2024-03-22

Prosodic Speech Rate, Utterance Duration, Interruption Rate, and Turn-Taking Latency in Autistic and Neurotypical Adults

Grace Madeline Bell
Brigham Young University

Prosodic Speech Rate, Utterance Duration, Interruption Rate, and

Turn-Taking Latency in Autistic and Neurotypical Adults

Grace Madeline Bell

A thesis submitted to the faculty of
Brigham Young University
in partial fulfillment of the requirements for the degree of

Master of Science

Shawn L. Nissen, Chair
Garrett Cardon
Dallin Bailey

Department of Communication Disorders

Brigham Young University

ABSTRACT

Prosodic Speech Rate, Utterance Duration, Interruption Rate, and
Turn-Taking Latency in Autistic and Neurotypical Adults

Grace Madeline Bell
Department of Communication Disorders, BYU
Master of Science

The purpose of this study was to examine the following prosodic elements: speech rate, turn-taking latency, number of interruptions, and utterance duration across two groups—neurotypical and autistic young adults. Furthermore, the end goal of this study is to help provide a baseline and clinical application of prosodic differences between autistic and neurotypical adults. Speech samples were collected from 11 neurotypical and 11 autistic young adults from the ages of 18–26. Speech samples were recorded responses from a 10-minute interview between two research assistants and the autistic or neurotypical individual. Using Praat software, speech samples were analyzed and used to calculate speech rate, utterance duration, turn-taking latency, and the number of interruptions for each subject. Across the four prosodic elements, there were significant differences between the autistic and neurotypical groups. The neurotypical group exhibited significantly higher speech and interruption rates when compared to the autistic group. Whereas, the autistic group displayed longer turn-taking latency periods and longer utterance durations. Across all conditions, there were no significant difference between biological sex or effect of familiarity within the autistic and neurotypical groups. Results of this study provide clinicians and researchers a baseline of prosodic differences found between autistic and neurotypical individuals. Future research is needed to better understand how these findings might improve the assessment and treatment of autistic individuals.

Keywords: autism, prosody, speech rate, speech pause, speech interruptions, turn-taking latency

ACKNOWLEDGMENTS

I would like to express my appreciation for all the support and assistance I have received throughout this project. I would first like to thank my committee chair, Dr. Nissen, for his mentorship and positive guidance throughout this project. I would also like to thank my committee chair members, Dr. Cardon and Dr. Bailey, for their valuable input and feedback. I want to express gratitude to the other graduate and undergraduate students who helped me along the way through collecting data and moral support. Lastly, I would like to thank my husband, family and friends for supporting and encouraging me endlessly throughout this project and through life.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

DESCRIPTION OF THESIS STRUCTURE AND CONTENT

This thesis, *Prosodic Speech Rate, Utterance Duration, Interruption Rate, and Turn-Taking Latency in Autistic and Neurotypical Adults,* is part of a larger study exploring the patterns of prosodic pause and speech rate in autistic individuals. Portions of this thesis may be submitted for publication, with the thesis author being included in the list of contributing coauthors. An annotated bibliography is provided in Appendix A, and the consent form used in this study is provided in Appendix B. Language disclosure: In this paper, we have used identity-first terminology in line with the published preferences of the autistic community (e.g., Bottema-Beutel et al., 2021; Kenny et al., 2015). However, we acknowledge and respect the preference of others for person-first language.

Introduction

Autism is a lifelong neurodevelopmental condition that impacts individuals' social communication including interpersonal interactions, as well as restricted and repetitive behaviors and interests (Scattoni et al., 2021). Autistic individuals may also present with two cognitive characteristics: advanced performance on the Embedded Figures Task, and a deficit in "theory of mind" (Baron-Cohen & Hammer, 1997). It is estimated that 3% of individuals in the United States and Europe have been diagnosed with autism (Brian et al., 2019). With a diagnosis of autism many individuals receive communication and behavioral services from educational and medical professionals, including but not limited to speech therapy, occupational therapy, physical therapy, feeding therapy, psychosocial therapy, in-class aides, and other types of educational resources. Diagnosing autism at an early age often leads to the most effective results of subsequent therapy due to the high amount of support and consistent services.

Services for Autistic Individuals

Autistic children living in the United States typically receive state and federally funded services from 3 to 18 years of age, often provided as part of their K–12 education. However, once an individual turns 18, therapy services often become less available to autistic individuals, despite autism often being a life-long challenge. Thirty-one percent of autistic adults felt that the support they received after they turned 18 was inadequate, with particular concern about long-term support to assist them in maintaining their quality of life (Scattoni et al., 2021). Not only are therapy services more limited for autistic individuals over the age of 18, but the type of services needed by older individuals is vastly different compared to treatment for autistic children.

Autistic adults face challenges when it comes to independent living, working, engaging in higher education, and feeling connected socially. These challenges arise from core autistic traits, including, but not limited to, repetitive and restricted behaviors, social communication difficulties, and other challenges common for autistic individuals (Micai et al., 2021). To help autistic adults manage these difficulties, psychosocial and cognitive behavioral interventions have been developed to reduce individuals' stress, such as social skills training, interview skills, video modeling, employment support, and anxiety management techniques. However, the rate at which autistic adults participate or receive these types of therapy services have been found to be relatively low compared to other medical diagnoses which limit an individual's ability to live and function independently. Survey research conducted by Micai et al. (2021) found that autistic adults accessed treatment opportunities focused on family intervention to facilitate their independence at a rate lower than 9%, whereas adults with social or medical diagnoses other than autism participated in similar family interventions more than 44% of the time. A reason for the differences in participation rate may be the inability to access services or lack of awareness of how these types of intervention might assist an autistic adult.

