The Effects of Gender and Autism Spectrum Disorder on Prosody

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1 Introduction

1.1 Linguistic Characteristics of Autism Spectrum Disorder

Autism spectrum disorder (ASD) is a neurodevelopmental disorder that is characterized by difficulty with social and emotional reciprocity, nonverbal communication, and developing and maintaining relationships (APA 2013). Communication disorders are more common among people with ASD than those who do not have ASD, and adults with ASD vary from being nonverbal to having no difficulty with phonemes, words or morphosyntax (see Schaeffer et al. 2023 and references therein).

Some people with ASD who do not have difficulty producing phonemically well-formed utterances nonetheless have speech that is prosodically aberrant. Kanner (1943) noted that despite "clear articulation and phonation," ASD speech was sometimes "peculiarly unmodulated" or had "odd intonation." ASD speech is described as being both robotic and exaggerated (see Wehrle et al. 2020), and in their meta-analysis, Asghari et al. (2021) found ASD speech typically has a higher fundamental frequency (F0), greater F0 range and variability and longer duration, with these differences being more pronounced for adolescents and adults than children, for people with ASD who have cognitive or structural language impairments and for prosody produced during narration tasks.

Although there is consensus that the prosodic *form* of ASD speech is often atypical, it is less clear the extent to which people with ASD are impaired in the *functional use* of prosody. In their meta-analysis of functional uses of prosody in ASD, Knutsen and Stromswold (2021) found that some studies report that people with ASD have difficulty producing (e.g., Filipe et al. 2018, Peppe et al. 2011) or perceiving affective prosody (e.g., Globerson et al. 2015, Jarvinen-Pasley et al. 2008), whereas other studies find no difficulty in affect prosody production (Paul et al. 2005) or perception (Filipe et al. 2018, Grossman et al. 2010). Similarly, although some studies report that people with ASD have difficulty producing or comprehending the pragmatic function of contrastive stress (McCann and Peppé 2003, Paul et al. 2005, Peppe et al. 2011, Lyons et al. 2014), other studies have not (Globerson et al. 2015). Furthermore, although pragmatic and affective prosody are typically more affected by ASD than lexical or grammatical prosody (e.g., Shriberg et al 2001, Paul et al. 2005, Fine et al. 1991), some studies have found that people with ASD also have impairments on the comprehension and/or production of lexical stress (e.g., Paul et al. 2005, 2008), phrase- and utterance-level stress (e.g., Baltaxe and Guthri 1987, Baltaxe and Simmons 1985, Shriberg et al. 2001) and phrase boundaries (e.g., Peppé et al. 2011, Paul et al. 2005, Diehl et al. 2008). These between-study differences likely reflect the heterogeneity in the ages of participants studied, whether participants had intellectual or structural language impairments, and the tasks used to assess functional prosody (Knutsen and Stromswold 2021).

Impairment in discourse pragmatics is generally agreed to be a linguistic hallmark of ASD (see Tager-Flusberg et al. 2005). People with ASD often have difficulty using language effectively in social situations, especially with initiating and taking turns in conversations (Mody and Belliveau 2013). Although people with ASD tend to interpret language literally rather than understanding the underlying, implied message, some aspects of discourse pragmatics are more impacted than others. People with ASD who do not have intellectual impairments may perform within normal limits on pragmatic tasks such as determining the illocution of an utterance or the implication of a scalar term, yet still struggle with idioms and metaphors (see Schaeffer et al. 2023 and references therein).

1.2 Gender Differences in ASD

ASD is more common in males than females, with recent studies usually reporting a male-to-female-

