Female gender is consistently under-expressed in pronoun production and under-inferred in comprehension

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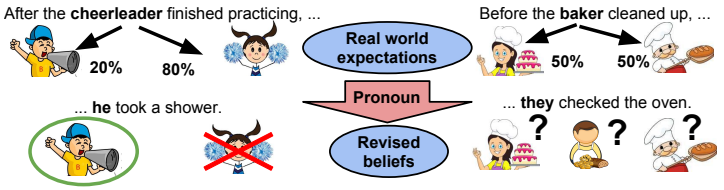
1. Introduction



How do prior expectations and pronouns combine to form later beliefs?

2. Methods

a. Production

Before the baker took out the trash, ..._____

b. Gender recall

After the baker ... he ...
5 * 7 + 12 - 3 = ___
In the story you read, what was the gender of the baker?
Female / Male / Other

1, 4, or 8 stories
working memory task
One question per story

c. Explicit Norm

If you encounter a gymnast, how likely are they to be female?

d. Implicit Norm

After the baker ... the baker ...
5 * 7 + 12 - 3 = ___
In the story you read, what was the gender of the baker?
Female / Male / Other

1, 4, or 8 stories
no pronouns
working memory task
One question per story

Sample Stimuli:

After the shop on High Street closed for the night, a **baker** stayed to tidy up. Before the **baker** took out the trash, **she** swept the floor and wiped down the counter.

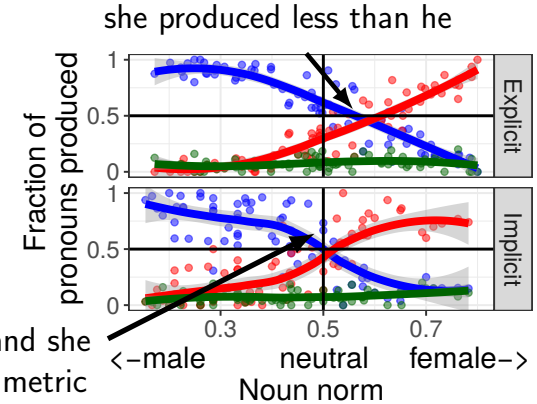
pronoun (he/she/they) or repeat of role noun (the baker)

80 role nouns

Experiment	Participants	Each Saw
a. Production	149	20 items
b. Gender recall	712	1, 4, or 8 items
c. Explicit Norm	51	All 80 nouns
d. Implicit Norm	569	1, 4, or 8 items

3. Production Results

she produced less than he



4. Predictions

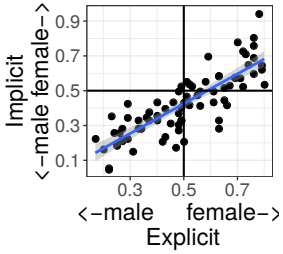
Using Bayes rule, ($g = gender, p = pronoun$)

$$P(g|p) = \frac{P(p|g)\,P(g)}{P(p)}$$

In production: $P(she|female) \leq P(he|male)$

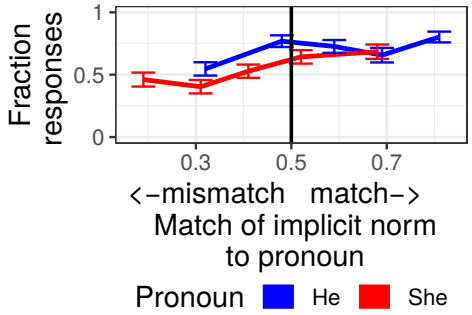
This implies $P(male|he) \leq P(female|she)$ if communicators are rational.

Norms



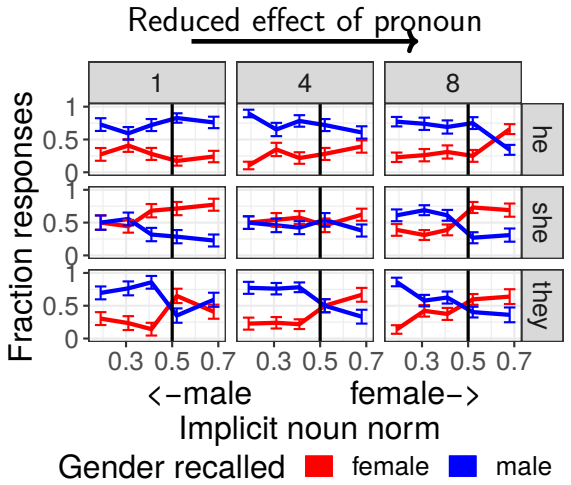
Implicit and explicit norms correlate (r=.83), but implicit norm labels nouns as more male.

5. Gender recall results



He is recalled as male more than she is recalled as female.

$P(male|he) > P(female|she)$



6. Conclusion

Production and comprehension are inconsistent on pronoun gender.

Female gender is consistently under-expressed in pronoun production and under-inferred in comprehension

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Language production and comprehension draw on a broad range of knowledge and beliefs, including general world knowledge and contextually variable information. Pronominal references to role nouns with diverse gender biases illuminate the interplay of these sources of information: violations of stereotypical gender elicit surprise (e.g., referring to a surgeon as *she*), but comprehenders can accommodate to non-stereotypical genders within a discourse (Duffy & Kier 2004, Sturt 2003, Osterhout et al. 1997). In two experiments, we investigate how gender expectations are reflected in the production and comprehension of pronominal references to role nouns. Our results indicate that female gender is consistently underused in English pronoun production (Fig. 1), and under-inferred in English pronoun comprehension (Fig. 2).