Diagnosing Autism

Autistic children are diagnosed as early as 2 years of age, but many individuals are not diagnosed until 4 or 5 years of age (Brian et al., 2019). For individuals younger than age 18, autism is typically assessed using informal observations, caregiver interviews, and a variety of standardized tests. The following were used as criteria for an autism diagnosis: Autism Diagnostic Observation Schedule, 2nd Edition (ADOS-2; Lord et al., 2012), Childhood Autism Rating Scale, 2nd edition (CARS-2; Schoper et al., 2010), and the Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-5; American Psychiatric Association, 2022). These assessment tools have been designed to examine the many facets of autism that may impair an individual's emotional regulation, psychosocial functioning, as well as their communication with others.

Autistic Traits in Women and Men

Characteristics of autism can manifest differently depending on an individual's age, biological sex, and where they fall on the autistic spectrum. Although both male and female individuals may have difficulties with social communication and restricted or repetitive behaviors and interests (Scattoni et al., 2021), the manner in which these difficulties are expressed may differ depending on an individual's biological sex. Using current diagnostic methodology, autism has been found to be more common in males with a ratio of four to one of (Werling & Geschwind, 2013). Differences in the incidence of autism across biological sex may be due to a lowered occurrence of heritable and de novo autism risk variants in female individuals, with genetic research also suggesting "sex chromosomal genes and/or sex hormones, especially testosterone, may modulate the effects of genetic variation on the presentation of an autistic phenotype" (Werling & Geschwind, 2013, p. 146). It is important to note that research also supports a possible male bias in how autism is identified and clinically described. Males have been found to externally demonstrate more behavioral problems than females, such as repetitive and restrictive behaviors, hyperactivity, reduced prosocial behavior, and interest (Werling & Geschwind, 2013). Autistic females may mask or internalize autistic difficulties more than males, which may subsequently result in anxiety, depression, and other emotional symptoms. A study by Lai et al. (2014) found that females more often exhibited shy or reserved behavior, copying others, having only one close friend, having more linguistic and imaginative capabilities, having restrictive interests involving people or animals rather than objects, having a high likelihood of being a perfectionist, and having a higher probability of eating disorders.

These possible sex differences in autistic traits may make it more difficult to diagnose female individuals compared to their male peers.

Prosody and Clinical Implications

One behavior characteristic used by clinicians to diagnose autism in younger individuals is speech prosody. The ADOS-2 (Lord et al., 2012) includes a rating scale to evaluate if a patient's prosody is "normal," "somewhat normal," or "not normal." Prosody is a term encompassing multiple "suprasegmental aspects of language that we use to communicate, modify, or highlight the meaning of spoken messages" (McAlpine et al., 2014, p. 120) such as speech pitch, intensity, or tempo. Prosody is commonly referred to as the melody of speech and is a key component in social communication. An individual's prosody is one of the first aspects of communication that is displayed, which can influence someone's first impression. Prosody includes speech rate, speech pause, intensity, rhythm, stress, and measures of pitch.

Clear and effective communication is not just what you are saying, it is how you say it. One's prosody impacts the semantic meaning of an utterance, as well as the pragmatic elements. It is likely that a speaker's "voice pitch, loudness, tempo, and rate are all important in helping establish rapport and credibility with an audience" (Nissen et al., 2020, p. 67). Psychological research has been conducted to examine what one's voice quality (prosody) conveys to their listeners. Results from these studies indicated that based on one's prosody, individuals will make judgements about a speaker's politeness, competence, truthfulness, confidence, and likeability. Using the correct prosody when speaking can improve the listener's comprehension of the speaker's message, which, in turn, can lead to the listener associating more positive personal attributes to the speaker (Nissen et al., 2020). Therefore, if someone is speaking with atypical prosody, it does not only impact the semantic meaning of the utterance, but also could negatively impact the likelihood of someone seeing the speaker in a positive light. This effect can trickle into the lives of autistic individuals, who typically have difficulty with prosodic elements. Clinical implications of incorrect prosodic elements could lead patients to pragmatically-related difficulties, such as having a difficult time developing relationships, being understood, or not appearing capable for a specific job. This indicates a need to investigate and research what specific prosodic elements are impacting autistic adults.

Acoustic Markers of Prosody

Speech prosody is marked by multiple acoustic characteristics, including but not limited to a speaker's voice pitch, loudness, and tempo. Pitch is the perceptual characteristic of the number of fundamental frequency (F0), which can be defined "as the frequency at which the vocal folds vibrate when voiced speech sounds are made" (Lee & Humes, 2012, p. 1700). Biological female speakers often exhibit a higher range of F0 due to anatomic differences in the length and mass of their vocal cords. A speaker's range may also differ depending on a speaker's age. Loudness is the perceptual characteristic of vocal intensity, which is typically measured in decibels (dB). Loudness and intensity can be defined as "the magnitude of an auditory sensation" (Röhl & Uppenkamp, 2012, p.369). These perceptual characteristics, loudness and pitch, greatly affect one's prosodic tone and have social implications to them.

Another important characteristic of speech prosody is the use of speech tempo through the degree and location of a speaker's pausing, rate of interruption, speech rate, and the time it takes a speaker to respond during a conversation or turn-taking latency. While speech pauses occur in almost all spontaneous speech, the frequency and duration of these pauses vary across speakers and utterances. Speakers who display high rates of atypical prosodic tempo have a more difficult time conveying their message in conversation (McConaghie, 2021).

The tempo of an individual's speech can serve a linguistic or cognitive function. Changes in a speaker's speech tempo can be used to communicate grammatical features, semantic focus, and phrase or sentence boundaries (Zellner, 1994). Depending on the linguistic context, tempo can also be used to indicate psychological or emotional importance of an utterance. Individuals also pause in their speech or delay the time they take to answer a question to create time to cognitively formulate an expression or response. Responses to more open-ended or complex questions will often require a greater degree of pause or turn-taking latency before or within a speaker's response. Likewise, a speaker's inability to efficiently tempo their speech might result in an excessive amount of interruptions in a conversation partner's utterances or impede the process of effective communicative turn-taking.

