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Examining the glottal stop as a mark of gender-inclusive language in German

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Abstract

Grammatical gender form influences readers' mental gender representations. Previous research demonstrates that the generic masculine form leads to male-biased representations, while some alternative forms lead to female-biased representations. The present research examines the recently introduced glottal stop form in spoken language in German, where a glottal stop (similar to a short pause), meant to represent all gender identities, is inserted before the gender-specific ending. In two experiments (total $N = 1188$), participants listened to sentences in the glottal stop, the generic masculine, or the generic feminine form and classified whether a second sentence about women or men was a sensible continuation. The generic feminine and the glottal stop led to female biases (fewer errors in sentences about women vs. men) and the generic masculine led to a male bias. The biases were smaller for the glottal stop and the generic masculine than for the generic feminine, indicating that the former two are more readily understood as representing both women and men.

Keywords: generic masculine; gender-fair language; gender-inclusive language; glottal stop; gender representations

Examining the glottal stop as a mark of gender-inclusive language in German

Languages differ in what kind of information they require speakers to state (Boas, 1938; Slobin, 2003). Number (singular or plural) is grammaticalized and therefore obligatory in English, while it can be frequently left unspecified in Japanese. Conversely, the source of information (evidentiality) is obligatory in about a quarter of the world's languages, for example, partially in Turkish and Japanese, but not English (Matsui & Fitneva, 2009). The present work examines another aspect that is sometimes obligatory: gender. In some languages, it is mostly (in genderless languages, e.g., Turkish) or frequently (in natural gender languages, e.g., English)

possible to mention people without specifying their gender (e.g., English: *The referee is unfair.*). However, in grammatical gender languages, a grammatical gender form, usually masculine or feminine, has to be chosen when referring to people (e.g., in Spanish: *El/la árbitro/árbitra es injusto/injusta.* "The$_{masc}$/the$_{fem}$ referee$_{masc}$/referee$_{fem}$ is unfair$_{masc}$/unfair$_{fem}$."; Corbett, 1991; Gygax et al., 2019; Stahlberg et al., 2007). As they are always explicitly stated, obligatory language aspects attract attention, and this has psychological consequences (Slobin, 2003; see also von Humboldt, 1836; Whorf, 1956). In the case of gender, the grammatical gender form influences representations of persons' gender (Stahlberg et al., 2007). This influence of gender form has been mainly examined for written language. In the present research, we examine the influence of different gender forms in spoken language. We especially concentrate on the glottal stop form, an increasingly used form in German, meant to represent all genders, and compare it to other linguistic forms.

Processing gender forms in written language

To refer to people in a generic (i.e., gender independent) way, almost all natural and grammatical gender languages traditionally employed the masculine form (Hellinger & Bußmann, 2015). Thus, the masculine form is ambiguous, as it can either specifically refer to men or generically refer to people of all genders. Readers need to determine which of these two interpretations is intended from additional information. In contrast, the feminine form has traditionally been used only specifically, that is, when referring to females. A generic usage of the feminine form is rare but it does exist (chiefly in feminist publications but occasionally also in universities or public media, e.g., the Grundordnung of the University of Leipzig: http://db.uni-leipzig.de/bekanntmachung/dokudownload.php?dok_id = 3683; for other examples, see Zifonun & Drewnowska-Vargáné, 2019). In the present work, we use the terms generic masculine form and generic feminine form to refer to the respective forms when they are used in a gender-inclusive context. We do not mean to imply that these forms are grammatically distinct from the gender-specific forms but only that they are used generically.

In several grammatical gender languages, the generic masculine has been shown to lead to male-biased person representations (for reviews, see Gabriel et al., 2018; Sczesny et al., 2016; Stahlberg et al., 2007). After reading generic masculine forms, participants were, for example, faster and more accurate to react to male compared to female exemplars and subgroups (e.g., Gabriel & Gygax, 2008; Garnham & Yakovlev, 2015; Gygax et al., 2008, 2012; Irmen & Roßberg, 2004; Körner et al., 2022; Sato et al., 2016; for similar findings using EEG, see Mikić Ljubi et al., 2022; Misersky et al., 2019; Glim et al., 2023a, 2023b; for an exception, see Rothermund, 1998). Similar results have also been observed when participants were directly or indirectly asked to indicate referents' gender (Bailey et al., 2022; Braun et al., 1998; Gabriel & Mellenberger, 2004; Gastil, 1990; Hamilton, 1988; Hansen et al., 2016; Heise, 2000; Kaufmann & Bohner, 2014; Keith et al., 2022; Schneider & Hacker, 1973; Stahlberg et al., 2001). This male bias has been found to have psychological

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consequences, influencing, for example, job motivation and intended career choices (Bem & Bem, 1973; Stout & Dasgupta, 2011; Vervecken et al., 2013).

To facilitate more balanced gender representations, several alternatives to the generic masculine have been suggested. These alternatives aim at either *neutralization* by replacing masculine endings or word parts with gender-neutral ones (e.g., in English *firefighters* instead of *firemen* and in German using the participle-I *Studierende* "studying persons" instead of *Studenten* "students$_{masc}$") or *feminization* by (also) naming feminine forms (e.g., in English, *congresswomen and congressmen*).[1] The probably most frequently used alternative to the generic masculine in grammatical gender languages is the pair form, where the masculine and feminine form are both enumerated (e.g., in Spanish: *los/las doctores/doctoras;* "the$_{masc}$/the$_{fem}$ physicians$_{masc}$/physicians$_{fem}$"). In behavioral studies, the pair form generally succeeded in leading to equally strong representations of women and men (e.g., Bailey & LaFrance, 2017; Lindqvist et al., 2019; Rothmund & Scheele, 2004; Stahlberg & Sczesny, 2001; Tibblin et al., 2023). However, by naming the feminine and the masculine forms, the pair form can be argued to emphasize gender and in particular a binary notion of gender (Bigler & Leaper, 2015; see also Hilliard & Liben, 2010). Additionally, the pair form is uneconomical. Especially for spoken communication, always mentioning two groups instead of one can be cumbersome.

In written language, shorter forms that are meant to be gender-inclusive exist.[2] In French, for example, the mid-dot form (e.g., *musicien·ne·s*) is used as a contracted version of the pair form (e.g., *musiciens et musiciennes*, "musicians$_{masc}$ and musicians$_{fem}$"). Similarly, in the German capital I form, which is also meant as a contracted pair form, the small *i* of the feminine ending is replaced by a capital *I* to indicate the omitted parts (i.e., the conjunction and the repetition of part of the noun; e.g., *MusikerInnen*; instead of *Musiker und Musikerinnen*, "muscicians$_{masc}$ and musicians$_{fem}$," so that "*und Musiker*" is omitted; for an overview of additional gender forms in German, see Diewald & Steinhauer, 2020). More recently, in the German gender star form, an asterisk meant to symbolize all—that is, also non-binary—gender identities is inserted after the word stem and before the (typically feminine) suffix (e.g., *Musiker*innen*; "musicians"). Empirically, these three forms have been found to lead to stronger representations of women compared to the generic masculine (Keith et al., 2022; Schunack & Binanzer, 2022; Stahlberg et al., 2001; Tibblin et al., 2022; Xiao et al., 2023; Zacharski & Ferstl, 2023), frequently even to a female bias, that is stronger representations of women than men (e.g., Heise, 2000; Körner et al., 2022; Rothmund & Scheele, 2004; Tibblin et al., 2023).

