMs, out of a maximum possible score of 9 points. Since no participant obtained a score of 0 (i.e., there were no absolute negative attitudes), the three-way attitude categorization was reduced to a two-way division, where a participant with a score of 8 or higher was classified as having a positive attitude, while those with scores of less than 8 were classified as having a mixed attitude. Given that our questions were not previously validated, we used the scores as general guidelines to categorize participants’ attitudes within the context of the linguistic sexism debate. The positive and mixed categories indicated that 27 participants fully aligned with feminist scholars, whereas the remaining 24 participants expressed agreement with views from both sides of the debate.

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7) In Spanish, gender inclusivity started with strategies that comprised a visual representation of the masculine and feminine grammatical gender. For this reason, we also considered them as a type of GIM strategy. The categorization of participants’ GIM strategies is further explained in the supplementary materials online (see Román Irizarry, 2024).

8) Questions 17 and 19 had two parts (a and b): the first (a) asked if the message written with GIMs was appropriate, while the second (b) asked if the participant would use the expression. Participants could receive points for each part of those two questions, which is why the seven attitudinal questions can lead to a maximum attitude score of 9.

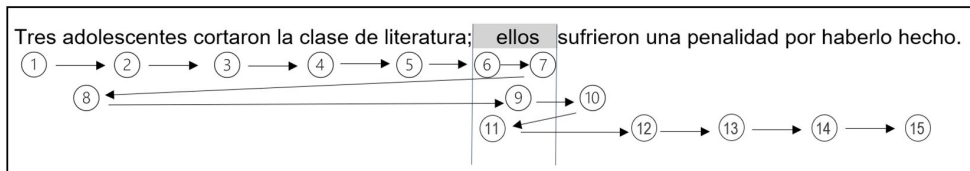
## Procedure

The data were collected in a university laboratory space used for linguistic studies. After discussing and signing the informed consent form, participants sat approximately 60 cm away from the computer screen. To control the visual degree of error and calculate overall accuracy, the eye-tracking equipment was calibrated for each participant before the experiment and at any point during the experiment, if necessary. Participants' viewing was binocular, but monocular eye-tracking data of the right pupil and cornea was performed at a sampling rate of 1000 Hz. Before starting the experiment, participants were instructed to read each sentence silently at their own pace, while their eye movements were recorded. The sentences were displayed in black 14-point Consolas font on a color 20-inch CRT monitor connected to an SR Research EyeLink 1000 desktop-mounted eye tracker with an IBM compatible interface. Following each sentence, they used two buttons on a video game controller to answer a yes/no comprehension question, to ensure that they were carefully reading and understanding each sentence. Participants began with three practice sentences, and moved on to the main reading task, which had an approximate duration of 40 minutes. After the eye-tracking task, participants answered the questionnaire on extralinguistic factors, which took about 15 minutes. The questionnaire was administered at the end to prevent the participants' sentence processing patterns from being influenced by their responses to the questions on GIMs.

## Statistical Analysis

### Data Preparation

Four reading measurements were extracted from the critical region, that is, the pronoun, for analysis: first fixation duration, gaze duration, regression path time, and total time (see Figure 1). First fixation duration is the duration of the first, and only the first, fixation on the critical region; gaze duration is the sum of all fixations on the critical region before moving to the right or the left of the critical region; regression path time is the sum of fixation durations on the critical region and any regressions to earlier parts of the sentence before moving past the right boundary of the critical region; and total time is the sum of all fixation durations in the critical region (Conklin & Pellicer-Sánchez, 2016). First fixation duration and gaze duration are considered to reflect early processing, while total time exhibits late processing (Rayner, 1998). Regression path time is considered to reveal both early and late processing (Clifton et al., 2007) because it signals difficulty integrating a word upon fixation (early effect), while also reflecting the time it took to overcome this difficulty (late effect).

**Figure 1***Example Sentence With Hypothetical Eye Movements*

*Note.* An example sentence with the critical region appears in gray. Each circle represents a hypothetical fixation. The number in each circle denotes the order of the fixations. The arrows indicate the direction of the eye movements. First-fixation (6), Gaze Duration (6 + 7), Regression Path Time (6 + 7 + 8 + 9), and Total Time (6 + 7 + 9 + 11). Translation: ‘Three adolescents skipped literature class. They received a penalty for doing so’ (Figure adapted from Conklin & Pellicer-Sánchez, 2016 to include a sentence item from the current study).

Only trials with questions that were answered correctly were included in the analysis; incorrect trials comprised 6.4% of the total trials. Gender-neutral nouns with a male bias were excluded from the study (see Norming Study on the Sentence Processing Materials); this resulted in dropping four items across all participants (195 observations per reading measurement). To control for outliers, fixations < 80 ms were excluded. This affected the following percentages of remaining data: first fixation 23.9%, gaze duration 23.7%, regression path time 23.7%, and total time 5.6%. Fixation times that were greater than 2.5 *SD* of the mean were replaced by the respective mean of each condition. This was done separately for each reading measurement and affected 2.6% of the data from first fixation, gaze duration, and regression path time, and 2.4% of the data from total time.