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odds ratio of between 3:1 and 4:1 (Loomes et al. 2017). Many researchers have suggested that ASD is underdiagnosed in females because ASD manifests differently in males than females. Consistent with this, teachers report that girls with ASD "blend in" better than boys with ASD (Gould and Ashton-Smith 2011, Hiller et al. 2014), and naïve adults rate their first impressions of school-aged girls who do and do not have ASD to be similar, whereas they rate girls with ASD more favorably than boys with ASD, even though the boys and girls didn't differ in ASD symptom severity (Cola et al. 2020). Parents report that girls with ASD maintain better eye contact during conversations, exhibit more interest in what others say, are better at repairing conversations than boys, and are less likely to interpret language literally or to speak in an "over-precise or pedantic way" than boys (de Giambattista et al. 2021). Similarly, naïve adults rate girls with ASD to be better conversational partners than boys with ASD (Cola et al. 2020). Analyses of speech samples also reveal gender differences. For example, Boorse et al. (2019) found that both boys and girls with ASD use more nouns than children who are neurotypical (NT), but only boys with ASD use fewer "cognitive processing" verbs (e.g., *think, want, believe, feel*) than NT children. In conversations, boys with ASD use fewer words overall, fewer first and third person plural pronouns and fewer words for people than girls with ASD (Song et al. 2021, Cola et al. 2022, Cho et al. 2023).

1.3 Gender Differences in Prosody

NT women tend to have higher F0s and F0 ranges and are more likely to use a rising tone than NT men (Jiang 2011, Orazbekova et al. 2015). Gender differences in the *functional uses* of prosody has received less attention. NT women may be more skilled at affective prosody than NT men (e.g., Orazbekova et al. 2015, Jiang 2011). Koch and Spalek (2021) have argued that NT women are more sensitive to contrastive stress prosody because they were better at recalling words with contrastive stress. However, this could merely indicate that NT women are better at detecting that a word is stressed, and not that they have greater understanding of the pragmatic *function* of contrastive stress.

Studies of gender differences in ASD prosody have yielded mixed results. Wehrle et al. (2020) describe the prosody of men with ASD as being more exaggerated than that of women, and parents report that boys with ASD are more likely to speak with an "unusual tone of voice" than girls (de Giambattista et al. 2021), yet Parish-Morris et al. (2017) and Cho et al. (2023) report no gender differences in pitch variation. Similarly, Cho et al. (2023) report that boys with ASD speak more slowly than girls, yet Parish-Morris et al. (2017) found no gender differences in speaking rates. We are unaware of any studies of ASD that have investigated gender differences in prosodic *function*.

In summary, most studies of ASD prosody have focused on prosodic form and not prosodic function. Furthermore, existing studies often include participants with concomitant intellectual or language impairments and, thus, it is unclear if NT-ASD differences are specifically due to autism. Finally, relatively little is known about gender differences in *NT* adults' functional use of prosody, and *no* studies have investigated whether men and women with ASD differ in their functional use of prosody. To fill these gaps in the literature, we conducted a study in which we assessed the prosodic abilities of cognitively-intact men and women who do and do not have ASD.

2 Materials and Methods

2.1 Participants

The study included 116 native English-speaking college students (76 females, 40 male).[1] Participants completed the Autism Spectrum Quotient (AQ, Baron-Cohen et al. 2001b), a self-report questionnaire that asks about traits commonly seen in ASD, and a questionnaire that asks about diagnoses of ASD, impairments in vision, hearing, spoken or written language, learning, and other neuropsychological disorders. Two women who did not have ASD was excluded because they reported having a stutter or dyslexia. Participants were classified as ASD if they reported having been diagnosed with ASD and/or had AQ scores above 28.[2] All other participants were considered neurotypical

[1] Participants self-reported gender. One person reported being nonbinary and was excluded from analyses.
[2] We used the threshold of an AQ score of 29 because this threshold had a false positive rate of 1% and a false negative rate of 14% for clinically significant autism traits in adults (Broadbent et al. 2013).

(NT). Using these criteria, there were 60 women and 31 men in the NT group (female: male ratio = 1.9:1), and 16 women and 9 men in the ASD group (female: male = 1.78:1). The gender ratios did not differ in the NT and ASD groups; X^2 (1, N = 116) = 0.03, p = .86).