The prosodic characteristic of tempo is also influenced by the speech rate or articulation rate, which can be defined as the number of speech units (syllables or words) within a given amount of time. Speech rate can vary depending on the linguistic context, type of speech task, emotional state of the speaker, or a speaker's idiolect (Crystal, 1976). Typical speakers and listeners perceive utterances spoken at a faster rate and higher pitch as more excited (Mann & Karsten, 2022). Speech rate can also vary as function of a speaker's native language. As stated by the linguist Peter Roach (1998), "Speakers of some languages seem to rattle away at high speed like machine-guns, while other languages sound rather slow and plodding."

Prosodic Tempo in Autistic Individuals

Research regarding prosodic tempo in autistic individuals is relatively limited when compared to findings available regarding other aspects of prosody (e.g., pitch and loudness) or other behavioral characteristics of the disorder. Mann and Karsten (2022) discovered that variations between ASD individuals and their peers may include the use of longer pauses between conversational terms. According to Patel et al.'s (2020) most recent study, autistic males presented with a slower rate of speech compared to the control group. When comparing speech rate, Patel discovered there were no significant differences between the autistic female group and the control group. According to Patel's findings, speech rate may prove to be a strength for autistic females. With further research in this area, further implications can be made regarding intervention for autistic females and males. Perceptual ratings of prosody were conducted amongst an autistic group and a control group. Listeners identified atypical intonation, aberrant speech rate, stress patterns, poor loudness control, and lack of affective quality in the autistic group (Patel et al., 2020). However, acoustic measurements determined autistic individuals displayed a slower overall speech rate. Speech rate calculations were the strongest indicators of autism, furthermore, emphasizing that speech rate is crucial for identifying atypical speech and prosodic patterns. Associations between autism severity and decreased speech rate were identified, greatly impacting the social pragmatic area for autistic individuals.

Turn-taking latency and the number of interruptions may impact an autistic individual's prosodic tempo. However, limited research has been conducted on autistic young adults regarding turn-taking latency and number of interruptions. There are a limited number of studies conducted on turn-taking latency and the number of interruptions in speech. A study conducted by Yoshimura et al. (2020) focused on turn-taking latency with Japanese speaking children ages 3–7 years. The author's findings indicated that autistic children do not demonstrate any significant delay in response time when compared to neurotypical children during a naturalistic conversation. Another study, conducted by Carmo et al. (2023), investigated turn-taking latency abilities in autistic adults within natural conversations with either predictable or unpredictable endings. Overall, autistic adults were significantly slower to respond overall. Currently, there is limited quantitative data regarding the number of interruptions that occur within a conversation in autistic individuals. Studies addressing interruptions of time or for behavior regulation have been conducted, but none have focused on interruptions within a conversation. This study will determine the number of interruptions that occur within a naturalistic conversation between autistic and neurotypical individuals. This will provide clinicians with a baseline knowledge for use in evaluations and treatment goals.

Purpose of This Study

Additional research on prosody in autistic adults may provide clinicians with a better understanding of the importance of prosody (specifically turn-taking latency and speech rate) and may provide clinicians a more effective starting point in intervention and assessment. There is currently limited information regarding the role and impact prosody has on autistic adults. Thus, the following four aims will be addressed in this study:

1. Evaluate if autistic adults exhibit prosodic patterns (i.e., utterance duration, speech rate, interruption rate, and turn-taking latency) that differ from neurotypical peers. Considering previous research, it is expected that the speech rate, utterance duration, interruption rate, and turn-taking latency will differ between autistic and neurotypical individuals.
2. Investigate if the participants' prosodic patterns differ as a function of their biological sex. Considering previous research, it is expected that participants' prosodic patterns differ as a function of their biological sex.
3. Examine if an autistic or neurotypical speaker's prosodic patterns change as an individual becomes more familiar (i.e., time in a discussion) with a communication partner. Limited research has been conducted on this topic, however considering characteristics of autism

it is expected there will be changes in prosodic elements in autistic individuals throughout the timing of the conversation.

4. Examine if the ADOS-2 (ADOS-2; Lord et al., 2012) measure of prosody correlates to any of the prosodic mechanisms measured in this study. Considering limited research has been conducted investigating the ADOS-2 prosody score, it is expected the ADOS-2 measure of prosody will correlate to the prosodic mechanisms measured in this study, specifically in autistic individuals.

Methodology

Participants

This study involved an acoustic analysis of speech recordings collected from a group of 11 neurotypical adults and a group of 11 autistic adults, with each group containing six male and five female participants. All individuals who had a clinical diagnosis of autism were allowed to participate in the study, regardless of the severity or characteristics of their diagnosis. The study participants ranged in age from 18 to 26 years for both the neurotypical (*M* = 22.9 yrs.) and autistic speaker groups (*M* = 22.2 yrs.). Details regarding participant demographics are reported in Table 1. All individuals were recruited locally from universities and colleges, trade schools, groups associated with autism, and other related organizations. Participants were recruited through a variety of means: curriculum-based recruitment efforts, word of mouth, social media posts and messages, university clinics, and informational emails being sent to individuals who participated in previous studies. Participants were compensated 10 dollars to participate in the research study.

Documentation of an individual's autistic diagnosis was determined through previous testing using the Autism Diagnostic Observation Scale 2nd edition (ADOS-2; Lord et al., 2012).