Processing gender forms in spoken language

Almost all studies that examined the influence of linguistic form on gender representations used written stimulus presentations. To our knowledge, there are only two exceptions. In a study examining Spanish by Anaya-Ramírez et al. (2022), participants first listened to a sentence about a group in the generic masculine; this was followed by an anaphoric reference to either a male or a female person from that group. Participants judged sentence pairs with a male compared to a female person more frequently to make sense, indicating a stronger inclusion of males than females

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when listening to the generic masculine form (Anaya-Ramírez et al., 2022). In a study examining Norwegian by Gabriel et al., (2017), visual and auditory sentence presentations were compared. Concerning groups with a balanced gender stereotype (e.g., pedestrians), a male bias was observed irrespective of whether participants read or heard the stimuli. Thus, the generic masculine had similar cognitive consequences for visual and auditory presentation. For forms other than the generic masculine, there is as yet no research examining auditory presentation.

As most gender-inclusive forms are essentially spelling conventions (Xiao et al., 2023), it is frequently unclear how to realize them in spoken language. However, for the recently introduced gender star form in German (and also for similar forms where the asterisk is replaced by a colon or an underscore), there is by now an established pronunciation—the glottal stop form. The glottal stop, [ʔ], is a change in voicing that sounds approximately like a creak and is inserted at the start of vowel-initial words in many of the worlds' languages (Garellek, 2013). The glottal stop has the advantage of being a phone in German, so that, although it formerly was not used to distinguish meaning, speakers of German are able to pronounce it (Haider, 2022). Since its introduction as a mark of gender inclusiveness, it is meant to carry meaning. /ʃtuˈdɛntɪnən/ (without a glottal stop) denotes a group of female students and /ʃtuˈdɛntʔɪnən/ (with a glottal stop) denotes a group of students of any gender. However, it is still unclear whether it is the glottal stop in itself or the changed suffix that carries a gender-inclusive meaning (for the latter position, see Völkening, 2022). Thus, in principle, the glottal stop form can be distinguished from gender-exclusive forms in German and is additionally very economical because it introduces only one additional phoneme.[3]

Although isolate uses of the glottal stop to denote an inclusion of men and women date back to the 1980s,[4] the wider German-speaking public did not come into contact with a gender-inclusive usage of the glottal stop until much later. In a study published as recently as 2018, participant articulations of gender-inclusive forms varied considerably, leading to the conclusion that there is currently no consistent spoken realization of written gender-inclusive forms (Slavik et al., 2018). Around 2019, the glottal stop form began to be used in mainstream media, garnering news coverage (e.g., Stephan, 2019) and heated discussions (Fromm, 2020). By now, the glottal stop form as a form meant to represent all genders is generally recognized and can be occasionally heard in mainstream media (examples include Germany's popular crime series *Tatort*, the political talk show *Anne Will,* news cast *heute*, and the spiritual impulse *Wort zum Sonntag*). Still, it is clearly infrequently used and is disliked by the majority of people (in 2022, the glottal stop form was endorsed by 27% and rejected by 69% of a representative sample).[5] Concerning usage in the general public, a non-representative survey in 2020 found that 10% of the participants stated that they use the glottal stop form when speaking (Michaux et al., 2021), indicating that the glottal stop form is in active use, though only by a minority of people.

Up to now, research on information processing entailed by the glottal stop form has concentrated on intelligibility. Encountering the glottal stop has been found to lead to small decreases in intelligibility ratings of short news introductions (Jöckel et al., 2021) but has been found to not impair learners' ratings of learning materials (Friedrich et al., 2022). However, as yet it is unclear whether this new usage of the

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glottal stop promotes gender inclusiveness (although judged gender ratios in Jöckel et al., 2021, point in this direction). Giving a new meaning to a speech sound might require long learning, so that the glottal stop form might not yet have acquired the intended meaning of gender inclusiveness in listeners. That is, it is unclear how the glottal stop form influences gender representations among listeners.

The present research

In the present experiments, we examined gender representations elicited when listening to the glottal stop form. We compared the glottal stop form with two other linguistic forms, the generic masculine and the generic feminine. As mentioned above, the generic feminine is rarely used in German (ca. 35% of the participants in Michaux et al., 2021, reported using the generic masculine and 0.5% reported using the generic feminine), but it is still useful as a control condition because the German glottal stop form is very similar to the generic feminine form. In fact, for many German words, the feminine and the glottal stop form are identical except for the added glottal stop. We expected the generic masculine and the generic feminine forms to lead to stronger representations for the explicitly named gender, that is, a female bias for the generic feminine and a male bias for the generic masculine.

Pairwise comparisons of the three forms enable us to address three questions. The first question is whether the masculine compared to the feminine form elicits more balanced gender representations, that is, whether the generic masculine form is more gender-inclusive than the generic feminine form. The feminine form is a marked form and used very rarely in a generic way, whereas the masculine is the traditional generic form. As we expected usage to influence gender representations, we expected a larger bias for the generic feminine compared to the generic masculine.

The second question is whether the glottal stop is understood in a gender-inclusive way. By comparing the glottal stop and the generic feminine form, we examined whether the insertion of a glottal stop leads to more balanced gender representations than hearing the same words without the glottal stop. If there is no difference in gender representations, the glottal stop does not (yet) work as a mark of gender inclusiveness concerning men and women. If the female bias is smaller in the glottal stop form compared to the generic feminine form, the glottal stop entails at least some increased inclusion of men.

The third question is whether the glottal stop or the generic masculine form elicits more balanced gender representations. If the bias size of one form is smaller, this could indicate that this form is currently more easily understood as representing both women and men.

Experiment 1

Method

Participants and design

253 native speakers of German (121 female, 129 male, 3 other gender; aged 18–71 years, $M_{age} = 32$ years, $SD_{age} = 11$; 50 participants were older than 40 years and 6 were older than 60 years; as their highest educational degree, 133 had an (applied)

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university degree, and 81 had completed high school; 39 selected one of four remaining highest educational degree options) were recruited in 2021 through Prolific Academic, participated online, and were compensated by receiving £4.00. On a scale from 1 (*not familiar*) to 5 (*very familiar*), most participants reported being very familiar with the generic masculine form ($M = 4.49$, $SD = 0.89$, $Median = 5$), moderately familiar with the glottal stop form ($M = 3.19$, $SD = 1.32$, $Median = 4$), and rather unfamiliar with the generic feminine form ($M = 1.98$, $SD = 1.20$, $Median = 2$). Concerning their attitude toward "gender-fair" language in general (the glottal stop form in particular), 111 (84) were in favor, 98 (92) were of the opinion that this is up to the individual, and 38 (73) were against its usage (the remaining 6 (4) participants stated that they had no opinion and were therefore not included in analyses that examined attitude as a moderator).

Participants were randomly assigned to a gender form in a 3 (gender form: glottal stop vs. generic masculine vs. generic feminine; between) × 2 (continuation: male vs. female; within) design. This yields a power of .80 (with $\alpha = .05$, and $r = .5$ for repeated measures) for finding $\eta_p^2 = .010$ in a mixed 3x2 ANOVA interaction, for finding $d_z = 0.31$ for within *t*-tests of gender representation, and for finding $d = 0.44$ in between *t*-tests of bias size. The main analyses were replaced by (generalized) linear mixed model analyses but we still report effect sizes from the aggregate analyses.