### Statistical Modelling

To answer our main research question, whether pronouns with *-x* differ from pronouns with *-o* and pronouns with *-a*, we fitted a Generalized Linear Mixed Effects Model (GLMM) for the accuracy data with binomial as family and Linear Mixed Effects Models (LMMs) for each reading measurement. The binomial family was chosen for our GLMM because it allows for estimation of a logistic regression model, which estimates the predictive probability of observing an error (Winter, 2019). All analyses were conducted in R (Version 4.3.3; R Core Team, 2024) using the lme4 package for mixed-effects modeling (Bates et al., 2015). Before building the LMMs, we used the boxcox function from the MASS package (Venables & Ripley, 2002) to determine whether it was necessary to transform the data to meet normality and homoscedasticity assumptions. The results showed that the optimal data transformation for first fixation, gaze duration, and total time would be achieved using the log scale. Following Winter’s suggestion (2019) for data transformation, we applied log<sub>10</sub> transformations to these measures. In contrast, the results for regression path time showed that the optimal transformation for this

measure would be achieved by performing an inverse transformation. Once the data were properly transformed, we proceeded to fit the maximal random effects structure (see Equation 1 below) allowed by our experimental design (Barr et al., 2013) using maximum likelihood estimation. This included random intercepts by subject and item as well as random slopes for morpheme in both subject and item. To test our main research question, how pronouns with -x differed from pronouns with -o and pronouns with -a, our fixed effect morpheme was coded using repeated contrasts (Schad et al., 2020). To test differences between -o and -a, we used pairwise comparisons from the emmeans function (Lenth, 2023) with Bonferroni corrections.

$$(1) \quad DV \sim \text{morpheme} + (\text{morpheme} \mid \text{item}) + (\text{morpheme} \mid \text{subject})$$

Fitting maximal models resulted in convergence issues. To alleviate this problem, we added `control = lmerControl(calc.derivs = FALSE)` to our models, but they still did not converge. Following the approach from Matuschek et al. (2017), we then proceeded to first remove the correlation terms between the random intercept and random slopes, and then removed one random slope at a time until convergence was achieved. Convergence was finally achieved for gaze duration, regression path time, and total time using Equation 2 below. Although the model for total time achieved convergence on its own, it resulted in a singular fit issue when estimating pairwise comparisons. This issue was solved when changing the optimizer to "bobyqa" in the original model.

$$(2) \quad \text{Transformed DV} \sim \text{morpheme} + (1 \mid \text{item}) + (1 \mid \text{subject}) + (0 + \text{morpheme} \mid \text{subject}),$$

`data = data, REML = FALSE, control = lmerControl(calc.derivs = FALSE)`

In contrast, both the first fixation LMM and the accuracy GLMM achieved convergence with only random intercepts by subject and item. All model *p*-values were estimated using the `lmerTest` package (Kuznetsova et al., 2017).

Regarding extralinguistic factors, low sample sizes do not enable us to properly estimate between group comparisons. Instead, we present emerging trends based on the descriptive statistics (see Table 3) at the end of the Results section as well as the co-occurrences of our extralinguistic factors with the goal of providing a potential starting point for future research that wishes to further examine how extralinguistic factors moderate the processing of gender-inclusive forms.

**Table 3**  
*Descriptive Statistics of Reading Measurements by Extralinguistic Factor*

Reading Measurements	Full Sample	Binary	Non-Binary	LGBTQI+	Heterosexual	Experience with GS	No Experience with GS	Positive Attitudes	Mixed Attitudes
<b>First Fixation</b>									
-0	239.7 (71.0)	237.4 (71.3)	251.2 (69.1)	247.4 (76.8)	230.4 (62.3)	242.6 (77.1)	236.5 (63.4)	244.5 (73.8)	233.8 (67.2)
-a	262.9 (106.3)	250.8 (96.2)	328.4 (133.0)	277.9 (111.6)	245.1 (97.1)	271.0 (111.7)	254.7 (100.2)	261.6 (107.6)	264.4 (105.2)
-x	256.6 (97.3)	253.8 (93.7)	272.4 (115.2)	260.0 (97.8)	253.1 (97.0)	252.4 (93.6)	260.9 (101.1)	258.0 (101.0)	255.2 (93.8)
<b>Gaze Duration</b>									
-0	297.7 (117.7)	294.4 (116.3)	313.8 (124.5)	314.0 (125.3)	277.9 (105.0)	307.9 (125.7)	286.0 (107.0)	295.7 (114.4)	300.2 (122.2)
-a	318.9 (146.3)	302.4 (130.8)	409.0 (189.5)	332.1 (153.5)	303.2 (136.1)	334.2 (155.0)	303.6 (135.8)	311.6 (149.0)	327.7 (143.2)
-x	368.0 (189.7)	361.3 (185.0)	405.7 (212.5)	369.3 (194.9)	366.7 (184.9)	373.0 (192.2)	362.8 (187.5)	351.2 (187.7)	385.0 (190.8)
<b>Regression Path Time</b>									
-0	385.0 (335.7)	389.0 (347.8)	365.8 (271.9)	362.0 (272.1)	413.0 (398.9)	374.4 (297.8)	397.2 (375.4)	318.1 (203.2)	469.6 (437.1)
-a	430.5 (375.5)	413.5 (364.3)	523.4 (423.5)	433.4 (380.7)	427.1 (370.5)	433.1 (345.9)	427.9 (404.2)	390.3 (344.3)	478.1 (405.3)
-x	461.0 (357.7)	455.4 (358.2)	491.9 (357.0)	424.3 (299.1)	498.5 (406.7)	467.3 (348.5)	454.3 (368.0)	411.0 (298.2)	511.4 (403.9)
<b>Total Time</b>									
-0	541.5 (341.7)	534.7 (331.4)	578.4 (394.3)	545.0 (353.9)	537.6 (328.6)	524.8 (347.9)	559.3 (335.0)	495.6 (330.4)	594.4 (347.7)
-a	741.6 (495.7)	709.2 (470.7)	959.5 (600.1)	783.3 (519.6)	694.5 (464.1)	748.4 (494.1)	734.7 (498.5)	698.9 (482.2)	789.3 (507.4)
-x	673.8 (450.1)	645.0 (430.3)	850.2 (527.2)	688.9 (479.5)	658.6 (418.9)	658.4 (448.2)	689.0 (452.6)	638.9 (460.3)	711.0 (437.1)
<i>n</i>	51	44	7	26	25	26	25	27	24

*Note.* GS = Gender Studies. Average fixation durations are shown in milliseconds. Standard deviations are in parentheses.