2.2 Stimuli

Participants' prosody was evaluated using the Online Profiling Elements of Prosody in Speech Communication (O-PEPS-C, Knutsen, Peppe and Stromswold, 2021), which is an online adaptation of the PEPS-C (Peppé and McCann 2003). In the PEPS-C, participants come into a lab or clinic and a trained experimenter administers the test. In contrast, participants take the O-PEPS-C on their own computer, and video instructions guide them through each subtest. The PEPS-C and O-PEPS-C have 14 subtests that assess comprehension and production of different aspects of prosody in the same order (first prosodic form, then declarative/question prosody, affective prosody, lexical stress, phrase stress, phrase boundary, and contrastive stress), with comprehension subtests always preceding production subtests. Each subtest has 8 pairs of items that differ minimally. For example, the 16 items of the lexical stress subtest include *ˈINsult* and *inSULTˈ* as the target item once.

Prosodic Form. In the comprehension subtest, participants judge whether pairs of speech samples that are lowpass filtered to obscure phonetic elements are identical or not. In the production subtest, participants imitate the prosody of utterances that are not bandpass filtered.

Declarative/Question Intonation. In the comprehension subtest, participants say whether single words that have rising intonation or flat or downward intonation are questions or declaratives. In the production task, participants say words with question or declarative intonation.

Affective prosody. In the comprehension subtest, participants listen to recordings of a person saying food words with "happy" or "sad" intonation, and judge whether they think the person likes or dislikes the food. In the production subtest, participants say whether *they* like or dislike a food, and say the food word with "happy" intonation if they like it and "sad" intonation if they don't.

Lexical stress. In the comprehension subtest, participants listen to words that are identical except for their stress pattern (e.g., the noun *ˈinsult* and the verb *insultˈ*), and choose which word was said. In the production subtest, participants read the comprehension subtest words aloud.

Phrase stress. These subtests assess participants' ability to recognize and produce adjective-noun and compound noun minimal pairs embedded in sentences (e.g., *The green house/greenhouse spoils the view.*). In the comprehension subtest, participants indicate whether a spoken sentence contains an adjective-noun string or a compound noun by choosing either the written adjective-noun string (e.g., *green house*) or the written compound noun (e.g., *greenhouse*). In the production subtest, participants read aloud the sentences from the phrase stress comprehension subtest.

Phrase boundary. The comprehension subtest uses a forced-choice picture matching task. For example, when participants hear "*chocolate cookies # and jam*" they should select a picture with chocolate cookies and a jar of jam, and when they hear "*chocolate # cookies and jam*," they should select a picture with a chocolate bar, white colored cookies, and a jar of jam. In the production task, they describe the pictures that are used in the comprehension test.

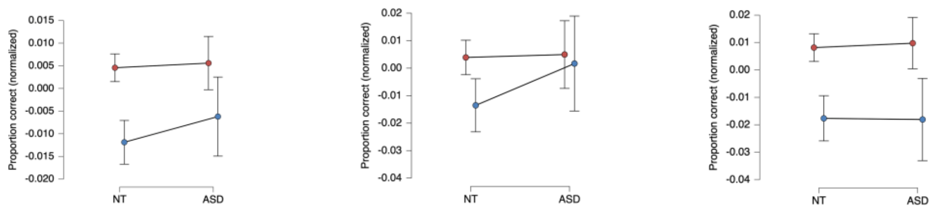
Contrastive stress. In the comprehension task, participants are told a shopper went to a store to buy different colored socks, but when she got home, she realized that she had forgotten to buy one type of socks. Participants listen to sentences said by the forgetful sock shopper, in which one color word is stressed to indicate which color socks she forgot to buy (e.g., *I wanted blue and 'black socks*). Participants' task is to identify which color socks the shopper forgot to buy. In the production subtest, participants use contrastive stress to correct a speaker. The premise of the task is that there is a soccer game between cows and sheep. The announcer for the game always makes a mistake in her commentary about the game, either incorrectly saying the color or the type of animal involved in a play. For example, in one trial the announcer says *The red cow has the ball*, but the image on the screen shows a blue cow with a ball. To receive credit, participants must correct the lexical error and say the corrected word with contrastive stress (e.g., *No, the 'blue cow has the ball*).