Materials

All materials, data, and analyses are available at https://osf.io/ad4ek/. The study employed an extended version of the materials provided by Körner et al. (2022), which is built on Gygax et al. (2008). Participants evaluated 144 pairs of sentences, 72 target sentence pairs and 72 filler sentence pairs. In target sentence pairs, the first sentence described a group of people using a category with a roughly balanced gender stereotype (e.g., pharmacists or neighbors; 39% from Gabriel et al., 2008; 7% from Kennison & Trofe, 2003; 54% from Misersky et al., 2014; with an average of 50.7% male associations, 50% being completely balanced). The linguistic gender form (manipulated between participants) was either the generic masculine (e.g., /ʃpɔrtlɐ/, *Sportler,* "athletes$_{masc}$"), the generic feminine (e.g., /ʃpɔrtlərɪnən/, *Sportlerinnen,* "athletes$_{fem}$"), or the glottal stop form (e.g., /ʃpɔrtlɐʔɪnən/, *Sportler_innen,* "athletes"). In each sentence, the group was described as doing something or being somewhere; for example, *Die Sportlerinnen überquerten den Rasen.* ("The athletes$_{fem}$ crossed the turf.") The second sentence provided additional information about either a female or a male subset of the group; for example, *Vorher hatte sich die Mehrheit der Männer/Frauen aufgewärmt.* ("Previously, the majority of the men/women had been warming up.")

Filler sentence pairs were similar to target sentence pairs with the difference that some information in the second sentence was incompatible with information from the first sentence. For example, the weather, occupation, or implied gender did not match. Additionally, some role nouns in filler sentences were stereotypically predominantly male or female. These fillers were included to encourage semantic processing and to facilitate a similar number of yes and no responses.

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The written sentences were then converted to audio using the text-to-speech software Microsoft Azure Speech (https://speech.microsoft.com/audiocontentcreation). When the result did not sound natural, the intonation of specific words was changed by adding pronunciation marks until it sounded satisfactory.

Procedure

After providing informed consent, participants were told that their task consisted of listening to sentence pairs and judging whether the second sentence was a sensible continuation of the first sentence. Participants were additionally informed about the employed gender form and that this form was used in a gender-inclusive way. Specifically, participants were explicitly informed, "when gender-mixed groups are referred to, we will use [form (e.g., example)]. This refers to both women and men." This was done to avoid participants' misunderstanding the masculine and feminine form as intended to refer to one gender only. As the sentence pairs were presented in isolation, there was no context from which participants could infer whether the speaker's intention was gender-specific or generic. It is possible that misunderstandings frequently occur even when more context is available. However, it has sometimes been argued that research produces a male bias that would not be present in other contexts (e.g., Eisenberg, 2022), we decided to err rather on the side of providing more disambiguation. This should lead to our studies' rather under- than over-estimating bias sizes, particularly for the generic masculine and perhaps even more so for the generic feminine form.

To familiarize participants with the task, the experiment started with a short practice block. Then, the main task, consisting of 144 sentence pairs (72 filler trials and 72 target trials—of which 36 had male and 36 had female continuations; sentence–gender mapping was balanced across participants) in random order ensued, randomized anew for each participant. At the beginning of each trial, the first sentence was presented auditorily. When participants pressed the space bar, the second sentence started (again presented auditorily). Participants responded that the second sentence was a sensible (not a sensible) continuation of the first sentence by pressing the right (left) response key. All instructions were presented as text on the screen. Participants were asked to respond quickly but to prioritize accuracy over speed. There was no time limit. After the response, an inter-trial interval of 500 ms ensued, followed by the next sentence pair.

After evaluating all sentence pairs, participants provided demographic information, rated their familiarity with all employed language forms and their attitudes toward "gender-fair" language. Finally, they were thanked, debriefed, and compensated.

In both experiments, we report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures.

Results

Accuracy data (affirming that the second sentence was a sensible continuation of the first sentence) for the target trials were entered into a 3 (gender form: glottal stop vs. generic masculine vs. generic feminine; between) x 2 (continuation: male vs. female;

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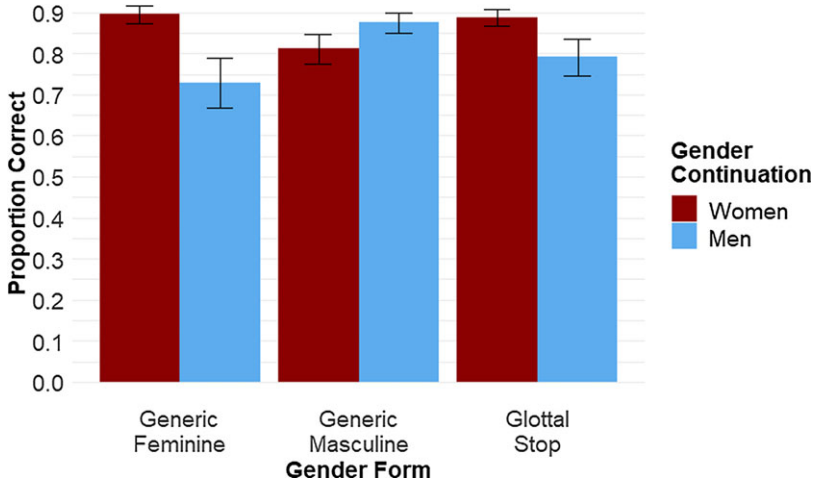

Figure 1. Proportion of correct acceptances of the second sentence as a continuation of the first sentence depending on gender form (in the first sentence) and gender (in the second sentence) in experiment 1. *Note.* The error bars represent 95% confidence intervals.

within) generalized linear mixed model analysis with random slopes as well as random intercepts for both participants and items.[6] As effect sizes, we report d_z and η_p^2 from the same analyses on mean values per participant. The main effect of gender form did not reach significance, $\chi^2(2) = 5.94$, $p = .051$, $\eta_p^2 = .011$, 90% CI [.000, .037]. However, the main effect of continuation was significant, $\chi^2(1) = 6.98$, $p = .008$, $\eta_p^2 = .113$, 90% CI [.059, .178], with more correct answers for sentences about women ($M = 86.6\%$, $SE = 0.8\%$) than sentences about men ($M = 79.4\%$, $SE = 1.4\%$). Importantly, the predicted interaction between gender form and continuation was also significant, $\chi^2(2) = 65.08$, $p < .001$, $\eta_p^2 = .187$, 90% CI [.117, .255], see Figure 1.

For all three gender forms, the comparisons of the answers to female and male continuations yielded significant differences. Specifically, following the generic feminine form, participants more frequently considered sentences about women to make sense ($M = 89.6\%$, $SE = 1.1\%$) than sentences about men ($M = 72.3\%$, $SE = 3.0\%$), $\chi^2(1) = 19.42$, $p < .001$, $d_z = 0.63$, 95% CI [0.40, 0.86]. Thus, the generic feminine form led to a female bias, a stronger representation of women than men. Following the glottal stop form, participants also more frequently considered sentences about women to make sense ($M = 88.7\%$, $SE = 1.0\%$) than sentences about men ($M = 79.1\%$, $SE = 2.2\%$), $\chi^2(1) = 8.68$, $p = .003$, $d_z = 0.51$, 95% CI [0.29, 0.73]. Thus, the glottal stop form also led to a female bias. After hearing the generic masculine form, in contrast, participants more frequently considered sentences about men to make sense ($M = 87.5\%$, $SE = 1.2\%$) than sentences about women ($M = 81.1\%$, $SE = 1.9\%$), $\chi^2(1) = 5.47$, $p = .019$, $d_z = 0.60$, 95% CI [0.35, 0.83], constituting a male bias.[7]

Comparing these biases (after recoding so that all three biases had the same direction) yielded significant differences for the generic feminine and the other two forms. Specifically, the bias for the generic feminine was larger than the bias for the

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generic masculine, $\chi^2(1) = 5.55$, $p = .019$, $d_z = 0.51$, 95% CI [0.20, 0.82], and the bias for the generic feminine was also larger than the bias for the glottal stop form, $\chi^2(1) = 5.16$, $p = .023$, $d_z = 0.33$, 95% CI [0.03, 0.63]. The latter two forms, the generic masculine and the glottal stop form, did not differ significantly in bias size, $\chi^2(1) = 0.82$, $p = .366$, $d_z = 0.21$, 95% CI [−0.10, 0.51].