## Results

Due to the mixed findings reported in the literature, we hypothesized that processing pronouns with -x would be either less costly than processing pronouns with -o and -a or costlier than processing pronouns with -o and -a. The latter prediction is mainly based on -x's novelty as a GIM, compared to -o and -a, which form part of the speaker's lexicon from an early age. Below, we present the results of our early and late processing measures (see Tables 4 and 5), followed by the accuracy data (Table 6). The accuracy data is presented last, as it serves as a way to measure general sentence comprehension.

**Table 4**

*Regression Coefficients for Early Processing Reading Measurements*

Model Parameters and Effects	First Fixation			Gaze Duration		
	Estimate	SE	t	Estimate	SE	t
<b>Fixed effects</b>						
Intercept	2.374***	.009	276.164	2.468***	.015	167.952
Morpheme -x vs -o	.024*	.011	2.176	.073***	.018	4.151
Morpheme -a vs -x	.011	.011	0.956	-.048**	.016	-3.034
<b>Pairwise Comparisons</b>						
Morpheme -o vs -a	-.034**	.011	-3.057	-.025	.015	-1.725
<b>Random effects</b>						
	<b>Variance</b>	<b>SD</b>		<b>Variance</b>	<b>SD</b>	<b>Correlation</b>
Subject	.003	.051		.008	.088	
Item	.000	.006		.001	.031	
Subject: Morpheme -x vs -o				.007	.086	
Subject: Morpheme -a vs -x				.004	.066	-.85
Residual	.019	.137		.024	.155	
N Subjects	51			51		
N Items	26			26		
Observations	941			943		

*Note.* The morpheme variable used repeated contrasts. All estimates are in the log10 scale. Pairwise comparisons used Bonferroni corrections.

\* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ .

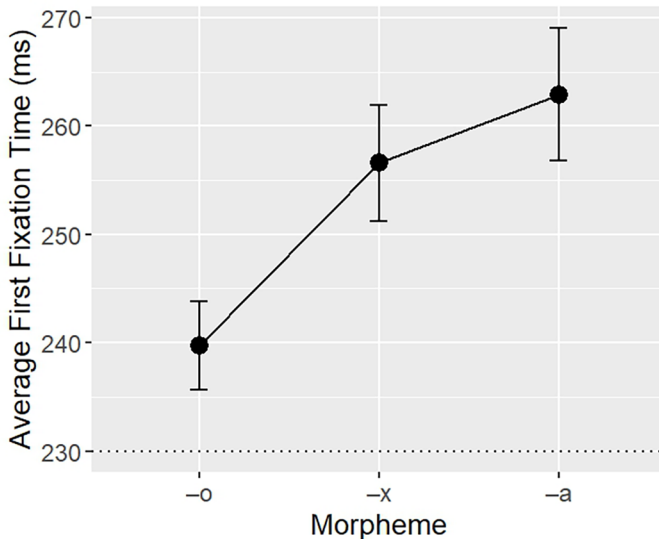
**Table 5***Regression Coefficients for Late Processing Reading Measurements*

Model Parameters and Effects	Regression Path Time			Total Time		
	Estimate	SE	t	Estimate	SE	t
<b>Fixed effects</b>						
Intercept	3.361e-3***	1.314e-4	25.570	2.715***	.029	93.949
Morpheme -x vs -o	-4.598e-4**	1.161e-4	-3.961	.089***	.017	5.307
	*					
Morpheme -a vs -x	2.670e-4*	1.164e-4	2.295	.046**	.017	2.682
<b>Pairwise Comparisons</b>						
Morpheme -o vs -a	1.930e-4	1.220e-4	1.579	-.134***	.017	-7.99
<b>Random effects</b>						
	<b>Variance</b>	<b>SD</b>	<b>Correlation</b>	<b>Variance</b>	<b>SD</b>	<b>Correlation</b>
Subject	6.409e-07	8.005e-4		.023	.153	
Item	7.237e-08	2.690e-4		.009	.094	
Subject: Morpheme -x vs -o	1.366e-07	3.696e-4		.001	.035	
Subject: Morpheme -a vs -x	1.371e-07	3.703e-4	-.42	.002	.044	-.67
Residual	1.651e-06	1.285e-3		.048	.220	
N Subjects	51			51		
N Items	26			26		
Observations	943			1167		

Note. The morpheme variable used repeated contrasts. Regression path time estimates used an inverse scale (1/fixation time). Total time estimates are in the log10 scale. Pairwise comparisons used Bonferroni corrections. \* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ .

## First Fixation

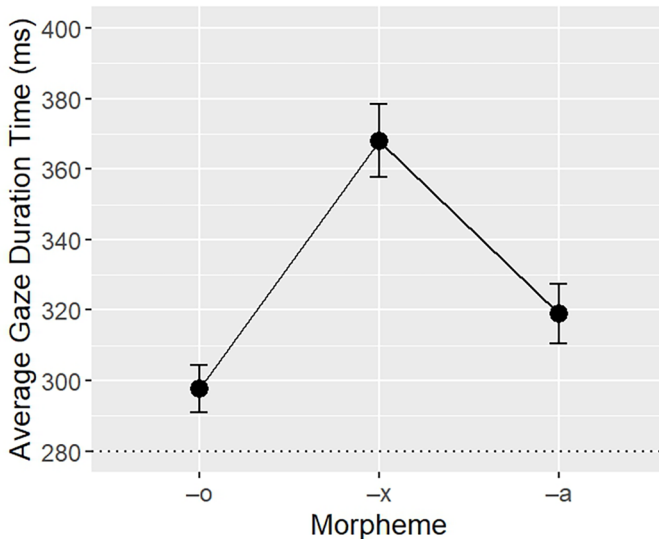
The results from the first fixation LMM, visually displayed in Figure 2, showed a significant main effect for the morpheme -x vs -o comparison ( $b = .024$ ,  $SE = .011$ ,  $p = .030$ ). In contrast, the comparison between morpheme -x and -a was not significant ( $b = .011$ ,  $SE = .011$ ,  $p = .339$ ). Finally, pairwise comparisons showed a statistically significant difference between morpheme -o and morpheme -a ( $b = -.034$ ,  $SE = .011$ ,  $p = .007$ ). The results from the random effects structure showed that there was more participant variation than item variation across first fixation time. In summary, the analysis from first fixation showed that pronouns with -x and pronouns with -a had statistically significant longer first fixations than pronouns with -o. The lack of a difference between pronouns with -x and pronouns with -a was unexpected, and possible explanations are offered in the Discussion section.

**Figure 2***Average First Fixation Time by Morpheme*

*Note.* Whiskers represent the standard error of the mean.

## Gaze Duration

In contrast to first fixation, the results from the gaze duration LMM, visually displayed in Figure 3, showed statistically significant main effects for both morpheme -x vs -o ( $b = .073$ ,  $SE = .018$ ,  $p < .001$ ) and morpheme -a vs -x comparisons ( $b = -.048$ ,  $SE = .016$ ,  $p = .004$ ). The results from the random slopes show that both effects differed across participants, with some participants showing stronger effects and others showing effects in the opposite direction ( $b = .073 \pm .086$ ;  $b = -.048 \pm .066$ ). Moreover, the strong negative correlation,  $r(49) = -.85$ , between the random slopes indicates that as the difference between -x and -o increased, the difference between -x and -a decreased and vice versa. Furthermore, the random intercepts show that, overall, there was greater variation in gaze duration time coming from participants than there was coming from individual items. Finally, when comparing gaze duration time on morpheme -o vs. morpheme -a, no significant differences were found ( $b = -.025$ ,  $SE = .015$ ,  $p = .273$ ). In summary, although overall pronouns with -x had statistically significant longer gaze duration time than pronouns with -o and -a, the random effects structure shows this overall effect is inversely related to individual responses.

**Figure 3***Average Gaze Duration Time by Morpheme*

*Note.* Whiskers represent the standard error of the mean.

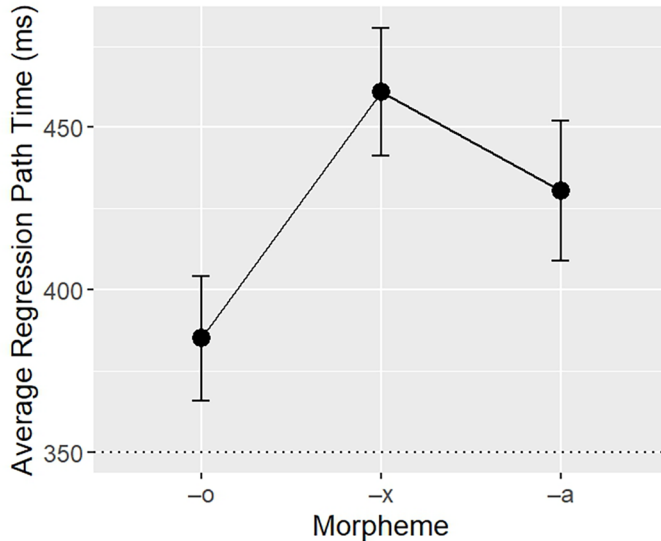
## Regression Path Time

The results from the regression path LMM, visually displayed in Figure 4, show similar results to those found in gaze duration, with the exception that the results from regression path time are in the inverse scale. In other words, there was statistically significant longer regression path time for pronouns with morpheme  $-x$  than pronouns with morpheme  $-o$  ( $b = -4.598e-4$ ,  $SE = 1.161e-4$ ,  $p < .001$ ), as well as statistically significant longer regression path time for pronouns with  $-x$  when compared to pronouns with  $-a$  ( $b = 2.670e-4$ ,  $SE = 1.164e-4$ ,  $p = .026$ ). The random slopes indicate that the difference between  $-x$  and  $-o$  was greater for some and smaller for others ( $b = -4.598e-4$ ,  $\pm 3.696e-4$ ), while the difference between  $-a$  and  $-x$  was stronger in some participants and in the opposite direction for others ( $b = 2.670e-4 \pm 3.703e-4$ ). When examining the random slopes correlation term, there was a moderate negative relationship,  $r(49) = -.42$ , between both effects at the individual variation level: as the difference between  $-a$  and  $-x$  increased, the difference between  $-o$  and  $-x$  decreased and vice versa. Regarding random intercepts, there was greater variation in regression path time amongst subjects than there was amongst items. Finally, when comparing pronouns with  $-o$  to pronouns with  $-a$ , the pairwise comparisons were not significant ( $b = 1.930e-4$ ,  $SE = 1.220e-4$ ,  $p = .363$ ). In summary, pronouns with  $-x$  had statistically significant longer regression path

time than pronouns with -o and pronouns with -a. However, individual variation shows these differences are also inversely related.

