Remember ‘him’, forget ‘her’:
Gender bias in the comprehension of pronominal referents

Veronica Boyce (MIT)
Titus von der Malsburg (University of Potsdam)
Till Poppels (UCSD)
Roger Levy (MIT)

March 29, 2019
von der Malsburg, Poppels, and Levy (2017)

- Presidential election season in 2016
von der Malsburg, Poppels, and Levy (2017)

- Presidential election season in 2016
- Natural experiment: Gender of next president is unknown
von der Malsburg, Poppels, and Levy (2017)

- Presidential election season in 2016
- Natural experiment: Gender of next president is unknown
- How did people refer to the next president? He? She? They?
von der Malsburg, Poppels, and Levy (2017)

- Presidential election season in 2016
- Natural experiment: Gender of next president is unknown
- How did people refer to the next president? He? She? They?
- How did pronoun choice relate to election outcome expectations?
von der Malsburg, Poppels, and Levy (2017)

How likely is a female to be the next president?

£ (female) $\sim 60\%$

They, 25% He, 10% She

The next US president will be sworn into office in January 2017. After moving into the Oval Office, one of the first things ...

This production asymmetry may be a surprise. But is it a concern?
How likely is ... to be the next president?
How likely is ... to be the next president?
How likely is ... to be the next president?

The next US president will be sworn into office in January 2017. After moving into the Oval Office, one of the first things that ...
How likely is ... to be the next president?

The next US president will be sworn into office in January 2017. After moving into the Oval Office, one of the first things that ...
How likely is ... to be the next president?

The next US president will be sworn into office in January 2017. After moving into the Oval Office, one of the first things that ...
How likely is ... to be the next president?

\[ P(\text{female}) \sim 60\% \]

The next US president will be sworn into office in January 2017. After moving into the Oval Office, one of the first things that ...
How likely is ... to be the next president?

\[ P(\text{female}) \sim 60\% \]

65% They, 25% He, 10% She

The next US president will be sworn into office in January 2017. After moving into the Oval Office, one of the first things that ...

How likely is ... to be the next president?

\[ P(\text{female}) \sim 60\% \]

65% They, 25% He, 10% She

The next US president will be sworn into office in January 2017. After moving into the Oval Office, one of the first things that ... ____________________________

This production asymmetry may be a surprise. But is it a concern?
What do comprehenders do?
What do comprehenders do?

Two possibilities:

• 'He' is a weaker signal of referent gender than 'She'
• Production pattern not necessarily a concern

• Comprehenders do not "reverse" the production asymmetry in interpretation
• 'He' is not a sufficiently weaker signal of referent gender than 'She'
• Female gender is systematically under-conveyed
What do comprehenders do?

Two possibilities:

1. Comprehenders “reverse” the production asymmetry in interpretation
   - ‘He’ is a weaker signal of referent gender than ‘She’
   - Production pattern not necessarily a concern
What do comprehenders do?

Two possibilities:

1. Comprehenders “reverse” the production asymmetry in interpretation
   - ‘He’ is a weaker signal of referent gender than ‘She’
   - Production pattern not necessarily a concern

2. Comprehenders do **not** “reverse” the production asymmetry in interpretation
   - ‘He’ is not a sufficiently weaker signal of referent gender than ‘She’
   - Female gender is systematically under-conveyed
Before the baker took out the trash, he swept the floor and wiped down the counter.

Symmetric

Stereotype – how female

Interpret as Female Rate

Production

He
She
They

baker
antique dealer
manicurist
Before the baker took out the trash, he swept the floor and wiped down the counter.
Before the baker took out the trash, ...
Before the baker took out the trash, ...
Before the baker took out the trash, ...
Before the baker took out the trash, ...
Before the baker took out the trash, ...

Symmetric
Before the baker took out the trash, ... he swept the floor and wiped down the counter.

Symmetric
Before the baker took out the trash, … he swept the floor and wiped down the counter.