Table 1

Participant Demographic Data

Subject	Biological Sex	Neurologic Status	Age
03	F	Neurotypical	24;7
04	F	Neurotypical	23;0
05	M	Neurotypical	25;0
07	F	Neurotypical	23;3
08	M	Neurotypical	25;2
16	M	Neurotypical	22;3
17	F	Autistic	23;11
18	F	Neurotypical	24;0
19	M	Autistic	21;0
20	M	Neurotypical	19;3
21	M	Neurotypical	23;11
22	F	Neurotypical	23;0
23	M	Neurotypical	19;3
24	F	Autistic	18;10
33	M	Autistic	20;7
34	F	Autistic	20;10
35	F	Autistic	20;9
38	F	Autistic	24;1
40	M	Autistic	27;0
43	M	Autistic	20;6
50	M	Autistic	25;0
52	M	Autistic	24;0

To verify an individual's current autistic status, participants were asked to complete the Autism Quotient (AQ; Baron-Cohen et al., 2001) and the Social Responsiveness Scale–Second Edition (SRS-2; Constantino & Gruber, 2012) assessments. This study was approved by the Institutional Review Board of Brigham Young University prior to any participants being contacted for participation.

Speech Sample Collection

During the data collection process, participants were asked to complete a number of different assessments which were part of a larger research project but not utilized in the current study, such as the Adolescent/Adult Sensory Profile (AASP; Brown & Dunn, 2002), Glasgow Sensory Quotient (GSQ; Robertson & Simmons, 2012), Behavior Rating Inventory of Executive Functioning–Adult Version (BRIEF-A; Roth et al., 2005), Empathy Quotient (EQ; Baron-Cohen & Wheelwright, 2004), Autism Quotient (AQ; Baron-Cohen et al., 2001), Social Responsiveness Scale–Second Edition (SRS-2; Constantino & Gruber, 2012), and the Reading the Mind in the Voice Test–Revised (RMV-R; Golan et al., 2007). For the current study, individuals were asked to participate in a 10-minute speech sample collected through Adobe Audition (Version 22.2.0.61). Adobe Audition software was used to record research participants' speech sample at a sampling rate of 44.1 kHz and quantization of 24 bits to a PC hard drive. The audio and video of the 10-minute conversation was recorded in a quiet room with acoustic wall treatments to help reduce background noise. Speech samples were edited with Adobe Audition to remove any signal artifact and any other disturbances.

To elicit the 10-minute spontaneous speech sample, two researchers engaged with each participant in conversation. The administrators elicited the conversations by using everyday questions such as, "Where are you from?" "Tell me about yourself?" "What are you studying?"

and “What do you enjoy doing in your free time?” Follow up questions were asked if needed to elicit ongoing conversation, such as “What happens next?” “Tell me more” or “Is there anything else you would like to tell me?”

From the recordings, a spoken language transcript was created using text-to-speech software, which was then corrected by a research assistant listening to the speech samples and confirming or editing the original transcript. The transcript was also coded by each speaker’s utterance, to subsequently measure the mean utterance duration, rate of interruptions, and turn-taking latency.

ADOS-2 Prosody Scoring

Three adult listeners unfamiliar with the participants examined the overall typicality of the prosody in each speech sample using the rating scale within the prosody subsection of the ADOS-2 (ADOS-2; Lord et al., 2012). The ADOS-2 rating scale gives individuals a score of 0, 1, or 2 to indicate their prosody. A score of 0 indicated intonation varied appropriately throughout the conversation, loudness was within reasonable limits, speaking rate appeared within normal limits, and rhythm throughout utterances appeared within normal limits. A score of 1 indicated flat intonation, with very little variation in pitch and tone while speaking, however the individual’s intonation was not marked as “odd” immediately. A score of 1one could also indicate unusual or inconsistent speaking volumes, and varied rates that indicate the speech was too fast, slow, or jerky. A score of 2 indicated the individual had abnormal prosody through inconsistent speech rates, extensive pausing, and abnormal rhythm. A rating of 2 represented atypical prosody that would likely impact speech intelligibility, as well as creating an unusual intonation with abnormal stress, pitch, or loudness.