**Figure 4**

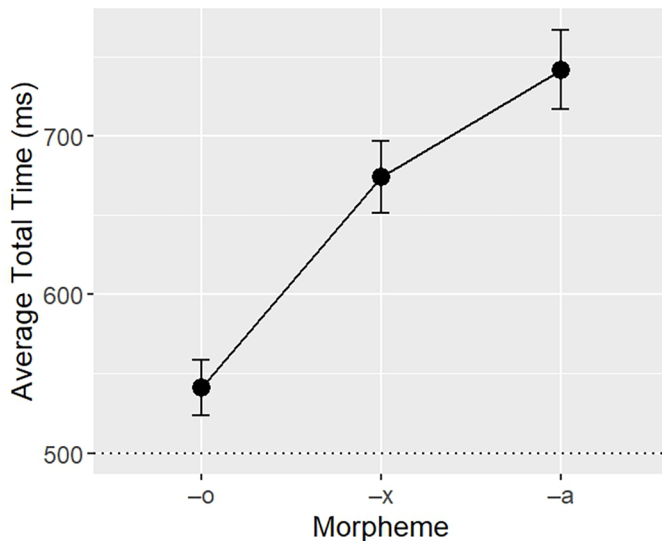
*Average Regression Path Time by Morpheme*



Note. Whiskers represent the standard error of the mean.

## Total Time

The results from the total time LMM, visually displayed in Figure 5, differ slightly from the previous differences reported. Although pronouns with -x had statistically significant longer total time than pronouns with -o ( $b = .089$ ,  $SE = .017$ ,  $p < .001$ ), they resulted in shorter total time when compared to pronouns with -a ( $b = .046$ ,  $SE = .017$ ,  $p = .009$ ). The random slopes indicate that the strength of these differences varied by individual ( $b = .089 \pm .035$ ) and, in some cases, almost disappeared for the -x and -a comparison ( $b = .046 \pm .044$ ). The correlation term between random slopes showed a moderately strong negative correlation,  $r(49) = -.67$ , between these differences. The random intercepts also showed there was greater variation in total time coming from subjects than from items. Finally, the difference between pronouns with -o and pronouns with -a was statistically significant ( $b = -.134$ ,  $SE = .017$ ,  $p < .001$ ). In summary, although pronouns with -x resulted in longer total time than pronouns with -o, they resulted in shorter reading time than pronouns with -a, which also differed from -o. As with the previous two reading measurements, individual variation showed an inverse relationship between these differences.

**Figure 5***Average Total Time by Morpheme*

*Note.* Whiskers represent the standard error of the mean.

## Accuracy

The results from the GLMM, displayed in Table 6, revealed no significant differences in accuracy between conditions: (-x vs -o:  $b = .009$ ,  $SE = .016$ ,  $p = .559$ ; -a vs -x:  $b = .004$ ,  $SE = .016$ ,  $p = .797$ ; -o vs -a:  $b = -.009$ ,  $SE = .016$ ,  $p = 1.00$ ). The random intercepts showed there was slightly more item variation than subject variation in accuracy. Although the errors were distributed across all items, some participants made mistakes on a few similar items. What is most relevant to highlight for purposes of our study's main objective is that pronouns with -x did not pose an extra cost for overall sentence comprehension, when compared to pronouns with -o and -a.

**Table 6***Accuracy Regressed on Morphemes*

Model Parameters and Effects	Estimate	SE	t
<b>Fixed effects</b>			
Intercept	.933***	.014	65.031
Morpheme –x vs –o	.009	.016	0.584
Morpheme –a vs –x	.004	.016	0.257
<b>Pairwise comparisons</b>			
Morpheme –o vs –a	-.014	.016	-0.84
<b>Random effects</b>			
	<b>Variance</b>	<b>SD</b>	
Subject	.001	.031	
Item	.004	.061	

Note. Estimates are in the log-odds scale. Pairwise comparisons used Bonferroni corrections.

\* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ .

## Emerging Trends in Extralinguistic Factors

### Co-Occurrence of Extralinguistic Factors

Before discussing the emerging trends in the reading measurements by extralinguistic factors—gender identity, sexual orientation, experience with gender studies, and attitudes towards GIMs—, we first examine the co-occurrence of extralinguistic factors, for which we conducted chi-square tests and Fisher’s exact test for cell counts of less than five.

These results are presented in Table 7. Fisher’s exact test revealed that identifying as non-binary and LGBTQIA+ significantly co-occurred as well as identifying with a binary gender and heterosexuality. Gender identity did not significantly co-occur with any other extralinguistic factor, probably due to the low sample size of non-binary individuals. However, interesting trends suggest that non-binary identity might also co-occur with experience with gender studies and positive attitudes. Other significant co-occurrences were sexual orientation and attitudes towards GIMs: people with positive attitudes had experience with gender studies, while people with mixed attitudes did not have experience with gender studies. Finally, attitudes towards GIMs and experience with gender studies also significantly co-occurred: people with positive attitudes had experience with gender studies, while those with no experience with gender studies had mixed attitudes. Although sexual orientation and experience with gender-studies did not significantly co-occur, the data were trending towards co-occurrence: LGBTQIA+ individuals and experience with gender studies, and heterosexuals with no experience with gender studies. In summary, the factors that co-occurred were gender identity and sexual orientation, sexual orientation and attitudes towards GIMs, and attitudes towards GIMs and experience with gender studies.