Symmetric
Before the baker took out the trash, ... he swept the floor and wiped down the counter.

Symmetric
Before the baker took out the trash, ... he swept the floor and wiped down the counter.
Before the baker took out the trash, ... he swept the floor and wiped down the counter.
Are speakers’ referent gender expectations faithfully conveyed?
Are speakers’ referent gender expectations faithfully conveyed?

\[ P_S(\text{ref.gender}) \overset{?}{=} P_L(\text{ref.gender}) \]
Are speakers’ referent gender expectations faithfully conveyed?

\[ P_S(\text{ref.gender}) \overset{?}{=} P_L(\text{ref.gender}) \]

Symmetric

Symmetric
Are speakers’ referent gender expectations faithfully conveyed?

\[ P_S(\text{ref.gender}) \overset{?}{=} P_L(\text{ref.gender}) \]

\[ \sum_{\text{pro}} P(\text{pro}|P_S(\text{ref.gender})) \cdot P(\text{ref.gender}|\text{pro}) = P_L(\text{ref.gender}) \]
Are speakers’ referent gender expectations faithfully conveyed?

$$P_S(ref.\text{ gender}) \overset{?}{=} P_L(ref.\text{ gender})$$

Symmetric

$$\sum_{pro} P(pro|P_S(ref.\text{ gender})) \cdot P(ref.\text{ gender}|pro) = P_L(ref.\text{ gender})$$
Are speakers’ referent gender expectations faithfully conveyed?

\[ P_S(\text{ref.gender}) \overset{?}{=} P_L(\text{ref.gender}) \]

\[ \sum_{\text{pro}} P(\text{pro}|P_S(\text{ref.gender})) \cdot P(\text{ref.gender}|\text{pro}) = P_L(\text{ref.gender}) \]
Are speakers’ referent gender expectations faithfully conveyed?

\[ P_S(\text{ref.gender}) \overset{?}{=} P_L(\text{ref.gender}) \]

\[ \sum_{\text{pro}} P(\text{pro}|P_S(\text{ref.gender})) \cdot P(\text{ref.gender}|\text{pro}) = P_L(\text{ref.gender}) \]
Are speakers’ referent gender expectations faithfully conveyed?

\[ P_S(\text{ref.gender}) \overset{?}{=} P_L(\text{ref.gender}) \]

\[ \sum_{\text{pro}} P(\text{pro} | P_S(\text{ref.gender})) \cdot P(\text{ref.gender} | \text{pro}) = P_L(\text{ref.gender}) \]
Are speakers’ referent gender expectations faithfully conveyed?

\[ P_S(\text{ref.gender}) =? P_L(\text{ref.gender}) \]

Symmetric
Symmetric
Faithfully Conveyed

Calibrated

\[ \sum_{\text{pro}} P(\text{pro}|P_S(\text{ref.gender})) \cdot P(\text{ref.gender}|\text{pro}) = P_L(\text{ref.gender}) \]
Interpretation

Symmetric

Production

Calibrated

Stereotype − how female
Pronoun Production Rate
Interpret as Female Rate
Stereotype − how female
Stereotype − how female
Interpretation

Symmetric

Calibrated

Asymmetric

Production

Symmetric

Pronoun Production Rate

Stereotype – how female

Interpret as Female Rate

Stereotype – how female

Pronoun Production Rate

Stereotype – how female

Calibrated

Mis-calibrated

Interpret as Female Rate

Stereotype – how female

Interpret as Female Rate

Stereotype – how female
Interpretation

Symmetric

Asymmetric

Production

Calibrated

Mis-calibrated

Stereotype − how female
Interpret as Female Rate
Pronoun Production Rate

Stereotype − how female
Interpret as Female Rate
Pronoun Production Rate

Stereotype − how female
Interpret as Female Rate
Pronoun Production Rate
Interpretation

Symmetric

Asymmetric

Stereotype − how female

Interpret as Female Rate

Symmetric

Asymmetric

Pronoun Production Rate

Interpret as Female Rate

Calibrated

Mis-calibrated

Symmetric

Asymmetric

Pronoun Production Rate

Interpret as Female Rate

Calibrated

Mis-calibrated

Stereotype − how female
Experiments

Test with 80 role nouns (ex. diplomat, butler, nanny, reporter)

a. Explicit Norm
If you encounter a baker, how likely are they to be female?

b. Production
Before the baker took out the trash, ...

