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Authors

Wen, Vic Tianlan

Conrod, Kirby

Grodner, Daniel

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Processing of, and Adaptation to, Nonbinary Pronouns

Vic Tianlan Wen¹ (twen1@swarthmore.edu), Kirby Conrod², & Daniel J. Grodner¹

¹Department of Psychology, Swarthmore College

²Department of Linguistics, Swarthmore College

Abstract

In recent years, the pronoun system of English has begun to accommodate gender diverse identities. The present study investigates how individuals process and adapt to two novel pronouns: nonbinary *they* and the neopronoun *ze*. Using a Web-based maze task, we compared processing of these pronouns relative to binary *s/he* pronouns. We also examined how reading behavior adapted to repeated exposure to each pronoun. Perhaps unsurprisingly, the rarer *ze* elicited greater processing difficulty than singular *they* overall. However, participants adapted more quickly to *ze* than to *they*. We propose that *ze* may be more easily learned than singular *they* because it does not compete with plural *they*.

Keywords: nonbinary pronouns; singular *they*; neopronouns; online processing; adaptation

Introduction

In recent years, nonbinary pronouns have become increasingly common alongside growing awareness of gender diverse identities. As of 2021, 26% of US adults, and 46% of those under 30, reported knowing someone with nonbinary pronouns, an increase from 2018 by 8 and 14 percentage points respectively (Minkin and Brown 2021).

This growth in usage has potential to affect language processing. Difficulty may arise from the fact that not all English users perceive nonbinary pronouns to be fully grammatical (Conrod 2019, Rose et al. 2023). On the other hand, people may gradually adapt to the pronouns with increased exposure.

English nonbinary pronouns are third person singular animate pronouns commonly associated with nonbinary referents. By far the most common of these is specific singular *they*, however many individuals adopt neologistic pronouns such as *xe*, *ze*, *fae*, and *thon*. All nonbinary pronouns share syntactic environments with their binary-gendered counterparts, *she* and *he*:

(1) Alex_i went to bed because she/they/ze_i felt tired.

In this paper, we investigate how English users process and adapt to specific *they* and the neopronoun *ze*. We ask: (1) Do *they* and *ze* incur different processing costs compared to binary pronouns? (2) Do people adapt differently to *they* and *ze* over the course of the experiment? and (3) Do individual differences in explicit off-line acceptance of nonbinary pronouns predict on-line processing difficulty and

adaptation? *Ze* may be more difficult than *they* due to its status as a neologism in a closed class. However, *ze* is also less referentially and pragmatically ambiguous than *they*, whose nonbinary sense is the least common of many usages. This might facilitate learning for *ze*. For both pronouns, difficulty may be reduced for those who accept definite specific usages of *they* compared to those who find them ungrammatical.

By investigating the adaptability of nonbinary pronouns, we hope to inform relevant learning strategies that would reduce misgendering, which is associated with poor mental health (McLemore 2015). More generally, our findings could contribute to a better understanding of how the language processing system handles novel grammar.

Specific singular *they*

As a third-person animate singular pronoun, *they* can refer to generic, indefinite, or specific antecedents. The nonspecific usages date back to at least to the 1300s (Baron 2019). Specific usages, attested more recently, can be used when an individual's gender is unknown, irrelevant, or obfuscated (Camilliere, Leventhal, Izes, & Grodner 2021). The most novel use of specific *they* is for individuals whose pronouns are known to be *they/them* (Konnolly, Conrod & Bradley 2023). We will refer to this use as nonbinary *they*.

Work on explicit judgment has identified varied levels of acceptability for specific *they* (Bjorkman 2017, Konnolly & Cowper 2020), predicted by age (Conrod 2019), prescriptivism (Hernandez 2020), sexism (Bradley 2020), and familiarity with nonbinary individuals (Ackerman et al 2018). Camilliere et al. (2021) identified three subgroups of English speakers who accept *they* to different extents: non-innovators, who only accept generic antecedents (2a); innovators, who also allow specific antecedents without strong association to binary genders (2a-b); and super-innovators, who accept any animate antecedent (2a-c).

(2a) Someone_i called and they_i left a message.

(2b) Your student_i called and they_i left a message.

(2c) Your sister_i called and they_i left a message.