**Table 7**  
*Crosstabulation of Extralinguistic Factors*

Extralinguistic Factors	Sexual orientation			Experience with GS			Attitudes towards GIM		
	Heterosexual	LGBTQIA+	Estimate	No	Yes	Estimate	Positive	Mixed	Estimate
Gender identity <sup>a</sup>	Binary	19	Infinite**	23	21	2.68	21	23	0.16
	Non-binary	7		2	5		6	1	
Sexual orientation	Heterosexual			15	10	1.58	8	17	7.06**
	LGBTQIA+			10	16		19	7	
Experience with GS	No						9	16	4.39*
	Yes						18	8	

Note: Chi-square estimates are presented as odds ratio.

<sup>a</sup>All of the gender identity contingency tables used Fisher's exact test for cell counts of less than five.

\*  $p < .05$ . \*\*  $p < .01$ . \*\*\*  $p < .001$ .

## Extralinguistic Factors and Reading Measurements

Although we cannot test our research question regarding the influence of extralinguistic factors on processing GIM -x, we can speak to the emerging trends we observed in our data. Regarding gender identity, non-binary individuals tended to have longer reading time across all conditions than their binary counterparts. An interesting trend is that, even if, overall, they had longer reading time, non-binary individuals tended to have longer reading time on pronouns with -a than their binary counterparts. In other words, the non-binary individuals in our study trended towards processing -o as the fastest, -x as the second fastest, and -a as the most difficult across all four measurements. In contrast, their binary counterparts trended towards processing -o as the fastest, -a as the second fastest, and -x as the most difficult for the first three reading measurements. When comparing both groups of sexual orientation, the trends are similar to those found for gender identity. LGBTQIA+ individuals trended towards processing -o as the fastest, followed by -x as the second fastest, and -a as the most difficult at first fixation, regression path time, and total time. In contrast, heterosexuals trended towards processing -o and -a as the fastest and -x as the slowest in the first three reading measures. This emerging trend seems more informative than the previous one. Although all non-binary individuals in our study were LGBTQIA+, the remaining LGBTQIA+ members in our study identified with a binary gender. A possible explanation for these emerging trends could be due to non-binary and LGBTQIA+ individuals embracing the -x as a new GIM, as opposed to -a, which, despite forming part of the lexicon from early ages, represents both an exclusive plural form in Spanish and a form of the gender binary. In contrast, although -o is also part of the gender binary, its use as the generic plural is present from early on in life, regardless of gender identity and sexual orientation.

Examining the experience with gender studies variable, those who had experience trended towards processing -o as the fastest, -x as the second fastest, and -a as the most difficult only in first fixation and total time, while those without experience trended towards processing -o and -a as the fastest, and -x as the slowest. Although the trends are not as common in all measurements as they were for sexual orientation and gender studies, they suggest that experience with gender studies may affect how -x is processed, compared to -o and -a. Finally, when examining differences in attitudes towards GIMs, both groups trended towards similar behavior in terms of the morphemes' processing difficulty: -o, -x, and -a for first fixation and total time, and -o, -a, and -x for gaze duration and regression path time. Despite these overall similarities, a potential difference was observed when comparing total time on pronouns with -x: those with positive attitudes trended towards shorter total time than those with mixed attitudes. This emerging trend is informative as it might suggest that the degree of positiveness in attitudes towards GIMs might reduce reading time on pronouns with -x. It also calls for the use of a validated questionnaire that would enable researchers to gain a more precise

and continuous measure of how attitudes towards GIMs moderate processing time on GIM -x (Sczesny et al., 2016).

## Discussion

The main goal of this study was to examine how the linguistic processing of GIM -x differed or not from the linguistic processing of traditional morphemes -o and -a. Based on previous studies with inconsistent results, we predicted that the linguistic processing of -x would result in either longer or shorter reading time, when compared to -o and -a. The results extracted from the reading measures indicate that -x was more costly to process than -o at both early and late processing stages, but that, when compared to -a, -x resulted in longer reading time only for gaze duration and regression path time. However, in terms of the overall comprehension of the sentence, no differences in accuracy were found across all three conditions. Taken together, the results confirm our prediction of longer reading time in comparison to -o and partially confirm our predictions in comparison to -a. Regarding accuracy, we did not have a specific prediction. Below, we first interpret the -o comparison results, followed by the -a comparison results and the accuracy results.

In our study, 70% of our participants listed -x as one of their preferred GIMs. One possible explanation for -x's effect on both early and late processing could be that, although participants were aware of how the morpheme was used, its use was still novel in comparison to -o, especially considering that these participants were raised using -o as the generic plural morpheme in both formal schooling and everyday informal conversations. They were exposed to the morpheme -x later in life, when they got to college (see Román Irizarry, 2021, for data regarding this sample's exposure to GIMs). When comparing the difference between -o and -x with previous studies, our findings align with Zarwanitzer (2019), but not Stetie and Zunino (2022, 2024) or with Vergoossen et al. (2020). There could be several reasons for the lack of alignment with the latter studies. First, 75% of the sample from Stetie and Zunino's (2022) study reported using gender-inclusive forms from occasionally to frequently, while all the participants from Vergoossen et al.'s (2020) study were familiar with gender-inclusive *hen*. In contrast, we only inquired about which GIMs participants used, but not how frequently they did so. This could also explain why our results align with Zarwanitzer's (2019), since that study did not report participants' use of, exposure to, or familiarity with gender-inclusive forms. Although it is not clear what Vergoossen et al.'s familiarity with *hen* means in terms of exposure and frequency of use, the higher sample size in that study ( $n = 130$ ) leads us to speculate that familiarity with *hen* was related in some way to degree of use.