Gender recall
After the baker ... he ...
1, 4, or 8 stories

5 * 7 + 12 - 3 = ___

working memory
task

In the story you read, what was the gender of the baker?
Female / Male / Other

One question per story
Experiments

Test with 80 role nouns (ex. diplomat, butler, nanny, reporter)
Experiments

Test with 80 role nouns (ex. diplomat, butler, nanny, reporter)

a. Explicit Norm

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

Test with 80 role nouns (ex. diplomat, butler, nanny, reporter)

<table>
<thead>
<tr>
<th>a. Explicit Norm</th>
<th>b. Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>If you encounter a baker, how likely are they to be female?</td>
<td>Before the baker took out the trash, ... ___________</td>
</tr>
</tbody>
</table>

5 * 7 + 12 - 3 = ___

working memory task

In the story you read, what was the gender of the baker?
Female / Male / Other

One question per story
Experiments

Test with 80 role nouns (ex. diplomat, butler, nanny, reporter)

a. Explicit Norm
If you encounter a baker, how likely are they to be female?

b. Production
Before the baker took out the trash, ... __________

c. Gender recall
After the baker ... he ... 1, 4, or 8 stories
5 * 7 + 12 - 3 = ___
working memory task
In the story you read, what was the gender of the baker?
Female / Male / Other
One question per story
Experiments

a. Explicit Norm

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

- 51 participants each rated all 80 nouns
- Half asked “how male”, half asked “how female”
- We averaged results into a 0-1 ‘how female’ norm
Experiments

b. Production

After the shop on High Street closed for the night, a **baker** stayed to tidy up. Before the **baker** took out the trash, ...

- 149 participants each completed 20 items
- We coded pronoun completions
### Experiments

<table>
<thead>
<tr>
<th>c. Gender recall</th>
</tr>
</thead>
<tbody>
<tr>
<td>After the shop on High Street closed for the night, a <strong>baker</strong> stayed to tidy up. Before the <strong>baker</strong> took out the trash, <strong>he</strong> swept the floor and wiped down the counter.</td>
</tr>
</tbody>
</table>

1,4, or 8 stories
Experiments

c. Gender recall

\[(70 - 4) \div 3 + 9 = \]
c. Gender recall

<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>In the story you read, what was the gender of the <strong>baker</strong>?</td>
<td>Female, Male, Other</td>
</tr>
</tbody>
</table>

One question per story
Experiments

c. Gender recall

In the story you read, what was the gender of the **baker**?

- Female
- Male
- Other

One question per story

- 712 participants
- We only consider male, female responses
Explicit Norm − How Female Pronoun Production Rate

<table>
<thead>
<tr>
<th>Pronoun</th>
<th>Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>He</td>
<td>0</td>
</tr>
<tr>
<td>She</td>
<td>0.25</td>
</tr>
<tr>
<td>They</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>0.75</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

Asymmetric
Explicit Norm − How Female Pronoun Production Rate

Production

Pronoun Production Rate

Explicit Norm – How Female

Pronoun  He  She  They

Asymmetric
Explicit Norm − How Female Pronoun Production Rate

Production

Asymmetric

Explicit Norm – How Female

Pronoun Production Rate

Pronoun: He, She, They

Graph showing the production rates for pronouns 'He', 'She', and 'They' against the explicit norm of 'How Female'. The graph indicates an asymmetric distribution with a higher production rate for 'She' compared to 'He' and 'They'.
<table>
<thead>
<tr>
<th>Interpretation</th>
<th>.25</th>
<th>.5</th>
<th>.75</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asymmetric</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Explicit Norm − How Female Interpret as Female Rate