In contrast to explicit offline judgments, work on implicit online processing has found a cost associated with nonbinary *they* for all subgroups of *they* users. Using a web-based maze task (see discussion below), Mansoor et al. (2022) found that singular *they* referring to a named antecedent was read more

slowly than plural *they* for all groups. However, super-innovators exhibited smaller differences than other subgroups. In addition all groups were reliably better at accommodating nonbinary *they* than gender-mismatched binary pronouns. Similar patterns have been observed using ERP methods. Chen et al. (2021) observed a P600 effect in response to nonbinary *they* compared to plural *they* for both innovators and super-innovators.¹ The P600 component is associated with syntactic processing difficulty (see Lecky & Federmeir 2020 for a review).² Taken together, this work suggests that while nonbinary *they* may not be ungrammatical for all subgroups, all subgroups find it more difficult to process than plural *they*. One possible explanation for this difficulty is that *they* is inherently ambiguous. Note that there are many usages for *they* – e.g., plurals, generics, institutions – among which specific *they*, especially nonbinary *they*, is a recent innovation. The nonbinary sense must therefore compete with more established (and more common) alternative uses in comprehension. Note that even if nonbinary *they* were to be universally adopted and accepted pronoun for nonbinary individuals, it would still be less common than plural *they*. There is an enduring processing cost for resolving an ambiguous lexical item to a less common interpretation (Burgess & Simpson, 1985). If this ambiguity is the primary cause of difficulty, then it is not likely to be eliminated with continued exposure. In contrast, an unambiguously nonbinary neopronoun would not have to compete with alternative referential interpretations. A nonbinary neopronoun then might be learned faster than the nonbinary *they*. The present study investigates this possibility.

Neopronouns

Neologistic pronouns, or neopronouns, have been coined since at least the 1800s as gender-neutral alternatives to generic *he*, though none had achieved widespread usage (Baron 2019). In recent years, a variety of neopronouns are being adopted and coined by gender diverse people as their personal pronouns of reference (Gender Census 2023, Miltersen 2017). Corpus research suggests this revival to have taken place around the 2010s on blogs and creative writing sites, likely led by young people (Hakanen 2021, Rose et al 2023).

Work on explicit judgment suggests that English neopronouns are not as accepted as the canonical *he*, *she*, and *they*. Hekanaho (2020) found that, when referring to a nonbinary antecedents, the neopronouns *xe* and *ze* were perceived as less acceptable than *they*, and that cisgender women and transgender people rated them higher than cisgender men. Similarly, Rose et al. (2023) found that *xe*, *ze*, *ey*, and *fae* were rated lower than *s/he* and *they*, albeit higher than ungrammatical controls, and that age, gender, and sexual

orientation predicted acceptability. These findings may be attributed to the pronouns' status as closed-class morphemes. Because such morphemes are grammatical elements, they are less amenable to innovations.

Syntactic Adaptation

Of course, languages do undergo grammatical change. Work on syntactic adaptation suggests that people may be capable of acclimating to unfamiliar grammatical structures even in the course of an experimental session. For instance, when presented with the “needs done” construction (e.g., “the car needs washed”), participants unfamiliar with it were gradually able to read it as quickly as its standard counterpart (“the car needs to be washed”), and this learning generalized to related novel constructions (Kaschak & Glenberg, 2004; Kaschak, 2006). Comparison with controls who use the construction in their dialect yielded similar results (Fraundorf and Jaeger, 2016). However, since participants did not differentiate between regionally acceptable and unacceptable constructions, it is unclear whether adaptation effects represented early-stage grammar acquisition or increased tolerance for perceived errors (Boland et al., 2023).

With respect to pronouns, there is also evidence that comprehenders adapt to recently observed usage patterns (Ye & Arnold, 2023). Of particular relevance to the current study, Kesan and Arnold (2025), asked participants who *they* referred to in referentially ambiguous sentences (e.g., *The gardener showed the man some new snapdragons, and then they decided to wash up.*). They found that readers who were exposed to definite singular uses of *they* (e.g., *The cyclist walked into the store and they bought some milk*) were more likely to choose a singular referent for an ambiguous use of *they* (44% of the time) than participants who were exposed to plural *they* (33.6%). This demonstrates that referential patterns are sensitive to local statistical patterns. An open question is whether this extends to non-binary uses of *they*.

Experiment

The present study investigates how readers adapt to processing non-binary pronouns and whether reading behavior is affected by the subgroup (non-innovator, innovator, or super-innovator) to which an individual belongs. To assess online processing, participants read sentences using a web-based Maze task. To assign subgroup, participants completed a survey in which they judged the acceptability of *they* with various antecedent types.