Utterance Duration, Rate of Interruption, and Speech Rate

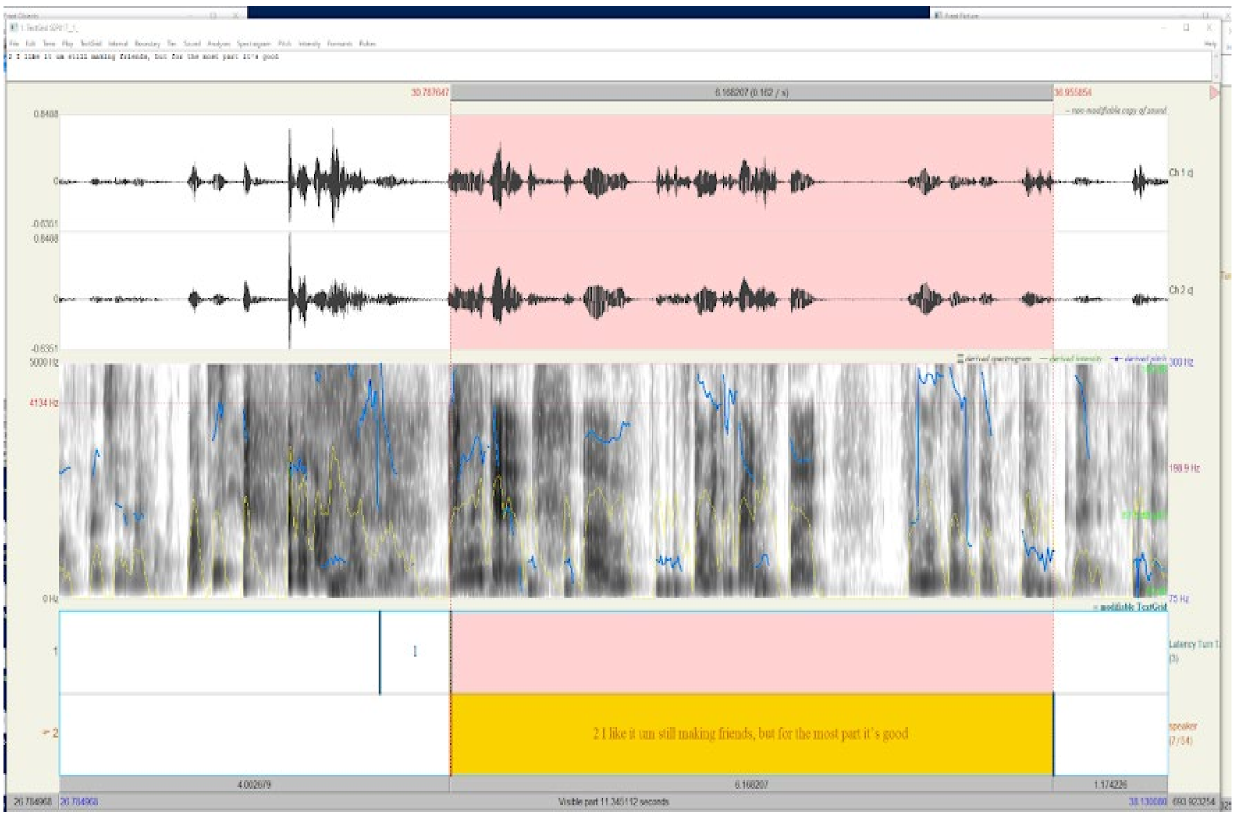
The prosodic features of utterance duration, rate of interruption, and speech rate were analyzed using Praat software (Boersma & Weenink, 2021). Utterance and turn-taking boundaries were marked in a Praat text grid which overlays the original acoustic signature of the speech sound file as shown in Figure 1. Boundary decisions were aided by visual inspection of the acoustic waveform and the relative degree of acoustic intensity, with a dramatic increase or decrease indicating the beginning or end of the speech stream. These decisions were then verified auditorily by listening to each speech segment. Temporal boundaries were measured to the closest millisecond.

Using the methodology from Patel et al. (2020), we did not include an utterance if the utterance met any of the following criteria: "the utterance contained character speech, a question, unfinished words, fewer than two words, an interruption by the examiner, or was unintelligible, directed towards someone else in the room and not related to the narrative, or abandoned" (p. 3035). Utterances were chronologically coded based on the temporal location within the overall speech sample. This study analyzed 20 inclusive utterances per speech sample, located every 30 seconds throughout the recording. These utterances were used to calculate the speech rate for each participant. The speech rate was evaluated by calculating the total number of syllables in an utterance divided by the total duration of each utterance.

The turn-taking latency was also measured using Praat acoustical analysis software (Boersma & Weenink, 2021). The pause between the end of an interviewer's utterance and the initiation of the participant's responses were defined as the turn-taking latency period. If the last utterance of the interviewer was unintelligible or a phrase containing no significant meaning to the conversation (e.g., ah, um, woah, yep, etc.), it was not considered a true turn-taking opportunity. This same principle applied to laughter, clearing of throat, coughing, etc. Turn-taking was measured throughout the entire recording to identify if turn-taking latency increased or decreased throughout the recording.

Figure 1

Example of Praat Acoustic Software



Reliability

The reliability of the acoustic boundary measurements was calculated by reanalyzing the segmentation points of 10% of the target utterances by a second research assistant and correlated to the initial measurement values. A significant Pearson correlation was found for the two sets of measurements ($r = .89$, $p < .001$). The utterances to be measured a second time were randomly selected from the overall set of utterances analyzed in the study.

Results

Descriptive statistics of mean and standard deviations were used to describe the dependent measures of utterance duration, speech rate, turn-taking latency, and rate of speech interruptions. Each dependent variable, as a function of neurologic status and speaker biological sex, are reported in the sections below. The ADOS-2 (Lord et al., 2012) scores reported below are part of a larger study evaluating prosody in autistic individuals (Cardon et al., 2023).

Utterance Duration

An analysis of variance (ANOVA) found a significant main effect between neurotypical and autistic individuals for mean duration of utterances within the speech sample, $F(1, 18) = 16.584$, $p = .001$, $\eta^2_p = .480$. As illustrated in Figure 2, the utterance duration of autistic individuals ($M = 4.46$ sec) was found to be significantly longer than utterances produced by neurotypical speakers ($M = 2.90$ sec). Autistic and neurotypical speakers mean utterance duration did not differ as a function of either speaker biological sex or the location within the sample. A detailed listing of the specific speech interruption values as a function of neurologic status, speaker biological sex, and speech sample location can be found in Table 2.