2.3 Procedure

The web-based platform FindingFive (FindingFive Team 2019) presented stimuli, recorded participants' responses, and scored comprehension subtest items. Participant's responses were recorded using their microphones, and 4 trained coders, who were blind to the correct answers and participants' diagnoses, later evaluated the accuracy of production items. Inter-rater reliability was very high (Krippendorf's alpha = 0.83), and coders' mean accuracy rates were used in the analyses.

2.4 Results

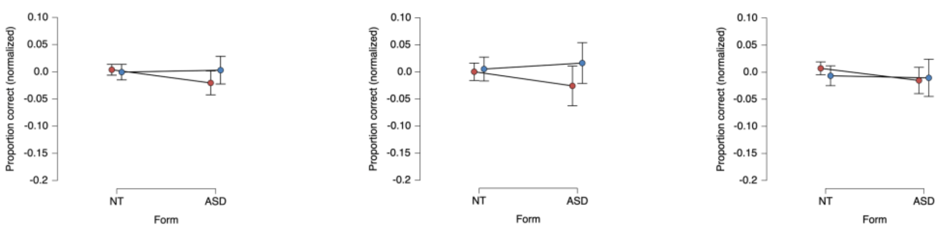
Overall Performance. Accuracy data were normed separately for each of the 14 subtests. These normed data were analyzed using JASP v. 0.17.2 (JASP team 2023) in a series of gender (male vs. female) x neurological status (ASD/NT) Bayesian ANOVAs with item as a random factor. As depicted in Figure 1a, when the production and comprehension data from all subtests were included, in the best-fitting model ($BF_{10} = 1.92 \times 10^7$), there was decisive evidence of a main effect of gender, with women outperforming men ($BF_{inc} = 1.28 \times 10^7$). There was no effect of neurological status, nor did gender and neurological status interact. When just the comprehension data were analyzed, there was very weak evidence that women's overall ability to interpret prosody was better than men's ($BF_{10} = 2.03$, $BF_{inc} = 1.36$, see Figure 1b). Analysis of just the production data revealed that, in the best fitting model ($BF_{10}= 2.50 \times 10^7$), there was decisive evidence that women were better at producing prosody than men ($BF_{inc} = 1.67 \times 10^7$, see Figure 1c).



a. All trials **b. All Comprehension Trials** **c. All Production Trials**

Figure 1: Overall Accuracy (Error bars = 95% credible intervals. Red = women. Blue = men)

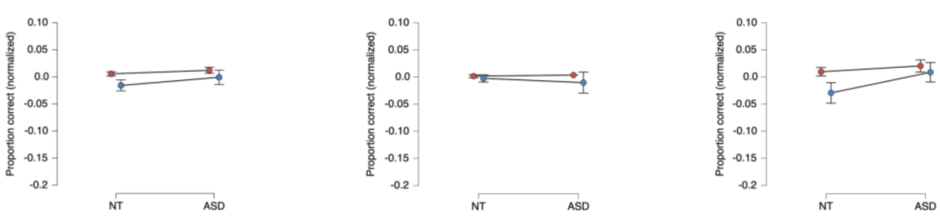
Prosodic Form. For prosodic form (Figure 2), the null model was the best model when all data were analyzed together and when the comprehension and production data were analyzed separately.



a. All Trials **b. Comprehension Trials** **c. Production Trials**

Figure 2: Prosodic Form (Error bars = 95% credible intervals. Red = women. Blue = men)

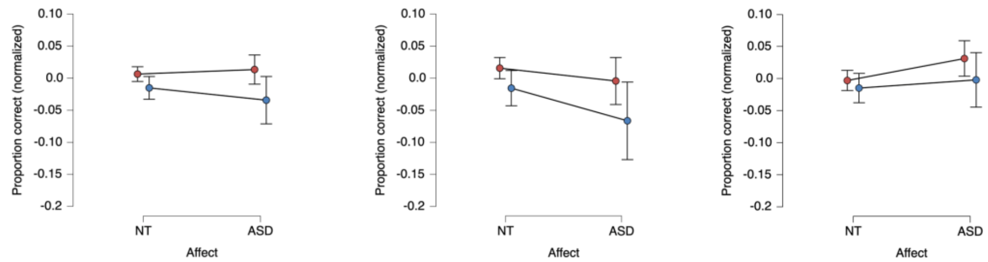
Declarative vs. Question Intonation. When all data were combined, the best fitting model ($BF_{10}=2.13 \times 10^4$) provides decisive evidence of women outperforming men ($BF_{inc}=1.52 \times 10^4$). For just the comprehension data, the null model was the best model. However, for production, the best-fitting model($BF_{10}=3.43 \times 10^3$) decisively shows that women outperformed men ($BF_{inc}=2.94 \times 10^3$).