Methods³

Participants. A total of 117 participants were recruited to participate in an online experiment through Prolific. Participants were American, native English speakers, ages

¹ There were not enough non-innovators among their participants to analyze.

² Gender-mismatched *s/he* also elicited a P600, but in contrast to nonbinary *they*, mismatched *s/he* elicited an additional Nref effect. The Nref reflects difficulty identifying a referent (Van Berkum, et

al. 2007). These results suggest that the grammatical processing difficulty of nonbinary *they* does not cause referential confusion like mismatched *s/he* does.

³ Methods and analyses were preregistered at aspredicted.org

	Strong Match	Intermediate Match	Weak Match
Binary Pronoun	Amanda was studying for the bar because <i>she</i> wanted to be a lawyer.	Alex bought a new phone because <i>he</i> broke the old one.	Alice bought a new phone because <i>he</i> broke the old one.
Non- binary Pronoun	-	Alex bought a new phone because <i>they/ze</i> broke the old one.	Alice bought a new phone because <i>they/ze</i> broke the old one.

Table 1: Example stimuli. Sentences were preceded by an introduction: "This is a story about [name], who uses [pronouns] pronouns." Critical pronouns are noted in italics (they were not italicized for participants)

19-41 who had completed at least 100 Human Intelligence Tasks (HITs), and who had an excellent performance record on previous HITs (minimum of 95% approval rating). They were required to participate with a desktop device with a physical keyboard.

Materials. Stimulus sentences contained a pronoun that referred to a named antecedent. 100 stimuli were constructed with four variants each crossing two conditions: Pronoun Type and Antecedent Match. Pronoun Type was either binary (*he/she*) or nonbinary (*they* or *ze*). Antecedent Match described the degree to which the gender associated with named antecedent matched the gender features of the pronoun. Critical items consisted of intermediate matches for which the antecedent did not have strong association with a binary gender (e.g., *Alex...s/he*, *Alex...they/ze*), and weak matches, for which the antecedent had a strong association with a binary gender (e.g., *Alice...he*, *Alice...they/ze*) (see Table 1). The conditions of the 100 stimulus sentences were assigned to four presentation lists according a Latin square design. An additional 25 control sentences contained a gender biased antecedent that was referenced with a binary pronoun with matching gender features (Strong Match; e.g., *Amanda...she*). All participants read these controls for a total of 125 sentences per list.

The antecedents' names were sourced from the 1998-2004 Social Security Name Database, where names in each of the following categories were selected for norming (a) the 200 most common names assigned to females at birth that were not among the 1000 most common male names; (b) the 200 most common names assigned to males at birth that were not among the 1000 most common female names; and (c) the 200 most common names that appeared on both male and female birth lists. The names were then rated for gender association and familiarity on a five-point scale from masculine to feminine by 40 participants who did not participate in the reading study. The 50 most equi-biased names were assigned to the intermediate match conditions. 50 biased names (25 feminine) were assigned to the weak match conditions, and 25 biased names were assigned to the strong match condition

(13 feminine).

Procedure. Participants first read a short passage about the purpose and use of a nonbinary pronoun, either *they* or *ze*, before being asked to complete five sentences with the correct form of that pronoun (Table 2). Participants saw sentences one at a time and were given feedback if they entered the wrong answer, such that they could not proceed without correcting themselves. The purpose of this task was to familiarize people with the concept of nonbinary pronouns, and to ensure knowledge of the relevant forms.

After training, participants were directed to a web-based variant of the maze task (A-Maze; Boyce et al., 2020) in which they read the aforesaid 125 sentences. Prior to each stimulus sentence participants were told, "This is a story about <Name> who uses <pronouns> pronouns." The goal was to maximize the likelihood that participants would adapt to novel pronoun usages. The stimulus sentences were then read word by word. Each word of the sentence was presented alongside a foil word, which was length and frequency matched to the target word but did not grammatically fit within the unfolding sentence. Fit was determined as having high surprisal according to a LSTM large language model (Gulordava et al., 2018). Participants had to select the word that continued the sentence correctly. Reaction times and error rates at each word were recorded. Individuals tend to read more slowly and make more errors at points of increased processing difficulty.

After the maze task, participants completed an explicit judgment task on different usages of *they* replicated from Camilliere et al. (2021). 40 stimuli were constructed where some form of *they* (*they/them/their/themselves*, represented equally) was coreferential with an antecedent from one of eight categories (Table 3). These were interspersed with 15 filler items in which the antecedent was inanimate (e.g., "the cup"). Participants were asked to rate how naturally *they* referred to each critical antecedent.