One key difference between our study and the previous work on GIMs in Spanish is that we examined the processing of -x in Spanish pronouns with antecedents that constituted grammatically gender-neutral nouns with a neutral bias. The observed differ-

ences between Stetie and Zunino's studies and ours could also be due to the nature of the word where –x was used. While they examined –x in nouns, which belong to linguistically open classes, we examined –x in pronouns, which belong to linguistically closed classes that rarely admit new members (Paterson, 2014). It could have been the case that processing –x in pronouns was more costly because unlike nouns, pronouns engage in a resolution process in which readers must link the pronoun with its antecedent. Although this might be the case, this explanation does not account for why our –x/–o results aligned with Zarwanitzer's (2019). Establishing comparisons between previous processing studies and ours is also complicated due to the different sentence regions for which reading measures were extracted: while some researchers examine reading time of the entire sentences and others consider certain sentence chunks, we measured reading time on the pronouns. Future studies should explicitly compare how processing –x differs in nouns versus pronouns.

The nuanced findings regarding the –x/–a comparisons represent new findings for the literature on processing GIMs in Spanish. The lack of a difference between –x and –a in first fixation time hints at this nuanced relationship, since first fixation time represents the earliest point in which effects can be observed due to properties of a word, such as frequency (Liversedge et al., 1998). In this case both –x and –a are less frequent plural forms that serve as the generic, in contrast to the masculine –o, which is the default generic plural in Spanish. With respect to gaze duration, a measurement linked to the sensitivity of semantic and syntactic anomalies (Rayner et al., 2004), we interpret the longer gaze duration time of –x, when compared to –a, as evidence that, although most of our sample included –x as one of their preferred GIMs, readers have not yet fully integrated –x into their linguistic systems. This notion is further supported by the longer regression path time for –x in contrast to –a, which reflect lexical integration difficulties (Rayner et al., 2004). However, once readers move into total time, the –a morpheme results in the longest reading time. We believe this effect suggests two things. First, although –x was associated with early and late processing costs with gaze duration and regression path time, its processing in later stages is not insurmountable. The shorter total reading time, when compared to –a, suggest that, once readers engage in more conscious processes, they are able to overcome the temporary processing costs associated with –x. This interpretation makes sense particularly for speakers who use –x as a GIM. Second, the longer reading time for –a cannot be explained by an argument of novelty, since –a is part of the grammatical gender system acquired by Spanish speakers. Nevertheless, the use of –a in plural contexts is considered marked by Spanish grammarians (Roca, 2005, 2006). In other words, it can only be used to refer to a group of females. When processing the two traditional grammatical genders in Spanish, an asymmetry that favors the processing of the masculine grammatical gender over the feminine grammatical gender has been found (see Beatty-Martínez & Dussias, 2019, for a review on this topic). It is possible that this reported processing asymmetry emerged in our partici-

pants' later processing stages. Although GIM  $-x$  also showed a gender asymmetry when compared to  $-o$  in all processing stages, the fact that it did not show a clear asymmetry pattern when compared to  $-a$  may be suggestive of its initial stage of integration into the grammatical gender system of this participant sample. Further support for the beginning of this integration process is provided by our accuracy findings, which showed no differences between morphemes  $-o$ ,  $-a$ , and  $-x$  in predicting accurate comprehension. To our knowledge, this is a new finding since previous studies have not examined whether morphemes  $-o$ ,  $-a$ , and  $-x$  differ in their ability to predict accuracy. This finding suggests that when participants are recalling information to answer comprehension questions, the use of  $-x$  in pronouns does not pose an additional cost. In other words, any processing cost of  $-x$  that appears when reading sentences (online) no longer seems to influence participants' behavior (offline) when they answer comprehension questions. This finding can be associated with the lack of a difference found by [Stetie and Zunino \(2022\)](#) in total response time to the question.

The findings have implications for models of sentence processing. The longer reading time on pronouns with GIM  $-x$  indicate that readers faced increased cognitive demands when integrating this novel morpheme into sentence structures. These effects are in line with predictive processing models, such as those grounded in surprisal theory ([Hale, 2001](#); [Levy, 2008](#)). According to surprisal theory, comprehenders use fine-grained probabilistic knowledge derived from prior linguistic experience to form expectations about the structural interpretation of the input that they have received and that which may be upcoming; these expectations immediately determine processing difficulty and guide interpretation preferences. In our study scenario, processing pronouns with the GIM  $-x$  may disrupt participants' predictions due to its relative novelty and low frequency compared to the canonical grammatical gender forms. This, then, may lead to higher surprisal and processing costs, particularly for readers with certain characteristics (e.g., those who identify with binary gender, heterosexuals, those with mixed attitudes towards GIMs). In a related vein, the longer gaze durations and regression path time suggest that readers engage in reanalysis upon encountering GIM  $-x$ . This interpretation aligns with approaches, such as good enough processing ([Ferreira et al., 2002, 2009](#)), according to which sentence processing is not always necessarily complete and detailed, but simply good enough for the purpose at hand. Therefore, instead of relying on full syntactic analyses, comprehenders use heuristics to parse sentences; as a result, ambiguities may remain unresolved and underspecified during comprehension, and deep processing will only be carried out if it is required by the task that comprehenders must complete. In the context of sentences including pronouns with GIM  $-x$ , reanalysis likely reflects the reader's need to reconcile a novel grammatical gender marker with the broader syntactic, semantic, and perceived sociopragmatic context.