a. All Trials **b. Comprehension Trials** **c. Production Trials**

Figure 3: Declarative/Question (Error bars = 95% credible intervals. Red = women. Blue = men)

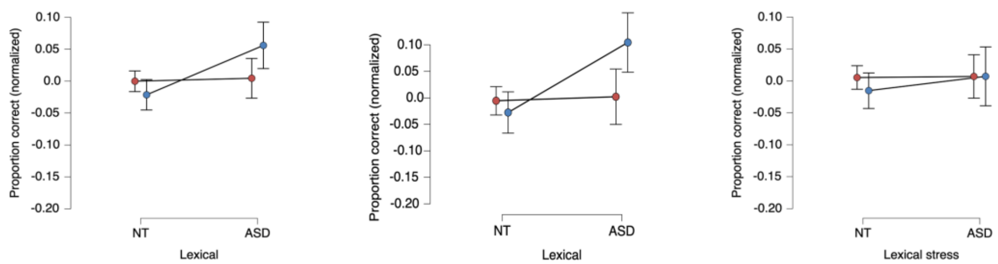
Affective Prosody. When the affective prosody comprehension and production data were combined, the best fitting model (BF_{10}=13.54) provides substantial evidence that women outperformed men (BF_{inc}=9.06, Figure 4a). When just the comprehension data were analyzed, the best fitting model (BF_{10}=4.36) weakly suggests that women were better at comprehending affective prosody (BF_{inc}=2.99). For affective prosody production, no model fit better than the null model.



a. All Trials **b. Comprehension Trials** **c. Production Trials**

Figure 4: Affective Prosody (Error bars = 95% credible intervals. Red = women. Blue = men)

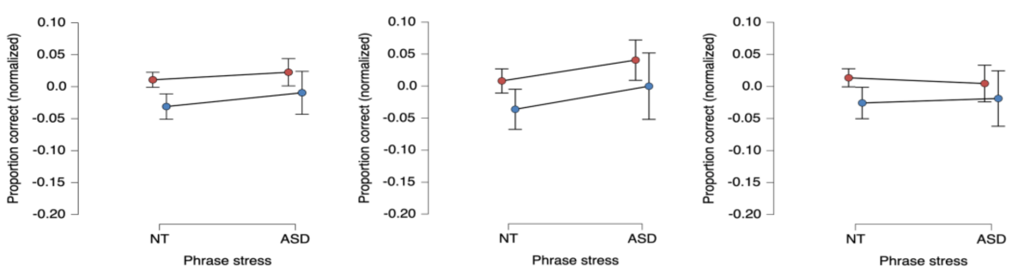
Lexical Stress. For lexical stress (Figure 5), the null model was the best model when all data were analyzed together and when the comprehension and production data were analyzed separately.



a. All Trials **b. Comprehension Trials** **c. Production Trials**

Figure 5: Lexical Stress (Error bars = 95% credible intervals. Red = women. Blue = men)