Table 2: Training items. Participants were instructed to "Complete the following sentence about [name], whose pronouns are [pronouns]."

Case	Sentence
Nominative	Harley dreamed that ___ was (were) being chased by a bear.
Accusative	Nicholas loved drawing because it helped ___ relax.
Possessive adj.	Jaiden found ___ life in college very fulfilling.
Possessive prn.	-Do you know Eve? -Yes, I'm a good friend of ___.
Reflexive	Moss excused ___ from the meeting to address a personal emergency.

Antecedent Type	Example
Plural noun phrase	The dentists
Quantified noun phrase	Every dentist
Socially distant, non-gendered	The dentist
Socially close, non-gendered	My friend
Socially distant, gendered	The actress
Socially close, gendered	My sister
Non-gendered Name	Taylor
Gendered Name	Sophia

Table 3: Example antecedents for the judgment task for the frame “__ said that they would be coming late to dinner”.

Results

A total of nine participants were excluded based on preregistered criteria, accounting for 7% of the data. Three participants were excluded for being inaccurate on every trial. An additional 4 participants were excluded for having accuracy more than 2.5 *SD* lower than the median, and 2 were excluded for having average response times 3 *SD* higher than the median. Analyses were conducted using linear mixed effects models via the lme4 package in R, with participant and item number as random effects. Categorical fixed effects were sum coded. Continuous factors were centered and scaled. Models contained the maximal random effects justified by the data and the design (Barr et al., 2013). Degrees of freedom for statistical tests were determined by the Satterthwaite approximation.

Accuracy rates were at ceiling (>97%) for all conditions so we focus on reaction time results (see Figure 1). Response times were compared in an LMEM with nonbinary pronoun type (*they* vs. *ze*) and match (intermediate vs. weak) as fixed effects. There was a main effect of nonbinary pronoun type: participants respond faster to *they* than to *ze* ($\beta=37.1$, $t(109.3)=2.65$, $p < .01$). However, there was no significant effect of match or interaction between match and nonbinary pronoun type ($t_s < 1$), suggesting that equibaised names did not ameliorate processing difficulty for either pronoun.

A second analysis modeled pronoun type (binary vs nonbinary) and match (intermediate vs weak) as fixed effects. There were main effects of pronoun type ($\beta=13.6$, $t(98.9)=3.59$, $p < .001$) and match ($\beta=14.25$, $t(9776)=4.23$, $p < .001$), as well as an interaction effect between pronoun type and match ($\beta=11.3$, $t(9768)=3.35$, $p < .001$). Participants responded faster to binary pronouns than to nonbinary pronouns, and faster to intermediate matches than to weak matches. Furthermore, the response time difference between intermediate and weak matches was larger for binary pronouns than for nonbinary pronouns.

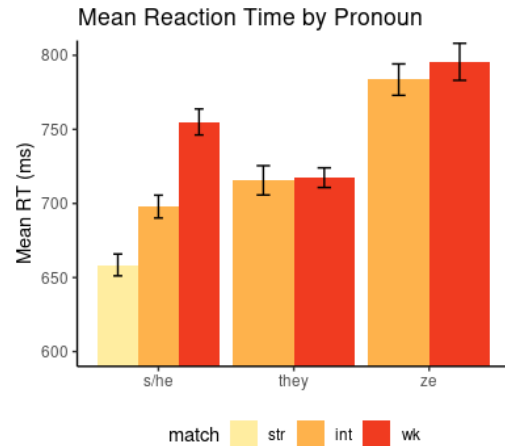


Figure 1: Mean reaction time at the pronoun for each condition. Error bars indicate 95% confidence intervals.

To examine adaptation effects, RTs were modeled with log corrected critical item order⁴, nonbinary pronoun type, match, and their interactions as fixed effects. There were main effects of item order ($\beta=-59.3$, $t(113)=-10$, $p < .001$), nonbinary pronoun type ($\beta=68.4$, $t(183)=3.5$, $p < .001$), and match ($\beta=37.6$, $t(97.2)=2.57$, $p < .05$): Participants were faster on later trials, faster with *they* than *ze*, and faster with intermediate matches than weak matches. There was also an interaction effect between critical order and nonbinary pronoun type, such that the decrease in response time over the course of the experiment was greater for *ze* than for *they* ($\beta=14.7$, $t(117)=2.48$, $p < .05$). Finally, there was an interaction effect between critical order and match, such that the decrease in response time over the course of the experiment was greater for weak matches than for intermediate matches ($\beta=16$, $t(111)=2.7$, $p < .01$). There was no interaction effect between nonbinary pronoun type and match, and no interaction between critical order, nonbinary pronoun type, and match ($t_s < 1$).

