The Effects of Sex and Autism Spectrum Disorder on Prosody

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Overview

Background
- What is autism spectrum disorder (ASD)?
- What is masking?
- Differences in masking by sex
- Sex differences in prosody: what do we know?

Methods
- Study participants
- Online PEPS-C
- Contrastive stress subtasks

Results
- Data, analyses, plots and summary

Discussion
- Conclusions and future directions
What is autism spectrum disorder (ASD)?

A developmental disorder

- **Main criteria (DSM-5; APA, 2013)**
  - Difficulties in social/emotional reciprocity
  - Difficulties in nonverbal communication
  - Deficits in developing and maintaining relationships

- **Secondary criteria: 2 of 4**
  - Stereotyped speech, echolalia, repetitive use of phrases
  - Rigid adherence to routines, resistance to change
  - Highly restricted interests, abnormal intensity/focus
  - Sensory issues, e.g., strong dislike for specific sounds
Linguistic characteristics

- Overall, good syntax, segmental phonology and vocabulary (college students)
- Difficulty using pronouns (pronoun reversal)
- Struggle to understand/use idiomatic expressions and metaphors
- Interpret language literally rather than understanding implied meanings or social cues
- Difficulty using language effectively in social situations, such as turn-taking and staying on topic (pragmatics)
- “Odd sounding” prosody (Kanner, 1943). Flat or monotone voice or an exaggerated, singsong-like voice

American Speech-Language-Hearing Association (ASHA, 2021)
What is masking?

Trying to appear more neurotypical or socially acceptable

• Also called camouflaging
• Avoiding social situations altogether
• Suppressing or hiding repetitive or stereotypic behaviors in public
• Overcompensating for difficulties in social situations, e.g., rehearsing conversations in advance
• Mimicking behaviors of neurotypical individuals, e.g., eye contact, using small talk
Differences in masking by sex

• Both men and women with ASD can engage in behavioral masking/camouflaging

• More common in women (Hull et al., 2017)
Differences in prosodic function by sex: What’s known

♀ Overall, women are better than men at comprehending and producing **affective** prosody (Orazbekova, 2015; Jiang, 2011)

♀ Overall, women may be more sensitive to **contrastive stress** than men (Koch & Spalek, 2021)

😢 Not much else!
Are there sex differences in prosodic masking?

Predictions: If women with ASD are more likely to use prosodic masking than men with ASD, we expect…

1. Women > Men
2. NT>ASD, particularly in pragmatic use of prosody
3. An interaction between sex and neurological status
4. Greater ASD-neurotypical (NT) difference for men than women
5. Greater difference in production than comprehension
Study participants

- N = 118 native English-speaking college students
- For purposes of this study:
  - ASD = diagnosis and/or AQ score > 28 (Simon Baron-Cohen, et al., 2001; Broadbent et al., 2013)
  - NT = otherwise neurotypical (no reported disorders)
- 93 NT: 62 female, 31 male, 2:1 ratio
- 25 ASD: 16 female, 9 male, 1.7:1 ratio
Online PEPS-C

• O-PEPS-C: Online version of Profiling Elements of Prosody in Speech Communication (PEPS-C; Peppé et al., 2003)

• Fully online (no experimenter involvement)

✧ 14 subtests: half comprehension, half production

▷ 2 subtests of prosodic form (acoustic/perpetual)

▷ 12 subtests of prosodic function
Online PEPS-C subtest descriptions

• Prosodic form
• Prosodic function:
  ▶ Sentence type (turn-end): *Carrots. vs Carrots?*
  ▶ Affect: expressing like/dislike
  ▶ Lexical stress: \textit{imPORT} (verb) vs \textit{IMport} (noun)
  ▶ Phrase stress:
    ▶ *The green house spoils the view*
    ▶ *The greenhouse spoils the view*
  ▶ Phrase boundary:
    ▶ *Chocolate cookies and jam*
    ▶ *Chocolate, cookies, and jam*
  ▶ Contrastive stress: \textit{pragmatic} prosody
Contrastive stress subtest: comprehension

I wanted blue and BLACK socks

Click the color of socks they emphasized were missing
Contrastive stress subtest: production
Contrastive stress subtest: production

And the red cow has the ball...

No, the BLUE cow has it!
**Contrastive stress subtest: production**

Now the blue sheep has it...  