Response times

An analogue analysis using the same fixed and random effects structure was performed on response times for correct answers. Response times were assessed relative to the beginning of the presentation of the second sentence. Incorrect responses (17.0% of trials) were excluded as well as response times that exceeded three standard deviations from a participant's mean (1.6% of trials). Two participants had no trials left in one cell and were therefore excluded from the analysis. Response times were entered into a 3 (gender form: generic masculine vs. glottal stop vs. generic feminine; between) x 2 (continuation: male vs. female; within) mixed linear mixed model analysis. We report Type III analyses of variance with Satterthwaite's method for calculating degrees of freedom. Neither the main effect of gender form was significant, $F(2, 244) = 0.29$, $p = .749$, $\eta_p^2 = .003$, 90% CI [.000, .018] nor the main effect of continuation, $F(1, 148) = 0.70$, $p = .403$, $\eta_p^2 = .036$, 90% CI [.008, .082]. However, the interaction between gender form and continuation was significant, $F(2, 220) = 9.00$, $p < .001$, $\eta_p^2 = .050$, 90% CI [.012, .097], see Figure 2.

In spite of the significant interaction, none of the simple effects reached significance. Specifically, following the generic feminine, response times did not differ for sentences about women ($M = 4124$ ms, $SE = 62$ ms) and sentences about men ($M = 4250$ ms, $SE = 77$ ms), $F(1, 140) = 2.76$, $p = .099$, $d_z = 0.35$, 95% CI [0.13, 0.57]; following the glottal stop form, there was no significant difference for response times for sentences about women ($M = 4159$ ms, $SE = 48$ ms) and sentences about men ($M = 4247$ ms, $SE = 61$ ms), $F(1, 143) = 2.74$, $p = .100$, $d_z = 0.32$, 95% CI [0.10, 0.54], and following the generic masculine form, there was also no significant difference for response times for sentences about women ($M = 4153$ ms, $SE = 61$ ms) and sentences about men ($M = 4111$ ms, $SE = 57$ ms), $F(1, 170) = 0.65$, $p = .423$, $d_z = 0.14$, 95% CI [−0.08, 0.37].[8] Pairwise comparisons of the size of these biases also yielded no significant differences; none for the generic feminine–glottal stop comparison, $F(1, 716) = 0.05$, $p = .822$, $d_z = 0.12$, 95% CI [−0.18, 0.42]; none for the generic feminine–generic masculine comparison, $F(1, 155) = 0.16$, $p = .693$, $d_z = 0.25$, 95% CI [−0.06, 0.56]; and none for the glottal stop–generic masculine comparison, $F(1, 160) = 0.13$, $p = .721$, $d_z = 0.16$, 95% CI [−0.15, 0.46].

Exploratory moderation analyses

To explore whether the present interaction between gender form and gender continuation was moderated by socio-demographic variables or by participants' attitudes, we performed additional exploratory analyses. All analyses used gender form and continuation in addition to the target moderator as fixed effects and a

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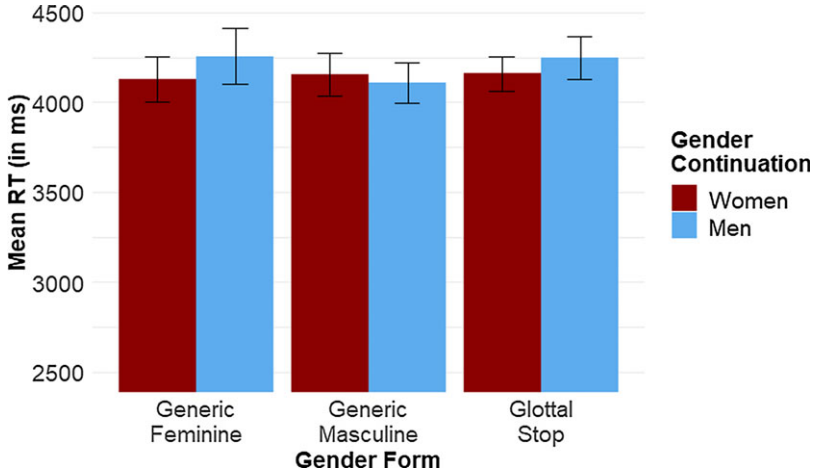

Figure 2. Mean response times of correct answers depending on gender form (in the first sentence) and gender (in the second sentence) in experiment 1.
Note. The error bars represent 95% confidence intervals.

maximal random effects structure (when this led to modeling issues, random effects were removed; for full information, see https://osf.io/ad4ek/).

Participant gender. Participant gender did not significantly moderate the effect. The three-way interaction was neither significant for accuracy, $\chi^2(2) = 0.30$, $p = .859$, $\eta_p^2 = .001$, 90% CI [.000, .009], nor for response times, $F(2, 217) = 1.96$, $p = .144$, $\eta_p^2 = .012$, 90% CI [.000, .033].

Participant age. Examining participants' age, there was a significant three-way interaction between gender form, gender continuation, and participants' age for accuracy, $\chi^2(2) = 7.05$, $p = .030$, $\eta_p^2 = .033$, 90% CI [.004, .073]. Age did not significantly moderate the effect of the glottal stop form, $\chi^2(1) = 0.05$, $p = .818$, $\eta_p^2 = .001$, 90% CI [.000, .030] nor the effect of the generic masculine form, $\chi^2(1) = 0.72$, $p = .397$, $\eta_p^2 = .001$, 90% CI [.000, .036]. However, the moderation by age was significant for the generic feminine form, $\chi^2(1) = 5.42$, $p = .020$, $\eta_p^2 = .060$, 90% CI [.005, .158]. When splitting participants into four roughly equally sized age classes (18–23 years, 24–29 years, 30–39 years, and 40 years and older), the bias for the generic feminine form was largest for the eldest age group, $\chi^2(1) = 13.67$, $p < .001$, $d_z = 0.86$, 95% CI [0.38, 1.32]. For the other age groups, the bias was smaller, with $\chi^2(1) = 6.20$, $p = .013$, $d_z = 0.65$, 95% CI [0.14, 1.16], and $\chi^2(1) = 4.24$, $p = .039$, $d_z = 0.59$, 95% CI [0.16, 1.01], as well as $\chi^2(1) = 3.69$, $p = .055$, $d_z = 0.45$, 95% CI [−0.02, 0.90] for descending age. For response times, the three-way interaction with age was not significant, $F(2, 230) = 2.24$, $p = .108$, $\eta_p^2 = .035$, 90% CI [.004, .076].

Individual familiarity with linguistic forms. Concerning participants' degree of familiarity with the employed gender forms, there were no significant three-way interactions. Specifically, for accuracy, participants' degree of familiarity with the glottal stop form did not significantly moderate the interaction between gender form and continuation, $\chi^2(2) = 5.74$, $p = .057$, $\eta_p^2 = .027$, 90% CI [.001, .064].

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Similarly, there was also no significant three-way interaction with participants' degree of familiarity with the generic feminine form, $\chi^2(2) = 0.07$, $p = .966$, $\eta_p^2 = .001$, 90% CI [.000, .010], nor with participants' familiarity with the generic masculine form, $\chi^2(2) = 1.80$, $p = .407$, $\eta_p^2 = .017$, 90% CI [.000, .048]. For response times, the moderation was also neither significant concerning participants' familiarity with the glottal stop form, $F(2, 224) = 1.45$, $p = .236$, $\eta_p^2 = .017$, 90% CI [.000, .047], nor for familiarity with the generic feminine form, $F(2, 226) = 2.22$, $p = .111$, $\eta_p^2 = .027$, 90% CI [.001, .064], nor for familiarity with the generic masculine form, $F(2, 243) = 0.61$, $p = .545$, $\eta_p^2 = .008$, 90% CI [.000, .018].