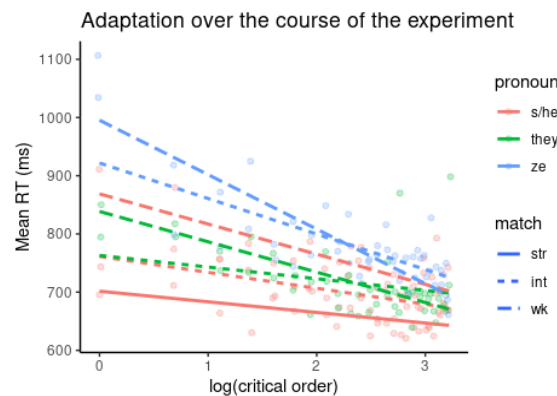


Figure 2: Adaptation over the course of the experiment

To examine differences among subgroups, participants were classified into clusters as non-innovators, innovators, Model results and patterns of significance were qualitatively similar when models were fit assuming a linear relationship.

⁴ We follow Fine and Jaeger (2016) and Prasad and Linzen (2021) in assuming logarithmic adaptation across items and reading time.

and super-innovators based on their performance on the acceptability judgment task using the procedure from Camilliere et al. (2021). An LMEM was constructed with cluster and nonbinary pronoun type as fixed effects. There were marginal effects of nonbinary pronoun type ($p = 0.066$) and cluster ($p = 0.052$): participants responded more slowly to *ze* than to *they*, and non-innovators responded slower than innovators and super-innovators, but the response times of innovators and super-innovators did not differ significantly. There was no interaction of cluster and nonbinary pronoun type ($t < 0$).

Separate models were fit to the data for each nonbinary pronoun predicting RT with participant subgroup and log of critical order as fixed effects. For *they*, there was an effect of critical order ($\beta = -53.5$, $t(910) = -5.5$, $p < .001$) and a marginal effect of subgroup: non-innovators read more slowly than innovators and super-innovators ($\beta = 169$, $t(150) = 1.77$, $p = .08$), but innovators and super-innovators did not reliably differ. For *ze*, there was again a reliable effect of order ($\beta = -59.3$, $t(113) = -10$, $p < .001$) indicating significant adaptation. Non-innovators were reliably slower than the other subgroups ($\beta = 240$, $t(142) = 3.6$, $p < .001$), but innovators and super-innovators did not reliably differ. There were also interactions between subgroup and item order: non-innovators adapted more over the course of the experiment than innovators and super-innovators ($\beta = -57.8$, $t(2185) = -3.0$, $p < .01$), and innovators adapted more than super-innovators ($\beta = -41.43$, $t(2190) = -2.3$, $p < .05$).

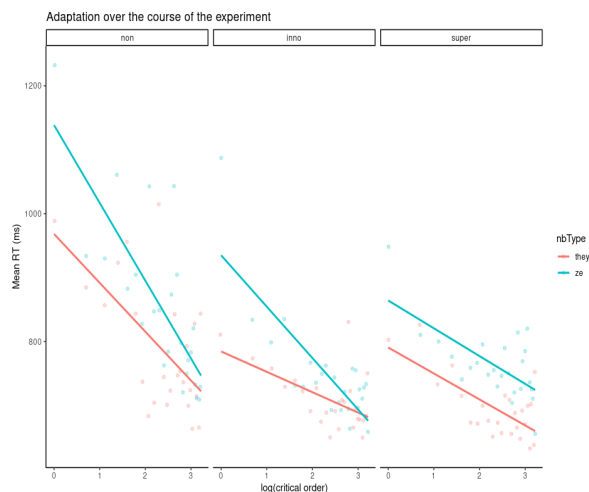


Figure 4: Adaptation to each pronoun type by subgroup

Discussion

Participants responded more slowly to *ze* than to *they*. This may be due to *ze*'s neologistic status in a closed class: English pronouns form a small category of function words that resists the addition of novel items. If this is the case, then the difference in response time to *they* and *ze* may be ameliorated for English users to whom *ze* is less neologistic and more accepted. The current study found no interaction between *they*-user subgroup and nonbinary pronoun type overall, suggesting that greater acceptability for singular *they* does