No, the blue COW has it!
Data

• **Comprehension**: Accuracy [& RT]
• **Production**: Verbal response [& onset of response]
  • How productions were coded:
    ▶ Offline
    ▶ Blind to “correct” answer, diagnosis
    ▶ 2+ coders (High inter-rater reliability, Krippendorf’s alpha >.82)
    ▶ Mean score of coders
Analyses

• Bayesian ANOVAs of normalized accuracy data
• Factors:
  › Participant factors
    • Sex
    • ASD/NT
  › Stimuli factors
    • Comprehension/Production
    • 7 Subtests
  › Random variable: Item
All subtests, comp. & prod. combined

Main Effect (ME) Sex: $BF_{10} = 1.33 \times 10^7$
All subtests combined

Comprehension

_production correct (normalized)_

<table>
<thead>
<tr>
<th></th>
<th>NT</th>
<th>ASD</th>
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<tbody>
<tr>
<td>women</td>
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<td>men</td>
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ME Sex

\[ BF_{10} = 2.06 \times 10^7 \]
Predictions: a reminder

• An interaction between sex and neurological status
• Greater ASD-NT difference for men than women
• Greater for production than comprehension
• Especially in pragmatic use of prosody (e.g., contrastive stress)
By subtest

Form

All

Comprehension

Production

Proportion correct (normalized)

NT

ASD

Form

women

men
By subtest

Sentence type (Turn-end)

Carrot. vs Carrots?

All

Comprehension

Production

ME Sex

$BF_{10} = 7.74 \times 10^3$

ME Sex

ME ASD/NT

$BF_{10} = 1.58 \times 10^3$

$BF_{sex} = 1.13 \times 10^3$
By subtest

Affect

Like/Dislike

ME Sex
BF_{10} = 3.35
Lexical stress

ImPORT vs IMport

By subtest

All

Comprehension

Production

Lexical stress

Proportion correct (normalized)

women
men

NT ASD

NT ASD

NT ASD
By subtest

Phrases stress

The green house spoils the view
The greenhouse spoils the view

All

Comprehension

Production

ME Sex
BF_{10} = 3.74 \times 10^2

ME Sex
BF_{10} = 5.225

ME Sex
BF_{10} = 5.774
By subtest

Phrase boundary

Chocolate cookies and jam
Chocolate, cookies, and jam

All

Comprehension

Production

ME NT/ASD
BF_{10} = 5.782
By subtest

Contrastive Stress

Comprehension & Production combined

Contrastive stress

ME Sex
$BF_{10} = 4.10 \times 10^7$
Contrastive Stress

Comprehension only

I wanted blue and BLACK socks

Click the color of socks they emphasized were missing

By subtest

Contrastive stress

ME Sex
BF_{10} = 6.977
By subtest

Contrastive Stress

Production only

And the red cow has the ball...

No, the BLUE cow has it!

ME Sex & NT/ASD & Sex x NT/ASD

Women: no difference NT/ASD

Men: NT/ASD, $BF_{10} = 8.322$
Summary

- Women outperformed men
- NT did not outperform ASD
- No interaction between sex/neurological status for overall scores
Summary

Contrastive Stress

All

Comprehension

Production

ME Sex
\[ BF_{10} = 4.10 \times 10^7 \]

ME Sex
\[ BF_{10} = 6.977 \]

ME Sex & NT/ASD & Sex x NT/ASD
\[ BF_{10} = 8.13 \times 10^7 \]

Female: no difference NT/ASD

Male: NT/ASD
\[ BF_{10} = 8.322 \]
Summary

Contrastive Stress

**ME Sex**
- BF$_{10}$ = 4.10x10$^7$

**Comprehension**
- ME Sex
  - BF$_{10}$ = 6.977

**Production**
- ME Sex & NT/ASD & Sex x NT/ASD
  - BF$_{10}$ = 8.13x10$^7$

**Female**: no difference NT/ASD

**Male**: NT/ASD
  - BF$_{10}$ = 8.322
Discussion

Differences between men and women with ASD

• **FACT:** 4:1 ratio men:women diagnosed ASD (CDC, 2023)

• **FACT:** ASD manifests differently in men than women (Lai et al., 2015)

• **FINDING:** Women > men at prosody overall

• **FINDING:** ASD women mask when using **pragmatic** prosody
Women with ASD are under diagnosed

• Growing evidence women under diagnosed (e.g., Ratto et al., 2018)
• Our sample: 25 ASD: 16 female, 9 male, 1.7:1 ratio
• Diagnosed: 4 female, 4 male
• AQ > 28 added 12 female, 5 male
Future directions

Outreach: more ASD participants
Future directions

Acoustic analyses

Acoustic differences in between men/women, ASD/NT in contrastive stress?
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