Attitudes. The three-way interaction with participants' attitude toward so-called gender-fair language in general (pro general usage vs. up to individual speaker vs. contra general usage) moderated the effect for accuracy, $\chi^2(4) = 10.44$, $p = .034$, $\eta_p^2 = .048$, 90% CI [.004, .087]. Examining which language form drove this moderation, we found neither an interaction between attitudes and gender continuations for the generic masculine, $\chi^2(2) = 0.16$, $p = .923$, $\eta_p^2 = .004$, 90% CI [.000, .031] nor for the glottal stop form, $\chi^2(2) = 2.31$, $p = .316$, $\eta_p^2 = .020$, 90% CI [.000, .079]. However, for the generic feminine form, participants' attitude moderated the bias, $\chi^2(2) = 8.54$, $p = .014$, $\eta_p^2 = .107$, 90% CI [.016, .212]. This interaction was caused by a larger bias for opponents of so-called gender-fair language, $\chi^2(1) = 13.61$, $p < .001$, $d_z = 1.14$, 95% CI [0.39, 1.86]; however, the female bias was also significant for participants who thought everybody should decide for themselves, $\chi^2(1) = 5.99$, $p = .014$, $d_z = 0.49$, 95% CI [0.11, 0.87] and for proponents of so-called gender-fair language, $\chi^2(1) = 10.18$, $p = .001$, $d_z = 0.62$, 95% CI [0.29, 0.94]. For response times, the same three-way interaction with participants' attitude toward so-called gender-fair language in general did not reach significance, $F(4, 215) = 1.59$, $p = .179$, $\eta_p^2 = .085$, 90% CI [.027, .135].

For participants' attitude toward the glottal stop form (instead of gender-fair language in general), the three-way interactions did not reach significance; neither for accuracy, $\chi^2(4) = 5.13$, $p = .274$, $\eta_p^2 = .053$, 90% CI [.001, .111], nor for response times, $F(4, 217) = 1.50$, $p = .204$, $\eta_p^2 = .068$, 90% CI [.016, .113].

Discussion

Experiment 1 replicated the finding that hearing generic masculine nouns leads to a bias toward stronger representations of men compared to women (see also Anaya-Ramírez et al., 2022; Gabriel et al., 2017). Specifically, using correct responses as a measure, we observed more acceptance of male compared to female continuations after hearing generic masculine nouns. In contrast, for the glottal stop and the generic feminine form, we observed female biases. The bias was largest for the generic feminine form, larger than for the glottal stop form and the generic masculine form, indicating that both the generic masculine and the glottal stop were understood as more inclusive than the generic feminine—although both were not absolutely generic, as they resulted in medium-sized biases. Concerning response times, the interaction between gender form and gender continuation was significant but none of the employed gender forms yielded significant biases.

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This rather inconclusive result might be caused by insufficient power given the larger variance in response speed. A second experiment with increased power addressed this issue and provided a replication of Experiment 1.

Experiment 2

Method

Participants and design

937 native speakers of German (524 female, 396 male, 17 other gender; aged 18–70 years, $M_{age} = 29$ years, $SD_{age} = 9$; 108 participants were older than 40 years, and 11 participants were older than 60 years. As their highest educational degree, 516 had an (applied) university degree, and 276 had completed high school; 145 selected one of the four remaining highest educational degree options) were recruited in 2022 through Prolific Academic and compensated by receiving £2.35 or through a survey swap platform in exchange for participation points. They participated online. On a scale from 1 (*not familiar*) to 5 (*very familiar*), most participants reported being very familiar with the generic masculine form ($M = 4.46$, $SD = 0.87$, $Median = 5$), moderately familiar with the glottal stop form ($M = 3.33$, $SD = 1.27$, $Median = 4$), and rather unfamiliar with the generic feminine form ($M = 2.00$, $SD = 1.25$, $Median = 2$). Concerning their attitude toward "gender-fair" language in general (the glottal stop form in particular), 401 (310) were in favor, 366 (363) were of the opinion that this is up to the individual, and 148 (237) were against its usage. The remaining 22 (27) participants had no opinion and were not included in analyses that examined attitude as a moderator.

Participants were randomly assigned to a gender form in a 3 (gender form: glottal stop vs. generic masculine vs. generic feminine; between) x 2 (continuation: male vs. female; within) design. This yields a power of .80 (with $\alpha = .05$ and $r = .5$ for repeated measures) for finding $\eta_p^2 = .003$ in a two-way interaction, for finding $d_z = 0.14$ for within-effects of gender representation, and for finding $d = 0.22$ for between-comparisons of bias sizes. The pre-registration can be found at https://osf.io/wy8r9/. Again, the analyses were later changed to (generalized) linear mixed model analyses.

Materials and procedure

Compared to Experiment 1, we reduced the number of trials by half, using only the sentences from Körner et al. (2022). Thus, the main task consisted of 72 sentence pairs (36 filler trials and 36 target trials; the role nouns of the target trials now had an average of 51.0% male associations). Additionally, minor wording changes were made and the audio tracks of some of the sentences were created anew to sound more natural; for materials, see https://osf.io/ad4ek/. Except for these alterations, the materials and procedure were identical to Experiment 1.

Results

As in Experiment 1, the answers (correct vs. incorrect) were entered into a 3 (gender form: glottal stop vs. generic masculine vs. generic feminine; between) x 2

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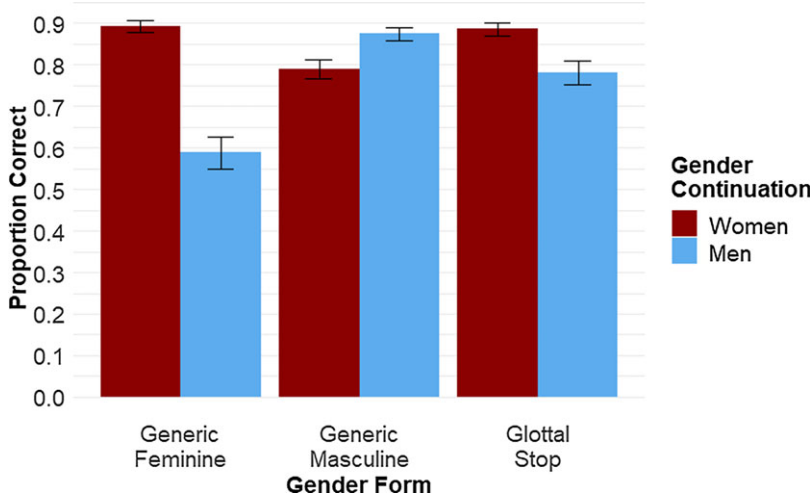

Figure 3. Proportion of correct acceptances of the second sentence as a continuation of the first sentence depending on gender form (in the first sentence) and gender (in the second sentence) in experiment 2. *Note.* The error bars represent 95% confidence intervals.