not predict a smaller difference in response time. Further research is needed to determine whether acceptability for *ze* is predictive of response time differences. Non-innovators were slower than both innovators and super-innovators in response to both *they* and *ze*. Camilliere et al (2021) found super-innovators to be younger, more familiar, and more accepting of nonbinary identities. These qualities might have contributed to a smaller processing cost for nonbinary pronouns. On the other hand, non-innovators adapted more quickly than innovators to *ze*, and innovators more quickly than super-innovators, but the same trend was not true for *they*. This may be because *they* is more familiar to all groups of speakers (and thus shows less variation in adaption); whereas *ze* may be more familiar to super-innovators, who consequently have less room for improvement.

Despite slower response times to *ze*, participants adapted more quickly to *ze* than to *they*. This supports the hypothesis that *ze* is more learnable than *they* due to being unambiguous. An alternative potential explanation for this difference in adaptation is error-based learning (Jaeger & Snider, 2013): participants had more difficulty with the novel neopronouns than singular *they* because neopronouns are more at odds with prior expectations. If learning in this task is error based, then we would expect faster learning for neopronouns, which elicit larger errors, than for singular *they*. A slightly different, but related explanation has been proposed by Prasad and Linzen (2021). They argue that much of adaptation in reading tasks is adaptation to the task itself. Moreover, this task adaptation is start point dependent: greater for sentences that are processed more slowly at the beginning of an experiment. This would result in a greater decrease in processing times for *ze* relative to *they* even if adaptation was to the task and not the linguistic items. Additional work is underway to determine which of these alternative accounts best explains the differential rates of adaptation to *ze* and *they*. For instance, we are currently examining whether these differences persist even after an initial exposure phase during which participants have fully adapted to the task with only the weak, intermediate, and strong binary pronouns conditions. If so, it would militate against a task-adaptation explanation. Another question is whether *ze* can be processed more quickly than *they* or weakly-matched *s/he* given sufficient exposure. The error-based learning account predicts that *ze* can never be faster than these forms given equal training.

It is worth asking what mechanistic changes underlie the present adaptation effects. There are a number of possibilities that could have been operative singly or in combination. It is possible that mismatched pronouns diminished participant assumptions about the gender of the individuals in the sentences based on their name. It is also possible that the various pronoun types decreased participants' expectations for a specific binary pronoun so they were better able to process different pronoun types. Another possibility is that exposure to the non-binary pronouns made participants more fluent with processing the word forms *they* and *ze* and integrating them with singular definite antecedents. Note that

adaptation appears to be a function of implicit practice. Each named individual was explicitly introduced with their pronouns prior to each sentence. This explicit guidance was not sufficient to override preexisting (presumably) implicit expectations associated with the gender bias of each name. Participants processed strong-matched *s/he* pronouns faster than intermediate- or weak-matched *s/he* pronouns. Explicit introductions also did not on their own eliminate difficulty with singular *they* or *ze*. Intermediate and strongly matched binary pronouns were processed faster than *they* or *ze* in any condition.

Conclusion

We found evidence that participants adapted more quickly to *ze* than to singular *they*. This is striking given that adding new grammatical elements to a language is extremely rare. We have argued that this could result from the ambiguity of *they*. Using *they* to refer to a definite named individual is far less common than using *they* to refer to a plural, indefinite, or generic antecedent. Difficulty may arise from resolving the pronoun to a relatively rare antecedent type. If this is the primary source of difficulty for singular *they*, then it may persist even if the use of singular *they* becomes more generally accepted. Future experiments should more directly assess this possibility by investigating the effect of ambiguity in the current linguistic environment on the processing of *they*. Another prediction of this view is that, with sufficient training, neopronouns will actually become easier to process than singular *they*.

The present work has important social implications. First, the fact that there are very low error rates across conditions demonstrates that nonbinary pronouns are not interpreted as wholly ungrammatical. Second, we have shown that even non-innovators speakers can adapt to both types of nonbinary pronouns. Third, if indeed there is special cognitive difficulty with processing singular *they*, this could hinder the adoption of inclusive language even as openness to trans and nonbinary identities increases. People tend to resist behaviors that are cognitively effortful. It will be important to spread awareness of such sources of resistance to change to reduce frustration among people aspiring to use more inclusive language, and to increase grace among people who already do so.

Acknowledgments

AI was used only to generate foils for stimuli in the maze task.

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