Interpretation

Interpret as Female Rate

Explicit Norm − How Female

Pronoun

He
She
They
Explicit Norm − How Female Interpret as Female Rate
Pronoun: He, She, They
Interpretation
Asymmetric
<table>
<thead>
<tr>
<th>Pronoun Production Rate</th>
<th>Production</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0.25</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>0.75</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interpret as Female Rate</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0.25</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>0.75</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Weighted Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pronoun</th>
<th>He</th>
<th>She</th>
<th>They</th>
</tr>
</thead>
</table>

Explicit Norm − How Female

Asymmetric

Mis-calibrated

Gender of referent not faithfully conveyed!

Female gender expectations are under-recovered!

\[
\sum_{\text{pro}} P(\text{pro} | \text{P}_S(\text{ref}.\text{gender})) \cdot P(\text{ref}.\text{gender} | \text{pro}) = P_{\text{L}}(\text{ref}.\text{gender})
\]
Asymmetric

Production

Interpretation

Weighted Interpretation

Pronoun Production Rate

Interpret as Female Rate

Interpret as Female Rate

Weighted Interpretation

Pronoun He She They

Explicit Norm – How Female

Asymmetric

Mis-calibrated

Gender of referent not faithfully conveyed!

Female gender expectations are under-recovered!

\[ \sum_{pro} P(pro | P_{S}(ref.\ gender)) \cdot P(ref.\ gender | pro) = P_{L}(ref.\ gender) \]
\[
\sum_{\text{pro}} P(\text{pro}|P_S(\text{ref.gender})) \cdot P(\text{ref.gender}|\text{pro}) = P_L(\text{ref.gender})
\]
Asymmetric
Production

Asymmetric
Interpretation

Mis-calibrated
Weighted
Interpretation

Gender of referent not faithfully conveyed!

\[
\sum_{pro} P(pro|P_S(ref.gender)) \cdot P(ref.gender|pro) = P_L(ref.gender)
\]
Gender of referent not faithfully conveyed!
Female gender expectations are under-recovered!

$$\sum_{\text{pro}} P(\text{pro}|P_S(\text{ref.gender})) \cdot P(\text{ref.gender}|\text{pro}) = P_L(\text{ref.gender})$$
Production

Interpretation

Weighted Interpretation

Pronoun
- He
- She
- They

Explicit Norm – How Female Rate

Interpret as Female Rate

Weighted Interpretation

1 trial

4 trial

8 trial
Gender of referent not faithfully conveyed!
Conclusion

Gender of referent not faithfully conveyed!

- Pronoun production and interpretation are not mutually calibrated

- A challenge for rational theories that expect listeners and speakers to calibrate for effective communication

- What might be the source of the miscalibration?

- Grammatical gender is often not central to communicative goals, so may not be under much pragmatic pressure?

- Speakers and listeners are rational, but they consider misgendering a male as female as costlier than vice versa?

- Socially concerning – what are consequences of this miscalibration?
Conclusion

Gender of referent not faithfully conveyed!

- Pronoun production and interpretation are not mutually calibrated
  - A challenge for rational theories that expect listeners and speakers to calibrate for effective communication

- What might be the source of the miscalibration?
  - Grammatical gender is often not central to communicative goals, so may not be under much pragmatic pressure?
  - Speakers and listeners are rational, but they consider misgendering a male as female as costlier than vice versa?

- Socially concerning – what are consequences of this miscalibration?
Conclusion

Gender of referent not faithfully conveyed!

- Pronoun production and interpretation are not mutually calibrated
  - A challenge for rational theories that expect listeners and speakers to calibrate for effective communication
- What might be the source of the miscalibration?
Conclusion

Gender of referent not faithfully conveyed!