(continuation: male vs. female; within) generalized linear mixed model analysis with random slopes as well as random intercepts for both participants and items. The main effect of gender form was significant, $\chi^2(2) = 19.71$, $p < .001$, $\eta_p^2 = .062$, 90% CI [.038, .088], with lower accuracy after the generic feminine form ($M = 73.8\%$, $SE = 1.2\%$) than after the generic masculine ($M = 82.7\%$, $SE = 0.7\%$) and the glottal stop form ($M = 83.2\%$, $SE = 0.8\%$). The main effect of continuation was also significant, $\chi^2(1) = 12.11$, $p = .001$, $\eta_p^2 = .137$, 90% CI [.105, .171], with higher accuracy for sentences about women ($M = 85.3\%$, $SE = 0.6\%$) than about men ($M = 74.6\%$, $SE = 0.9\%$). Importantly, the predicted interaction between gender form and continuation was also significant, $\chi^2(2) = 311.39$, $p < .001$, $\eta_p^2 = .268$, 90% CI [.229, .348], see Figure 3.

As in Experiment 1, a comparison of accuracy rates between female and male continuations yielded significant biases for all gender forms, female biases for the glottal stop and generic feminine and a male bias for the generic masculine. Specifically, following the glottal stop form, participants more frequently considered sentences about women to make sense ($M = 88.4\%$, $SE = 0.8\%$) than sentences about men ($M = 78.1\%$, $SE = 1.4\%$), $\chi^2(1) = 11.12$, $p = .001$, $d_z = 0.44$, 95% CI [0.32, 0.56]. Following the generic feminine form, participants also more frequently considered sentences about women to make sense ($M = 89.2\%$, $SE = 0.7\%$) than sentences about men ($M = 58.4\%$, $SE = 2.0\%$), $\chi^2(1) = 87.94$, $p < .001$, $d_z = 0.86$, 95% CI [0.73, 0.99]. However, after hearing the generic masculine form, participants more frequently considered sentences about men to make sense ($M = 87.2\%$, $SE = 0.8\%$) than sentences about women ($M = 78.3\%$, $SE = 1.2\%$), $\chi^2(1) = 14.07$, $p < .001$, $d_z = 0.47$, 95% CI [0.35, 0.59].

Comparing these biases (after recoding so that all three biases have the same direction) yielded significant differences for the generic feminine compared to both

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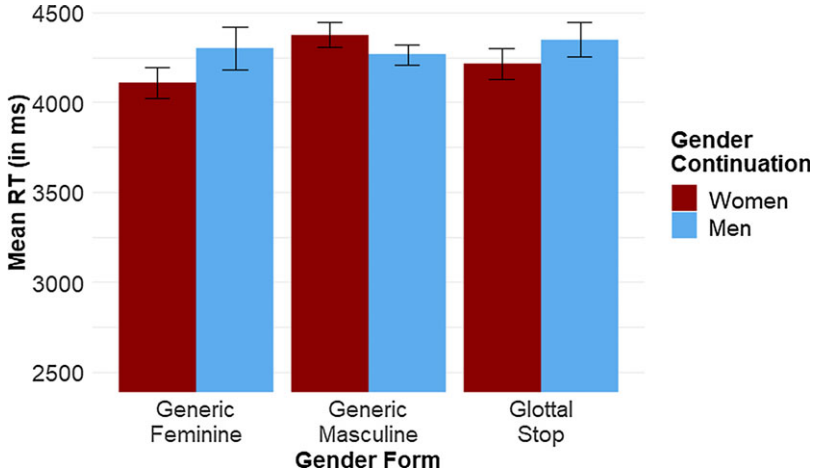

Figure 4. Mean response times of correct answers depending on gender form (in the first sentence) and gender (in the second sentence) in experiment 2.
Note. The error bars represent 95% confidence intervals.

of the other forms. The bias for the generic feminine was larger than the bias for the glottal stop, $\chi^2(1) = 66.40, p < .001, d_z = 0.68$, 95% CI [0.51, 0.84] and larger than the bias for the generic masculine, $\chi^2(1) = 19.94, p < .001, d_z = 0.77$, 95% CI [0.61, 0.93]. The biases for the generic masculine and the glottal stop form did not differ significantly, $\chi^2(1) = 0.05, p = .820, d_z = 0.07$, 95% CI [−0.09, 0.22].

Response times

An analogue analysis using the same fixed and random effects structure was performed on response times for correct answers. Response times were assessed relative to the beginning of the presentation of the second sentence. Incorrect responses (20.1% of trials) were excluded as well as response times that exceeded three standard deviations from a participant's mean (1.4% of trials). Thirty-two participants had no trials left in one cell and were therefore excluded from the analysis. Response times were entered into a 3 (gender form: generic masculine vs. glottal stop vs. generic feminine; between) x 2 (continuation: male vs. female; within) mixed linear mixed model analysis. As in Experiment 1, neither the main effect of gender form was significant, $F(2, 880) = 2.57, p = .077, \eta_p^2 = .004$, 90% CI [.000, .013] nor the main effect of continuation, $F(1, 71) = 0.95, p = .333, \eta_p^2 = .017$, 90% CI [.006, .033]. However, the interaction between gender form and continuation was significant, $F(2, 695) = 39.85, p < .001, \eta_p^2 = .074$, 90% CI [.048, .101], see Figure 4.

Only the simple comparison for the generic feminine reached significance; specifically, response times were faster for sentences about women ($M = 4120$ ms, $SE = 43$ ms) than sentences about men ($M = 4321$ ms, $SE = 59$ ms), $F(1, 82) = 7.19, p = .009, d_z = 0.33$, 95% CI [0.21, 0.45]. The gender biases for response times for the other two forms were not significant. Specifically, following the glottal stop form, response times for sentences about women ($M = 4217$ ms,

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SE = 42 ms) and sentences about men (*M* = 4346 ms, *SE* = 50 ms) did not differ significantly, $F(1, 72) = 3.44$, $p = .068$, $d_z = 0.28$, 95% CI [0.16, 0.40]. Similarly, following the generic masculine form, response times for sentences about women (*M* = 4395 ms, *SE* = 35 ms) and sentences about men (*M* = 4276 ms, *SE* = 29 ms) did not differ significantly, $F(1, 72) = 2.45$, $p = .122$, $d_z = 0.30$, 95% CI [0.19, 0.42].

Pairwise comparisons of the size of these biases yielded no significant differences; none for the generic feminine–glottal stop comparison, $F(1, 427) = 1.49$, $p = .224$, $d_z = 0.13$, 95% CI [−0.03, 0.30]; none for the generic feminine–generic masculine comparison, $F(1, 73) = 0.23$, $p = .636$, $d_z = 0.16$, 95% CI [0.00, 0.37]; and none for the glottal stop–generic masculine comparison, $F(1, 71) = 0.01$, $p = .928$, $d_z = 0.02$, 95% CI [−0.14, 0.18].

Exploratory moderation analyses

The same exploratory moderation analyses were performed as in Experiment 1. That is, we examined whether the interaction between gender form and gender continuation was moderated by socio-demographic variables or by participants' attitudes. All analyses used gender form and continuation in addition to the target moderator as fixed effects and a maximal random effects structure where possible (for full information, see https://osf.io/ad4ek/).

Participant gender. Participant gender did not significantly moderate the interaction between gender form and gender continuation. The three-way interaction was significant neither for accuracy, $\chi^2(2) = 0.17$, $p = .920$, $\eta_p^2 < .001$, 90% CI [.000, .002], nor for response times, $F(2, 682) = 0.24$, $p = .787$, $\eta_p^2 = .001$, 90% CI [.000, .006].