Figure 2

Mean Utterance Durations for Autistic and Neurotypical Participant Utterances Across Speaker Biological Sex

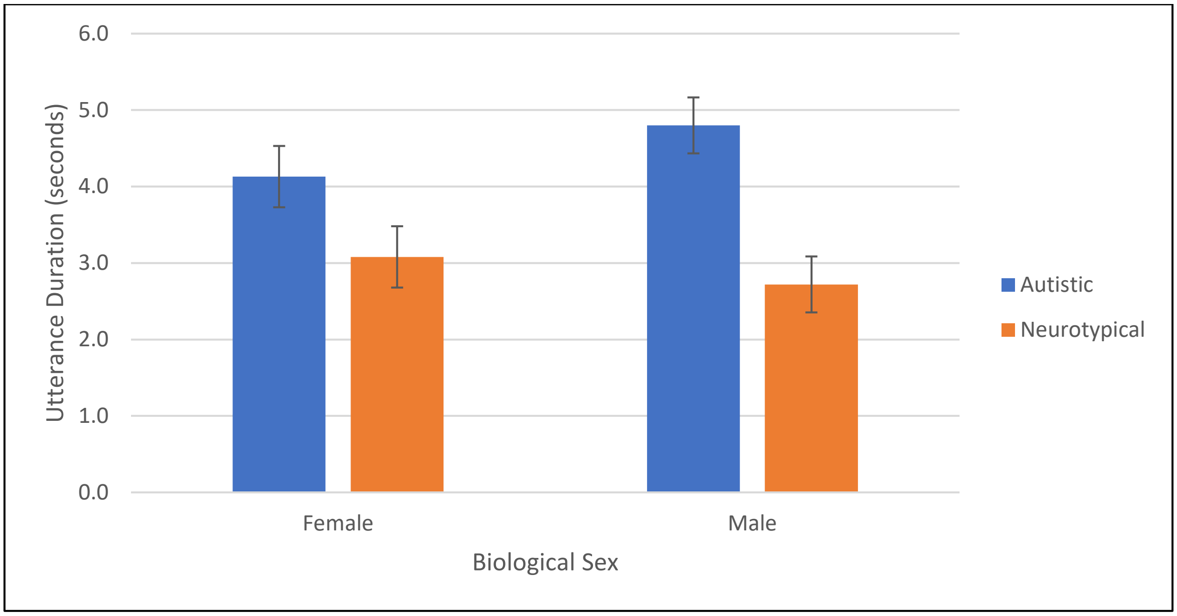


Table 2

Duration Measures for Autistic and Neurotypical Participant Utterances Across Speaker Biological Sex and Interview Location

Speaker Biological Sex	Interview Location[a]	Autistic		Neurotypical	
		Mean[b]	*SD*[b]	Mean[b]	*SD*[b]
Female	Initial	3.930	.822	2.864	.716
	Final	4.319	.370	3.288	.984
Male	Initial	4.520	1.065	2.962	.710
	Final	5.055	2.061	2.474	.627

Note. [a] Initial indicates the first half of total turn-taking within a 10 minute time period, final indicates the last half of total turn-taking opportunities within a 10 minute time period.

Speech Rate

Using an ANOVA to evaluate the speech rate data, a main effect between neurotypical and autistic individuals was found to be significant, $F(1,18) = 13.09$, $p = .002$, $\eta^2_p = .42$. As illustrated in Figure 3, the speech samples from the neurotypical speakers ($M = 5.56$ syllables per second) were found to be produced at a higher rate than samples produced by autistic speakers ($M = 4.50$ syllables per second). No other significant main effects or interactions were found for the dependent measure of speech rate. A detailed listing of the specific speech rate values as values as a function of neurologic status, speaker biological sex, and speech sample location can be found in Table 3.

Figure 3

Mean Speech Rate Measures for Autistic and Neurotypical Participant Utterances Across Speaker Biological Sex

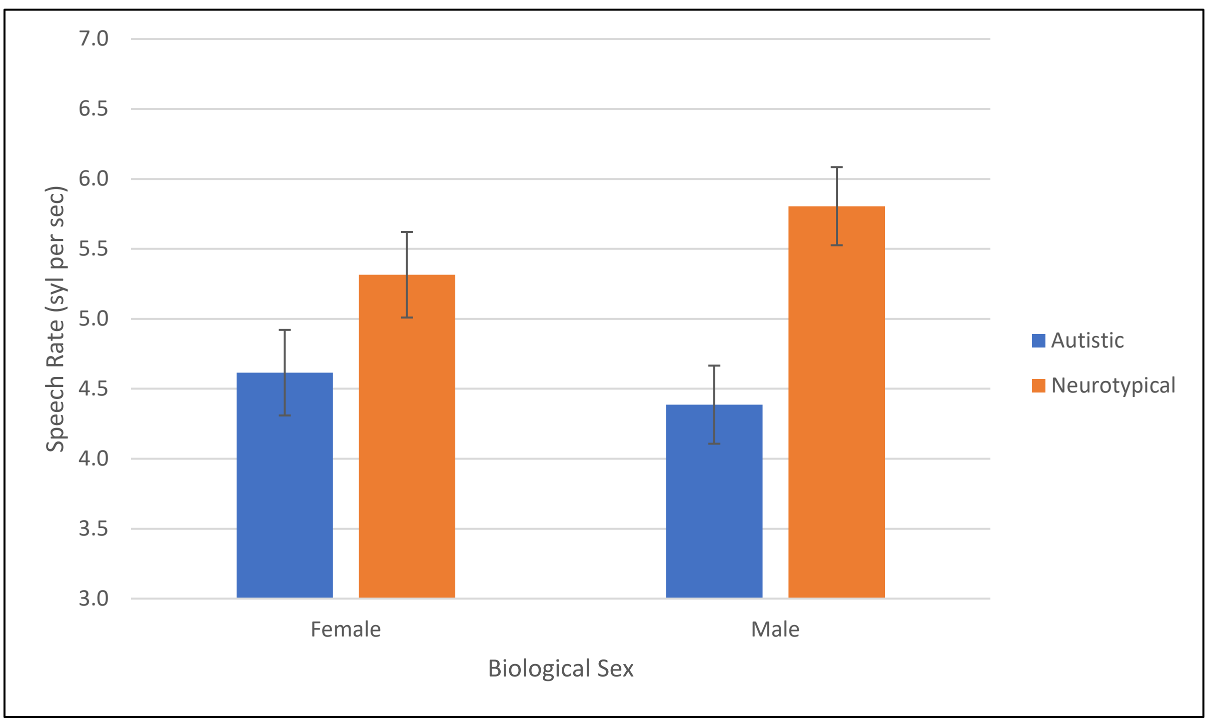


Table 3

Speech Rate Measures for Autistic and Neurotypical Participant Utterances Across Speaker Biological Sex and Interview Location

Speaker Biological Sex	Interview Location[a]	Autistic		Neurotypical	
		Mean	*SD*	Mean	*SD*
Female	Initial	4.65	.79	5.46	.72
	Final	4.58	.49	5.17	.88
Male	Initial	4.30	.61	5.72	.73
	Final	4.47	.94	5.89	.60

Note. [a] Initial indicates the first 10 utterances within a 10 minute time period, final indicates the last 10 utterances within a 10 minute time period. [b] Measured in seconds.