- Pronoun production and interpretation are not mutually calibrated
  - A challenge for rational theories that expect listeners and speakers to calibrate for effective communication
- What might be the source of the miscalibration?
  - Grammatical gender is often not central to communicative goals, so may not be under much pragmatic pressure?
Conclusion

Gender of referent not faithfully conveyed!

- Pronoun production and interpretation are not mutually calibrated
  - A challenge for rational theories that expect listeners and speakers to calibrate for effective communication
- What might be the source of the miscalibration?
  - Grammatical gender is often not central to communicative goals, so may not be under much pragmatic pressure?
  - Speakers and listeners are rational, but they consider misgendering a male as female as costlier than vice versa?
Conclusion

Gender of referent not faithfully conveyed!

- Pronoun production and interpretation are not mutually calibrated
  - A challenge for rational theories that expect listeners and speakers to calibrate for effective communication
- What might be the source of the miscalibration?
  - Grammatical gender is often not central to communicative goals, so may not be under much pragmatic pressure?
  - Speakers and listeners are rational, but they consider misgendering a male as female as costlier than vice versa?
- Socially concerning – what are consequences of this miscalibration?
After the shop on High Street closed for the night, a baker stayed to tidy up. Before the baker took out the trash, the baker swept the floor and wiped down the counter.

1, 4, or 8 stories
d. Implicit Norm

\[(70 - 4) \div 3 + 9 = \]
In the story you read, what was the gender of the **baker**?

- Female
- Male
- Other

**One question per story**
**d. Implicit Norm**

In the story you read, what was the gender of the **baker**?

- Female
- Male
- Other

One question per story

- 569 participants
- Only consider male, female responses
Implicit Norm

Production

Pronoun Production Rate

Implicit Norm – How Female

Pronoun

He
She
They
Implicit Norm

Interpretation

Implicit Norm – How Female

Interpret as Female Rate

Pronoun He She They

Interpretation

Implicit Norm – How Female

Pronoun He She They
Implicit Norm

Production

Interpretation

Weighted Interpretation

Pronoun Production Rate

Interpret as Female Rate

Interpret as Female Rate

Weighted Interpretation

Pronoun

He

She

They

Implicit Norm − How Female

0 .25 .5 .75 1

Production

Interpretation

Weighted

Interpretation

Pronoun He She They

Implicit Norm − How Female
Implicit Norm

Production

Interpretation

Weighted Interpretation

Interpret as Female Rate

Weighted Interpretation

Implicit Norm – How Female

Pronoun Production Rate

Pronoun

He
She
They

Interpret as Female Rate

Interpretation Weighted Interpretation

1 trial

4 trial

8 trial
By gender

Production

Explicit Norm − How Female

Pronoun Production Rate

Pronoun: He, She, They

Female Producer

Male Producer
By gender

Interpretation

Explicit Norm − How Female Interpret as Female Rate

Pronoun  
He  She  They
By gender

Weighted Interpretation

Explicit Norm – How Female

Interpret as Female Rate

Female Interpreter

Male Interpreter

Female Producer

Male Producer

0 .25 .5 .75 1

0 .25 .5 .75 1

0 .25 .5 .75 1

0 .25 .5 .75 1
Participant Demographics

Participants in Norming Study

Participant Gender
- Female
- Male

Age

Count

20 40 60 80
Participants in Gender Recall Study

<table>
<thead>
<tr>
<th>Age</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>60</td>
<td>80</td>
</tr>
<tr>
<td>80</td>
<td>20</td>
</tr>
</tbody>
</table>

Participant Gender
- Female
- Male

Participant Demographics

Gender recall study
Participant Demographics

Production study

Participants in Production Study

Age

count

Participant Gender
Female
Male

Participants in Production Study

Participant Gender

Female
Male

Age

count