Participant age. As in Experiment 1, for accuracy the interaction between gender form and gender continuation was significantly moderated by participants' age, $\chi^2(2) = 8.18$, $p = .017$, $\eta_p^2 = .013$, 90% CI [.003, .027]. Whereas age did not significantly moderate the effect of the generic masculine form, $\chi^2(1) = 0.41$, $p = .524$, $\eta_p^2 = .009$, 90% CI [.000, .033], the moderation by age was significant for the glottal stop form, $\chi^2(1) = 4.94$, $p = .026$, $\eta_p^2 = .026$, 90% CI [.005, .062] and for the generic feminine form, $\chi^2(1) = 7.35$, $p = .007$, $\eta_p^2 = .024$, 90% CI [.004, .059]. When splitting participants into five roughly equally sized age classes (18–22 years, 23–25 years, 26–30 years, 31–39 years, and 40 years and older; using the same age classes as in Experiment 1 leads to qualitatively identical results), the bias for the glottal stop form was largest for the two eldest classes, $\chi^2(1) = 9.01$, $p = .003$, $d_z = 0.55$, 90% CI [0.21, 0.88] and $\chi^2(1) = 8.05$, $p = .005$, $d_z = 0.56$, 95% CI [0.27, 0.84], respectively, and smaller with decreasing age, $\chi^2(1) = 6.12$, $p = .013$, $d_z = 0.50$, 95% CI [0.26, 0.74], and $\chi^2(1) = 4.54$, $p = .033$, $d_z = 0.44$, 90% CI [0.18, 0.70], with a non-significant effect for the youngest participants, $\chi^2(1) = 1.14$, $p = .286$, $d_z = 0.20$, 95% CI [−0.03, 0.43]. For the generic feminine form, the bias was also largest for the eldest age group, $\chi^2(1) = 42.76$, $p < .001$, $d_z = 1.28$, 95% CI [0.85, 1.70]. For the other age groups, the bias was smaller but always significant, with $\chi^2(1) = 37.78$, $p < .001$, $d_z = 0.97$, 95% CI [0.68, 1.26]; $\chi^2(1) = 28.13$, $p < .001$, $d_z = 0.78$, 95% CI [0.51, 1.06]; $\chi^2(1) = 25.59$, $p < .001$, $d_z = 0.74$, 95% CI [0.50, 0.97]; and $\chi^2(1) = 22.23$, $p < .001$, $d_z = 0.81$, 95% CI [0.51, 1.11] for descending

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age. For response times, the three-way interaction with age was not significant, $F(2, 725) = 1.00$, $p = .369$, $\eta_p^2 = .005$, 90% CI [.000, .014].

Individual familiarity with linguistic forms. Concerning participants' degree of familiarity with the employed gender forms, the three-way interactions were not significant. Specifically, for accuracy, the interaction between gender form and gender continuation was neither significantly moderated by participants' familiarity with the glottal stop form, $\chi^2(2) = 4.70$, $p = .095$, $\eta_p^2 = .003$, 90% CI [.000, .010], nor by participants' degree of familiarity with the generic masculine form $\chi^2(2) = 2.10$, $p = .350$, $\eta_p^2 = .007$, 90% CI [.000, .017], nor by participants' degree of familiarity with the generic feminine form, $\chi^2(2) = 1.41$, $p = .493$, $\eta_p^2 = .002$, 90% CI [.000, .007]. Similarly, for response times, there was no significant three-way interaction with participants' familiarity with the glottal stop form, $F(2, 707) = 0.51$, $p = .602$, $\eta_p^2 = .004$, 90% CI [.000, .012], none with participants' familiarity with the generic masculine form, $F(2, 754) = 2.89$, $p = .056$, $\eta_p^2 = .006$, 90% CI [.000, .015], and none with participants' familiarity with the generic feminine form, $F(2, 721) = 2.64$, $p = .072$, $\eta_p^2 = .003$, 90% CI [.000, .011].

Attitudes. Participants' attitude (pro general usage vs. up to individual speaker vs. contra general usage) toward so-called gender-fair language in general did not moderate the interaction between gender form and gender continuation, neither for accuracy, $\chi^2(4) = 5.27$, $p = .261$, $\eta_p^2 = .015$, 90% CI [.001, .024] nor for response times, $F(4, 726) = 1.46$, $p = .214$, $\eta_p^2 = .010$, 90% CI [.000, .020].

For participants' attitude toward the glottal stop form (instead of gender-fair language in general), the three-way interaction for accuracy was significant, $\chi^2(4) = 10.27$, $p = .036$, $\eta_p^2 = .009$, 90% CI [.000, .018]. More specifically, participants' attitude toward the glottal stop form influenced the bias of the glottal stop form, $\chi^2(2) = 16.10$, $p < .001$, $\eta_p^2 = .061$, 90% CI [.022, .108]. For participants who opposed usage of the glottal stop form, the bias was largest, $\chi^2(1) = 23.01$, $p < .001$, $d_z = 0.63$, 95% CI [0.33, 0.92], while it was smaller for participants who approved the usage of the glottal stop form, $\chi^2(1) = 8.02$, $p = .005$, $d_z = 0.40$, 95% CI [0.22, 0.58], and also smaller and non-significant for participants who think that this should be up to each individual $\chi^2(1) = 1.34$, $p = .247$, $d_z = 0.48$, 95% CI [0.29, 0.67].

For response times, participants' attitude toward the glottal stop form did not significantly moderate the interaction between gender form and gender continuation, $F(4, 703) = 2.21$, $p = .066$, $\eta_p^2 = .017$, 90% CI [.003, .030].

General discussion

Reading linguistic gender forms has been found to influence mental gender representations, with the generic masculine leading to male-biased representations and some other forms leading to female-biased representations. Using auditory stimulus presentation, the present research also demonstrated gender biases for three linguistic forms. Specifically, the generic masculine led to more accurate responses for male compared to female continuations, constituting a male bias. In contrast, both the generic feminine and the glottal stop form led to female biases, that is, more accurate responses to female compared to male continuations. Thus,

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none of the three examined forms led to equally strong mental representations of women and men. However, bias sizes differed, with a large bias for the generic feminine form and medium-sized biases for the glottal stop and generic masculine forms. Compared to the generic feminine, both the glottal stop and the generic masculine form led to smaller biases, while there was no significant difference between the latter two forms.[9]

The generic masculine led to a smaller bias in mental gender representations than the generic feminine. Thus, the masculine (vs. feminine) form was more readily understood as generic (for similar results, see e.g., Misersky et al., 2019; Zacharski & Ferstl, 2023). This might be caused by participants' previous experiences or by aspects inherent in the form itself. First, whereas the masculine form has traditionally been used generically (in addition to specifically), the feminine form is not in common use as a generic form. This was also the case for the present participants. On a 1–5 scale with higher values indicating higher familiarity, the median was 5 for the generic masculine whereas it was 2 for the generic feminine (and 4 for the glottal stop form). The present participants learned at an early age that for gender-mixed groups the masculine has to be used and the feminine form only refers to females. Thus, a reason why the generic feminine yielded a larger bias than the generic masculine could be that most participants were not used to encountering the feminine form with a generic meaning. Note however that, as both forms are also used specifically, even excessive usage would probably not completely annihilate gender biases resulting from these forms. Second, in German, the feminine compared to the masculine form is morphologically more complex. More (vs. less) morphologically complex forms might be less easily understood generically. Thus, complexity differences could also contribute to the larger gender bias for the generic feminine compared to the generic masculine form.

The smaller bias for the glottal stop compared to the generic feminine indicates that the glottal stop form is more readily understood as generic. Specifically, hearing words in the glottal stop form has led to a stronger inclusion of men in mental representations than hearing the same words without this glottal stop. Recall that this usage of the glottal stop to indicate gender inclusiveness is very recent in German. Although only a minority of people use it themselves, people speaking German are aware of this new meaning as the glottal stop form can sometimes be heard in the media and occasionally also in other situations. The present research indicates that although exposure has been limited, the glottal stop form already leads to more inclusive gender representations compared to the generic feminine form.