Turn-Taking Latency

In addition, the ANOVA revealed a significant main effect between neurotypical and autistic individuals for turn-taking latency, $F(1,18) = 20.02$, $p > .001$, $\eta^2_p = .53$. As illustrated in Figure 4, the turn-taking latency from speech samples produced by autistic speakers ($M = 680$ ms) were found to be significantly longer than samples produced by neurotypical speakers ($M = 333$ ms). Participants turn-taking latency did not differ as a function of either speaker biological sex or the location with sample. A detailed listing of the specific latency values as a function of neurologic status, speaker biological sex, and speech sample location can be found in Table 4.

Figure 4

Mean Turn-taking Latency Measures for Autistic and Neurotypical Participant Utterances Across Speaker Biological Sex

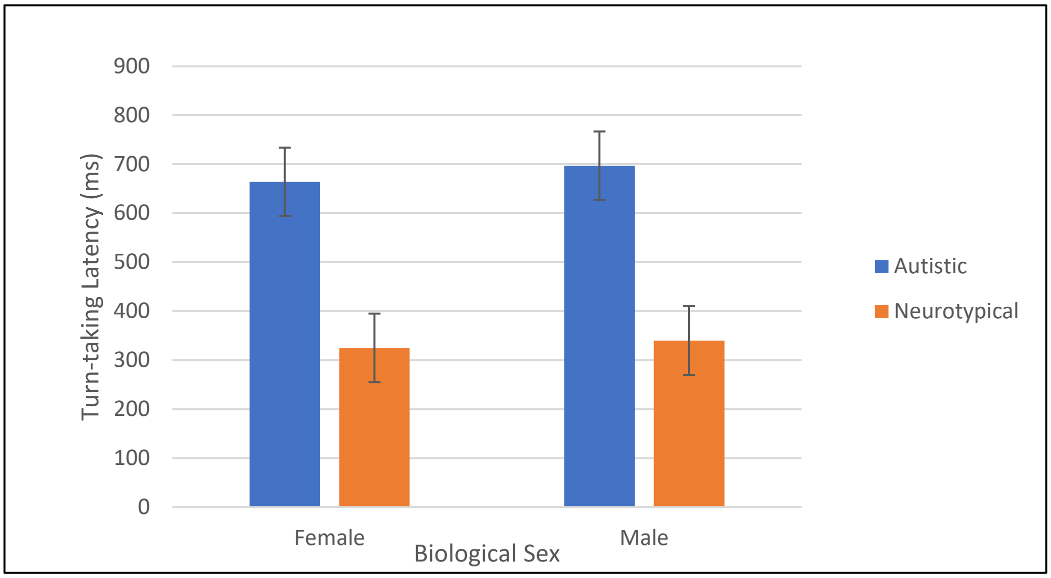


Table 4

Turn-taking Latency Measures for Autistic and Neurotypical Participant Utterances Across Speaker Biological Sex and Interview Location

Speaker Biological Sex	Interview Location[a]	Autistic		Neurotypical	
		Mean[b]	*SD*[b]	Mean[b]	*SD*[b]
Female	Initial	.717	.154	.307	.093
	Final	.610	.081	.343	.194
Male	Initial	.706	.248	.394	.151
	Final	.688	.364	.287	.085

Note. [a] Initial indicates the first half of total turn-taking within a 10 minute time period, final indicates the last half of total turn-taking opportunities within a 10 minute time period. [b] Measured in seconds.

Interruption Rate

The results of the ANOVA also revealed a significant main effect between neurotypical and autistic individuals for speech interruptions $F(1,18) = 23.41$, $p > .001$, $\eta^2_p = .57$. As illustrated in Figure 5, the number of interruptions from the neurotypical speakers ($M = .29$ interruptions per utterance) were found to be produced at a higher rate than samples produced by autistic speakers ($M = .13$ interruptions per utterance). No other significant main effects or interactions were found across speaker biological sex or location within the speech sample. A detailed listing of the specific speech interruption values as a function of neurologic status, speaker biological sex, and speech sample location can be found in Table 5.

Figure 5

Mean Rate of Speech Interruptions for Autistic and Neurotypical Participant Utterances Across Speaker Biological Sex