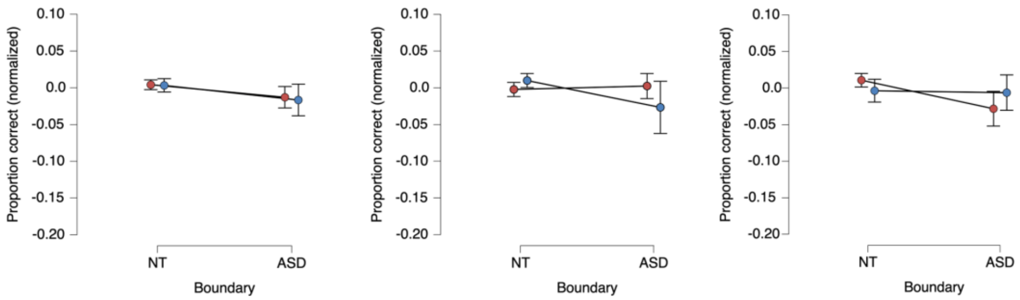
Phrase Stress. When comprehension and production data for phrase stress (e.g., *The green house/greenhouse spoils the view*) were combined, the best fitting model (BF_{10}= 253.08) showed decisive evidence of women outperforming men (BF_{inc} =171.13, see Figure 6a). As shown in Figure6b, when the comprehension data were analyzed separately, the best fitting model (BF_{10}= 4.11) revealed weak evidence of women outperforming men (BF_{inc} = 2.89). Analysis of just the production data yielded similar results (best fitting model BF_{10}= 4.96; BF_{inc} = 3.32, Figure 6c).



a. All Trials **b. Comprehension Trials** **c. Production Trials**

Figure 6: Phrase Stress (Error bars = 95% credible intervals. Red = women. Blue = men)

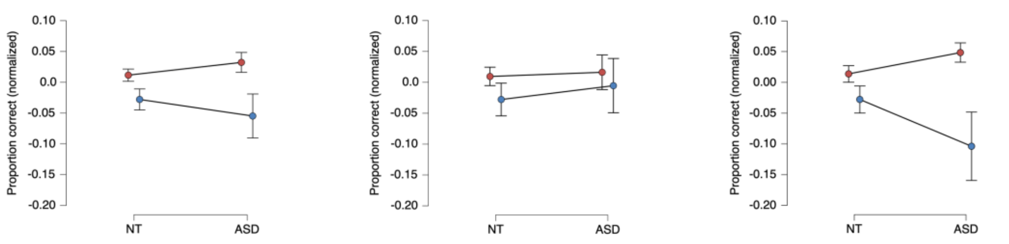
Phrase Boundary. When comprehension and production data were combined for the phrase boundary subtest (e.g., *chocolate # cookies and jam* vs. *chocolate cookies # and jam*), the best fitting model (BF_{10}= 2.98) provides weak evidence that participants who were NT were better at phrase boundary prosody than participants with ASD (BF_{inc}=1.99; see Figure 7a). When we analyzed just the comprehension data, no model fit better than the null model. However, for the production data, the best fitting model (BF_{10}=4.35) provides weak to substantial evidence that participants who were NT were better at producing phrase boundaries accurately (BF_{inc}=3.01, Figure 7c).



a. All Trials **b. Comprehension Trials** **c. Production Trials**

Figure 7: Phrase Boundary (Error bars = 95% credible intervals. Red = women. Blue = men)

Contrastive Stress. Of the subtests, the contrastive stress subtests place the greatest demand on discourse pragmatics because participants must consider a prior utterance to correctly interpret or produce contrastive stress. When the production and comprehension data were combined, the best-fitting model (BF_{10}= 2.64 x10^7; see Figure 8a) provides decisive evidence that women were better at contrastive stress than men (BF_{inc}= 1.90 x10^7). As depicted in Figure 8b, there was also substantial evidence that women more accurately interpreted contrastive stress than men (BF_{10}= 8.89, BF_{inc}= 6.01). As shown in Figure 8c, when just the production data were analyzed, the best-fitting model (BF_{10}=3.23x10^7) had main effects of gender and neurological status, and an interaction between the two factors. There was decisive evidence that women were better than men at producing contrastive stress accurately (BF_{inc}=2.09x10^7), very strong evidence that NT participants more accurately produced contrastive stress than participants with ASD (BF_{inc}= 21.01), and decisive evidence of an interaction between the two factors ($BF_{inclusion}$ =118.06). Because we predicted an ASD/NT difference for men but not women, we next analyzed the men's and women's data separately. These analyses revealed weak evidence that NT women *underperformed* women with ASD (BF_{10}=2.15) and substantial evidence that NT men *outperformed* men with ASD (BF_{10}= 8.12).