Our third research question was whether the biases caused by the generic masculine form and the glottal stop form differed in size. We observed a male bias for the generic masculine form and a female bias for the glottal stop form. However, these biases did not significantly differ in size. Thus, the present research does not provide any evidence for a difference.

There is one caveat, however, for the comparison of the generic masculine with the other two forms. The artificial language we employed sounded female. Moreover, for classifications of spoken words directly related to gender, a congruency effect with speaker gender has been observed (Green & Barber, 1981). Therefore, it is possible that in the present experiments, the female voice might have activated female-related concepts, which could have increased the biases for the

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generic feminine and glottal stop forms and attenuated the bias for the generic masculine form. However, in contrast to experiments that observed gender–voice congruency effects, in our experiment, voice gender did not vary from trial to trial. This constancy of voice probably decreased any influence of voice gender. Additionally, participants' task was not related to judging gender but sensibility. Therefore, the influence of voice gender was probably small. Nevertheless, future research needs to examine the influence of apparent voice gender on gender representations in auditory experiments.

Exploratory analyses indicated that several person-specific factors moderated the present findings. However, the size of the moderation was generally very small compared to the target interaction between gender form and gender continuation. Moreover, usually biases were significant for all participant groups. The most consistent finding in the present research concerned age, with stronger biases for older participants in both experiments. Additionally, familiarity with gender forms and attitudes toward so-called gender-fair language or the glottal stop form also moderated the biases in some analyses. Specifically, in some analyses, biases for the generic feminine or the glottal stop form were larger for people who opposed (vs. did not oppose) the usage of so-called gender-fair language; similarly, lower familiarity with the glottal stop form was associated with an increased bias elicited by the glottal stop form.

In previous research, similar to the present studies, results on the question whether person-specific factors moderate the influence of linguistic gender form on cognitive gender representations are not very consistent. Sometimes no moderation was found (e.g., Körner et al., 2022; Schunack & Binanzer, 2022) while at other times, person-specific factors did moderate gender biases or spontaneous use of so-called gender-fair forms (e.g., Gabriel & Mellenberg, 2004; Gustafsson Sendén et al., 2015; Koeser & Sczesny, 2014; Lindqvist et al., 2019; Sczesny et al., 2015). The nature of the experimental paradigm might have contributed to these differences. Whether this is indeed the case needs to be determined by future research. In the present studies, biased gender representations occurred although participants were explicitly informed that the gender form they were encountering was meant to represent all genders equally (for similar results, see also Gygax et al., 2012; Körner et al., 2022; Rothmund & Scheele, 2004). As the gender-specific masculine form is the same as the generic masculine form, gender biases can result from misunderstanding the masculine form as specific when it was intended generically. Some contexts can disambiguate between a masculine and a gender-inclusive meaning, so that providing little or unsuitable context has been argued could create (instead of only revealing) gender biases (e.g., Eisenberg, 2022). To prevent this in the present experiments, the inherent ambiguity in the masculine (and feminine) form was dissolved explicitly by informing participants about the generic intention. This should lead to our studies' rather under- than over-estimating bias sizes. However, even though participants knew that a grammatical form referred to both, men and women, their responses were biased toward the prominent gender. This suggests that automatic associations contributed to the observed biases and that they cannot be explained by a mere misunderstanding of the masculine and feminine forms as gender-specific instead of generic.

However, it is unclear which specific automatic processes drive these effects. First, gender forms might increase accessibility of information related to the

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associated gender. This increasing accessibility could then facilitate the processing of congruent information, facilitating responses concerning the more accessible gender (see Banaji & Hardin, 1996; Gabriel et al., 2018; Gygax et al., 2021). Second, reading and hearing texts have been found to elicit situation models (e.g., Van Dijk & Kintsch, 1983). Linguistic forms that are predominantly associated with one gender could lead to a situation model that includes predominantly people of that gender. The gender of the people in the situation model, in turn, could facilitate responding when later gender information is consistent (vs. inconsistent; see also Gygax et al., 2021; Irmen & Linner, 2005). Future research needs to examine the psychological processes more closely through which gender form influences gender representations.

In sum, the present research demonstrated that, similar to reading written texts, listening to linguistic gender forms in auditory speech leads to biased gender representations. None of the examined forms was bias-free but bias sizes differed. Specifically, compared to the female bias after the generic feminine form, the male bias after the generic masculine and the female bias after the glottal stop form were smaller, indicating that these latter forms are understood more—though not perfectly—generically.

Replication package. Data, analysis scripts, and materials can be found at https://osf.io/ad4ek/. Hypotheses, methods, and analyses for Experiment 2 were pre-registered, see https://osf.io/wy8r9/.

Competing interests. The authors declare none.

Notes

1 A disadvantage of neutralization strategies is that neutral terms often do not exist, so that neutralization requires creating new expressions. Concerning gender representations, neutralization forms have been found to lead to an attenuated but frequently still significant male bias (e.g., Braun et al., 1998; Irmen, 2007). For more information on neutralization, see Stahlberg et al. (2007).

2 However, these forms are typically not endorsed by orthographical regulations (for German-speaking countries, see https://www.rechtschreibrat.com/DOX/rfdr_PM_2021-03-26_Geschlechtergerechte_Schreibung.pdf)

3 However, sometimes the feminine and masculine words differ substantially, as in singular definite articles and pronouns; then, this solution is not economical.

4 See https://www.genderleicht.de/luise-f-pusch-und-der-genderstern/

5 https://www1.wdr.de/nachrichten/gender-umfrage-infratest-dimap-100.html

6 We used R, version 4.2.1 (R Core Team, 2022) and the packages lme4 (version 1.1.-30, Bates et al., 2015), lmerTest (version 3.1-3, Kuznetsova et al., 2017), as well as car (version 3.1-1, Fox & Weisberg, 2019) for Wald's chi-square test.

7 Performing the same analyses using only the items from Körner et al. (2022), which are also the items used in Experiment 2 below, yielded qualitatively identical results. The interaction between gender form and continuation was significant, $\chi^2(2) = 73.17$, $p < .001$, $\eta_p^2 = .213$, 90% CI [.141, .282]. Similarly, the simple analyses for the generic feminine, $\chi^2(1) = 22.57$, $p < .001$, $d_z = 0.69$, 95% CI [0.46, 0.92], for the glottal stop, $\chi^2(1) = 4.67$, $p = .031$, $d_z = 0.49$, 95% CI [0.27, 0.71], and the generic masculine, $\chi^2(1) = 6.03$, $p = .014$, $d_z = 0.57$, 95% CI [0.33, 0.81], were all significant. For more details, see https://osf.io/ad4ek/.

8 Performing the same analyses using only the items from Körner et al. (2022) and used in Experiment 2, yielded qualitatively identical results. The interaction between gender form and continuation was significant, $F(2, 139) = 3.43$, $p = .035$, $\eta_p^2 = .021$, 90% CI [.000, .055]. However, none of the simple analyses were significant; not for the generic feminine, $F(1, 84) = 0.29$, $p = .589$, $d_z = 0.10$, 95% CI [−0.12, 0.32], not for the glottal stop, $F(1, 67) = 1.14$, $p = .289$, $d_z = 0.22$, 95% CI [0.01, 0.44], nor the generic masculine, $F(1, 89) = 0.67$, $p = .414$, $d_z = 0.16$, 95% CI [−0.06, 0.38]. For more details, see https://osf.io/ad4ek/.

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9 For response times, none of these pairwise bias comparisons yielded significant differences. In the present studies, response time effects were always small and frequently not significant.

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