We experimentally estimated the gender stereotypes associated with 80 role nouns (ex. *diplomat, butler, nanny, reporter*) that were then used in both experiments. In experiment 1, 149 Mechanical Turk participants each completed 20 passages designed to elicit pronouns referring to a role noun (ex. *The day before the championships, the gymnast worked out. Before and after working out, the gymnast stretched ...*). While production of gendered pronouns generally tracks the stereotype of the noun (upward slopes in Fig. 1), *she*(*her*) was produced less often than *he*(*him*,*his*) for all levels of noun stereotype (gap between blue and red lines, Fig. 1): from pronouns matching the noun stereotype (babysitter-*she* < barber-*he*), to gender-neutral role nouns (baker-*she* < baker-*he*), to mismatching pronouns (diplomat-*she* < ice skater-*he*).

In experiment 2, 85 Mechanical Turk participants read researcher-completed versions of the Experiment 1 items, containing a *she*, *he*, or *they* pronoun referring to the role noun (ex. *The day before the championships, the gymnast worked out. Before and after working out, the gymnast stretched her muscles to avoid getting sore.*). After reading 9 vignettes (plus a short working memory task to prevent verbatim recall), participants stated the gender of each role noun's referent. As expected, participant responses regarding referent gender were influenced by role noun stereotype (upward slopes in Fig. 2). If inferences regarding referent gender take production biases into account, then the "female" response rate for role nouns referred to using *she* should be farther above the female stereotype than the "male" response rate for role nouns referred to using *he* is above the male stereotype, because our results in Experiment 1 show that *she* should be a stronger signal of a female referent than *he* is of a male referent. But we see the opposite pattern (Fig. 2): relative to the gender stereotype, *he*(*him*,*his*) is recalled as male well above the stereotype and far more often than *she*(*her*) is recalled as female at an equivalent stereotype strength.

Taken together, these results are scientifically interesting and societally troubling. First, feminine pronouns are consistently under-produced relative to the expectation for the referent to be female. Second, this bias is exacerbated, rather than compensated for, in comprehension: relative to role noun gender stereotype, comprehenders are more likely to remember the referents of female pronouns as male than than vice versa.

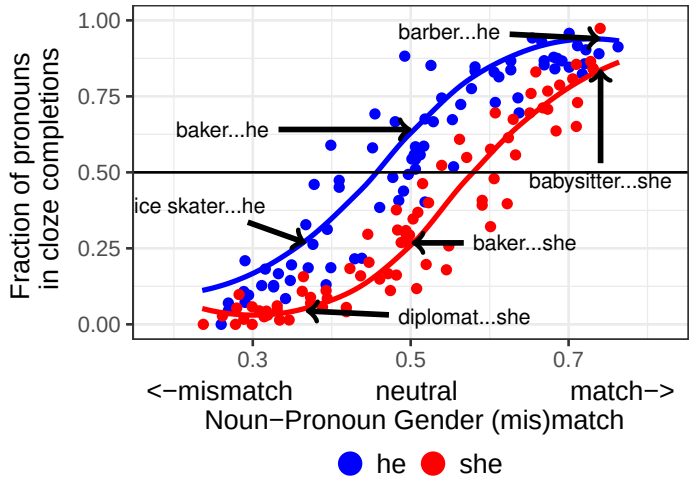

Figure 1: Production of gendered pronouns by pronoun gender and degree of match with noun stereotype. (Dots represent averages per role noun.) Across the range of stereotypes, we find a consistent bias against producing female pronouns.

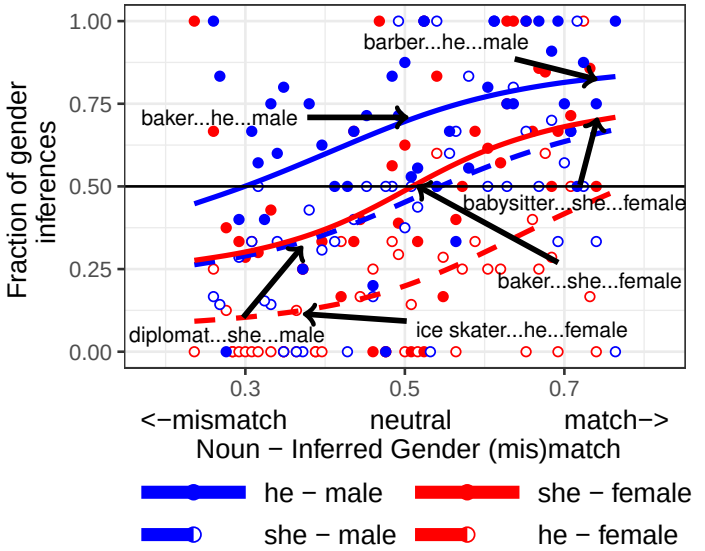

Figure 2: Inferred gender by degree of match with noun stereotype. Dots represent averages per role noun; solid dots and lines indicate inferred gender matched pronoun gender; open dots and dashed lines indicate inferred gender mismatched pronoun gender. Across the range of stereotypes, we find a consistent bias against recalling referents as 'female' (i.e. solid lines are above dashed lines).

References: Duffy, S. A., & Keir, J. A. (2004). *Mem Cognit*, 32(4), 551-559. • Osterhout, L., Bersick, M., & McLaughlin, J. (1997). *Mem Cognit*, 25(3), 273-285. • Sturt, P. (2003). *J Mem Lang*, 48,542-562.