a. All Trials **b. Comprehension Trials** **c. Production Trials**

Figure 8: Contrastive Stress (Error bars = 95% credible intervals. Red = women. Blue = men)

3 Discussion

Gender and prosody. Our findings are generally consistent with – and extend – the limited existing research on gender differences in prosodic function. Women were generally more prosodically skilled than men, especially in prosody production, with the gender difference being greatest for determining an utterance's illocutionary function, phrase stress and contrastive stress. Perhaps women's generally better prosodic skills reflect that women face greater societal pressures to be prosocial (Lakoff 1973, Maccoby 1998). However, if this is the explanation, contrary to our findings, the gender effect should be most robust for affective prosody. Some researchers have argued that Theory of Mind (ToM) and discourse-pragmatics go hand-in-hand (see Rosello et al. 2020), and NT women have more advanced ToM skills than NT men (Greenberg et al. 2023). However, a ToM account only predicts gender effects for prosodic tasks that require ToM, yet we found women clearly outperformed men on phrase stress which doesn't require ToM. The ToM account also predicts women should be better at comprehending *and* producing prosody, whereas we only found compelling evidence for a gender effect for prosody production.

Neurological status and prosody. Contrary to the results of many previous studies, when we analyzed production and comprehension data together, our NT participants did not outperform those with ASD overall, or on any specific type of prosody, except possibly phrase boundary prosody. Our participants who did and did not have ASD also did not differ in their overall ability to comprehend prosody, nor did the two groups' comprehension skills differ for any specific type of prosody. There also wasn't an NT/ASD difference in overall ability to produce prosody. However, consistent with some studies (Peppé et al. 2011, Paul et al. 2005, Diehl et al. 2008), there was substantial evidence that NT participants prosodically marked phrase boundaries more accurately than participants with ASD. Consistent with discourse pragmatic impairments and pragmatic prosody being particularly vulnerable in ASD, there was strong evidence that NT participants produced contrastive stress more accurately than participants with ASD did. Contrary to some previous studies, we found no NT-ASD differences for affective prosody. Why didn't we find more widespread prosodic deficits in our participants with ASD? One likely reason is that prosodic impairments are more common in people with ASD who have structural language impairments, and we excluded anyone who reported having a history of a spoken or written language impairment. A second reason is that prosodic impairments are more common in people with ASD who are cognitively impaired, and our participants were cognitively-intact college students.

Gender differences in ASD prosody. For contrastive stress production, we found a significant interaction between gender and neurological status, with women with ASD being as good or better than NT women at producing appropriate contrastive stress, and men with ASD performing substantially worse than NT men. Perhaps this simply reflects that women with ASD are less prosodically impaired than men with ASD. There are two problems with this account. First, it predicts that the NT-ASD differences would be smaller for women than men for *all* types of prosody, and not just contrastive stress. Second, it predicts that the NT-ASD differences would be smaller for women than men for both prosody production <u>and</u> comprehension, and not just prosody production.

Deficits in ToM are a core feature of ASD (e.g., Baron-Cohen 1989), and some researchers have argued that ToM deficits are the underlying cause of the discourse pragmatic impairments associated with ASD (e.g., Rosello et al. 2020). Perhaps our prosodic findings simply reflect gender differences in ToM in ASD. There are several problems with the ToM account. First, if ToM deficits are the root cause of the prosodic impairments associated with ASD, people with ASD should be more impaired on aspects of prosody that require higher levels of ToM, but this is not the case (Chevallier et al. 2011). Second, most studies have found no differences in ToM abilities in males and females with ASD (Wood-Downie et al. 2021, Baron-Cohen et al. 2015). Simply put, if men and women with ASD do not differ in ToM ability, gender differences in ToM can't be the cause of gender differences in ASD prosody. Furthermore, even if men and women with ASD *do* differ in ToM ability and this gender difference in ToM *is* the root cause of gender differences in prosody, we would expect to find gender differences in ASD for both prosody production *and* comprehension.