Additionally, the absence of significant accuracy differences across the three experimental conditions, despite increased processing effort for the GIM  $-x$ , highlights an

important distinction in certain cognitive load theories: processing effort does not necessarily impair comprehension. This finding contributes to the understanding of cognitive resource allocation in sentence processing. While readers incur greater cognitive effort when processing pronouns with -x, they successfully allocate resources to maintain accuracy in comprehension. This discrepancy between effort and outcome can be understood through the resource allocation model, also known as the capacity theory of attention (Kahneman, 1973), which suggests that attention is a limited cognitive resource that can be allocated to more than one task, but the capability to do so depends on the extent to which the tasks require attention. Therefore, readers dynamically adjust their focus and resource distribution depending on the goals at hand. When encountering new, unexpected, and potentially unfamiliar forms like -x, readers may engage in compensatory strategies, such as slower reading or reanalysis, without compromising overall understanding.

A secondary goal of this study was to explore the relationship between extralinguistic factors and the linguistic processing of GIM -x. These have proven to play a role in use of gender-inclusive language in previous studies (e.g., gender identity and interest in gender issues in Gustafsson Sendén et al., 2015; sexual orientation in Popič & Gorjanc, 2018). Despite not being able to properly estimate these effects, we can interpret the emerging trends in the data. We hypothesize that these emerging trends might be the ones responsible for the inverse relationship between the -x/-o and -a/-x contrasts identified by the random slopes of our models. In general, the trend that non-binary and LGBTQIA+ individuals had shorter reading time on -x in comparison to -a across all reading measurements suggests that there might be additional variables not captured by this study that affect speakers' experience with the GIM -x. One possible explanation is that -x might be more commonly used by non-binary individuals and LGBTQIA+ individuals on a daily basis, and this exposure might influence how they process the GIM -x. There was, after all, a tendency for participants with more experience with gender studies to display shorter reading time on -x; this could also reflect more familiarity with -x through increased exposure. Therefore, future studies should endeavor to accurately capturing an individual's usage of GIMs in different scenarios (work vs. school vs. peers). It is also important for future studies to continue to consider participants' attitudes towards gender-inclusive language. In the current study, participants with more positive attitudes or increased acceptance of GIM -x tended towards shorter reading time on -x. Taken together, these emerging trends regarding extralinguistic factors evince that sentence processing is not solely a linguistic phenomenon, but rather that it is deeply intertwined with sociocultural and individual experiences. Consequently, models of sentence processing should integrate as core components the social identities, perceptions, beliefs, and experiences of language users. This has been attempted by frameworks that aim for more flexible parsing, such as the constraint-based lexicalist approach (MacDonald et al., 1994), which proposes that the comprehension process is guided by a series of con-

straints pertaining to multiple sources of information, including syntactic, semantic, and contextual cues. In our study, the influence of individual differences, such as familiarity with gender studies and socio-cultural attitudes, supports models that emphasize the interplay between linguistic knowledge and extralinguistic factors in real-time processing. On a related, more applied note, it is crucial to develop in future work a validated scale that adequately measures attitudes towards gender-inclusive language. This will enable researchers to better disentangle the complex relationship between language attitudes, gender biases, and gender attitudes, as well as help achieve more consistency among different studies regarding the way attitudes are measured.

The present study contributes empirical data to the body of research focusing on the processing of gender-inclusive language in Spanish. To our knowledge, it is the first to use an eye-tracking technique (most studies have used self-paced reading), allowing us to obtain data that reflects both early and later processing stages. It is also the first to examine the processing of the GIM  $-x$  on pronouns (most studies have examined Det-N phrases) and to compare the  $-x$  to both traditional morphemes, the masculine  $-o$  and the feminine  $-a$  (most studies have considered only the generic masculine  $-o$ ). While our study provides valuable insights into the fine-grained processing of GIM  $-x$ , we must acknowledge the following limitations. First, although our sample size is close to the median reported in a recent methodological review of eye-tracking studies (King et al., 2019), it is likely underpowered, as pilot testing to obtain the necessary parameters for a mixed-effects power analysis (Brysbaert & Stevens, 2018) was not feasible in our context. Future studies should aim to recruit a larger sample size to test the trends we identified with our extralinguistic factors. Since this may be challenging, particularly regarding gender identity, as documented in previous studies, we encourage researchers to collaborate to recruit more individuals from underrepresented groups. In conclusion, despite these limitations, our study highlights the importance of examining the processing of GIM  $-x$  in contrast to both canonical morphemes. A comprehensive understanding of how Spanish speakers integrate GIMs into their language cannot be put forth unless both traditional grammatical genders are considered. In this case, having analyzed  $-x$  not only in relation to  $-o$ , but also with respect to  $-a$ , provided evidence of what may be considered initial steps towards people's incorporation of gender-inclusive forms into their linguistic system. Future work in this area should continue to examine how different GIMs are processed alongside traditional forms and explore how extralinguistic factors may modulate their processing.

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**Author Contributions:** *Alexandra Román Irizarry*—Conceptualization | Methodology | Formal analysis | Investigation | Writing – original draft | Writing – review & editing | Visualization. *Rosa E. Guzzardo Tamargo*—Methodology | Resources | Writing – review & editing | Supervision.

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**Ethics Statement:** This study protocol was approved by the Institutional Review Board of the University of Puerto Rico, Río Piedras under authorization number #1819-206. Informed consent was obtained from all participants prior to the study.

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**Preregistration Statement:** Although not pre-registered on any website, the study's original methods and analysis plan are described in *Román Irizarry (2019)*.

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**Data Availability:** For this article, data can be readily accessed online (see *Román Irizarry, 2024*).

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## Supplementary Materials

For this article, all of the materials and data are available in the Supplementary Materials (see *Román Irizarry, 2024*).

### Index of Supplementary Materials

Román Irizarry, A. (2024). *Processing of pronouns with gender-inclusive –x in Spanish: An eye-tracking study* [Materials, Data]. OSF. <https://osf.io/9gf3e>

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