Studies that failed to find ASD/NT accuracy differences for prosody comprehension sometimes have found differences using more sensitive measures like eye gaze (Pexman et al. 2011), response times (e.g., Wang et al. 2006, Colich et al. 2012, Pexman et al. 2011) and brain activity (Wang et al. 2006, Colich et al. 2012). To test this, we conducted gender x neurological status Bayesian ANOVAs on our participants' reaction time (RT) comprehension data. Analyses of the RTs for *just* the correct trials revealed that the null model was the best model for all prosody comprehension subtests.

When we analyzed the RT trials for all trials (i.e., including trials that participants got wrong), the null model was the best model for all comprehension subtests except contrastive stress. For contrastive stress comprehension, in the best-fitting model, there was substantial evidence of an effect of gender (BF_{10} = 6.75), with men responding faster than women (BF_{inc}=4.72) when RTs for both correct and incorrect trials were included. Of note, regardless of whether incorrect trials were included or excluded, there was no effect of neurological status, nor did gender and neurological status interact. The lack of an interaction between gender and neurological status on RT for *any* of the comprehension subtests is not consistent with the "ASD women are better at prosody" or "ASD women have superior ToM skills" accounts.

Gender differences in prosodic camouflaging. People with ASD will sometimes use camouflaging techniques to hide their symptoms in public. Camouflaging can manifest in different ways including suppressing stereotypic behaviors, rehearsing interactions or conversations in advance, mimicking another person's eye contact patterns or facial expressions (Lai and Baron-Cohen 2015) or speech intonation, or emphasizing some words (Cook et. al. 2022). Although both males and females engage in camouflaging, the consensus is it is more common in females, and this is part of the reason females are diagnosed with ASD less often than males (e.g., Gould and Ashton-Smith 2011, Dean et al. 2017, Lai et al. 2017, Wood-Downie et al. 2021, Parish-Morris et al. 2017, Jorgenson et al. 2020, Schuck et al. 2019). The demographics of our participants are consistent with women being more likely to go undiagnosed: the men in our study were twice as likely as the women to report having been diagnosed with ASD (10% vs. 5%, respectively), even though similar percentages of men and women had AQ scores in the ASD range (18% of men and 21% of women).

Although studies indicate women with ASD camouflage their behavior more than men with ASD, to date, no studies have investigated whether gender differences exist for *prosodic* camouflaging. If women with ASD prosodically camouflage more than men with ASD, gender and neurological status should interact, with there being a greater ASD-NT difference in prosody for men than women. Furthermore, this interaction should be greater in production than comprehension tasks because prosody production is a public-facing display of behavior and camouflaging is utilized in compensating for deficits in public-facing actions. Further, this difference should be most apparent in pragmatic uses of prosody, such as contrastive stress, because pragmatic prosody places the greatest demands on discourse pragmatics. This is exactly the pattern that we found.

Although, we believe our findings are more consistent with a gender difference in prosodic camouflaging than other accounts, our study is limited by our use of an online test. Even though detailed videos guide participants through the O-PEPS-C subtasks and there was no evidence of a floor effect for any subtasks, the fact that there wasn't an experimenter present to clarify instructions means that we can't rule out that some participants didn't understand instructions. In addition, it takes about an hour to complete the experiment, and it is possible that some participants got bored or distracted. Participants' spoken responses were recorded using their personal equipment, and the quality of 0.72% of recordings was too poor to determine whether participants said an utterance with correct prosody. In addition, although we only found an effect of neurological status for production *accuracy* for contrastive stress, the ASD and NT groups might have differed in *how* they produced other types of prosody. We are currently conducting acoustic and prosodic analyses of participants' spoken responses to determine if this is the case.

The generalizability of our findings is limited by who our participants are. Rather than being diagnosed by a clinician, our participants self-reported whether they had a diagnosis of ASD. We also counted as ASD those participants who had AQ scores above 28, even if they did not report having been diagnosed with ASD. Our findings may not generalize to people with ASD who have been formally diagnosed and/or are more seriously affected. Because our participants were all college students with no history of written or spoken language impairment, our findings also may not generalize to people with ASD who have cognitive or linguistic impairments.

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