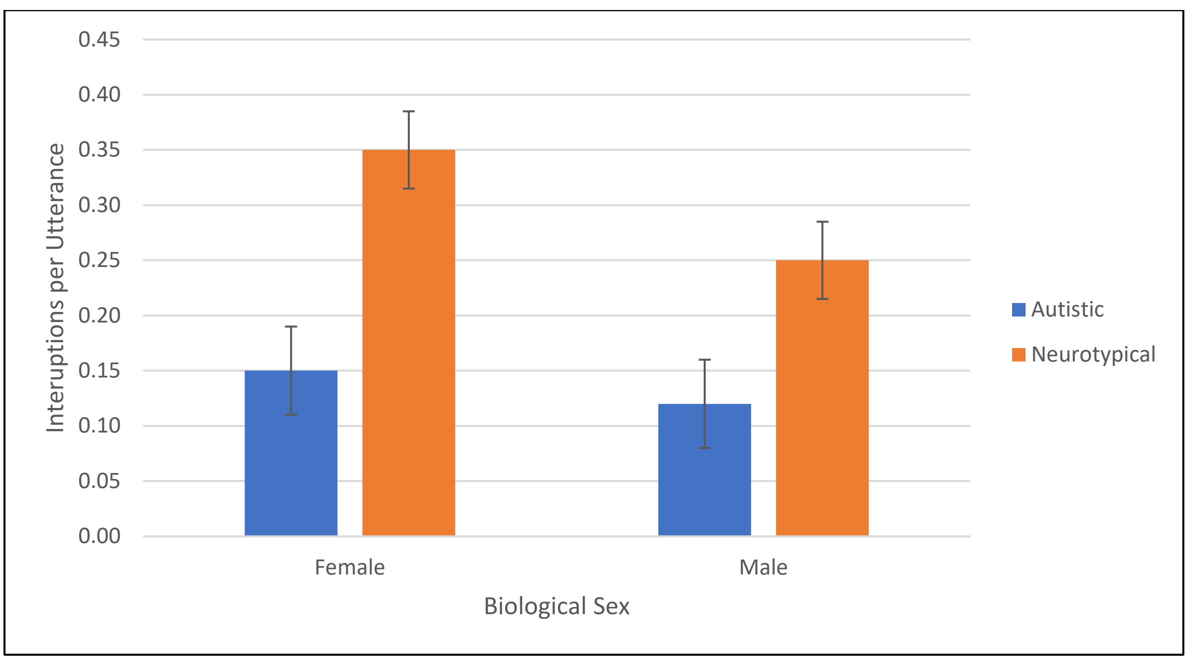


Table 5

Speech Interruptions Measures for Autistic and Neurotypical Participant Utterances Across Speaker Biological Sex and Interview Location

Speaker Biological Sex	Interview Location[a]	Autistic		Neurotypical	
		Mean [b]	*SD* [b]	Mean [b]	*SD* [b]
Female	Initial	.14	.07	.33	.07
	Final	.16	.17	.37	.15
Male	Initial	.10	.11	.22	.04
	Final	.14	.11	.27	.08

Note. [a] Initial indicates the first half of total turn-taking within a 10-minute time period and final indicates the last half of total turn-taking opportunities within a 10-minute time period. [b] Number of interruptions per utterance.

ADOS-2 Scores

Of the 20 subjects within the study, only four out of 11 autistic subjects were given a score differing from a score of 0, indicating abnormal prosody patterns to an unknown listener. Three of the four participants' speech samples were given a rating of 1 which indicates slightly atypical prosody. One of the four individuals was given a rating of a two, which indicates the individual's prosody was transparently atypical within the speech sample. As shown in Table 6, no significant correlations were found between the ADOS-2 (ADOS-2; Lord et al., 2012) values and either speech rate, turn-taking latency, or speech interruptions.

Table 6

ADOS-2 Ratings and Qualitative Description of Prosody

Subject	ADOS-2 Prosody Score	Qualitative Description of Prosody
03	0	
04	0	
05	0	
07	0	
08	0	
16	0	
17	0	
18	0	
19	2	Flat intonation, very long pauses, very slow rate of speech
20	0	
21	0	
22	0	
23	0	
24	0	
33	0	
34	0	
35	1	Flat intonation, did not change intonation even when discussing preferred topics
38	0	
40	1	Pausing and intonation were off throughout the recording
43	0	
50	0	
52	1	When counting to ten the rhythm was off, and rate was slower throughout the conversation. Slow and halting, little bit of interference with intelligibility but still intelligible, mostly flat and toneless. Flat affect was observed as well.

Discussion

This study evaluated the prosodic measures of speech rate, utterance duration, turn-taking latency, and number of interruptions between autistic and neurotypical individuals. The findings of this study and clinical applications are discussed below according to the associated research aims.

Neurological Status

The first aim of this study was to evaluate if autistic adults exhibit prosodic patterns (i.e., utterance duration, speech rate, interruption rate, and turn-taking latency) that differ from neurotypical peers. When addressing the variables of utterance duration and turn-taking latency between autistic adults and neurotypical adults, this study discovered autistic adults had a significantly higher utterance duration and turn-taking latency period when compared to neurotypical adults. Implications of these results may impact autistic individuals clinically and their future providers in the realm of voice and social therapy. Acknowledging that autistic adults may demonstrate longer utterance durations and turn-taking latency periods will impact how autistic patients are treated in a clinical setting. As mentioned previously in this study, prosodic elements can lead to social likeability, implying if an individual's displays prosodic differences, they may experience decreased likability.

Research regarding turn-taking latency is limited; however, current research indicates that pauses for individuals are typically within the 200-250 ms range (Zellner, 1994). This study found the average turn-taking latency for a neurotypical adult was an average of 333 ms, indicating a slight discrepancy between Zellner's study and this current study. Literature evaluating utterance duration is limited. However, from the results of these findings, longer utterance duration and turn-taking latency periods may be negatively impacting social communication and overall prosodic elements found in day-to-day conversation.

This study found a significantly higher rate of interruptions in the speech of the neurotypical individual when speaking with an autistic communication partner. The increased rate of interruptions from the neurotypical speakers during the communicative interactions may be due to the relatively long turn-taking latencies exhibited by the autistic speakers. It brings importance to the concern that communication partners of autistic individuals may not adequately wait for responses from autistic speakers prior to trying to repair the conversation with their own interruption.

Similar to the research of Patel et al. (2020), this study found that autistic speakers exhibited slower speech rates than their neurotypical peers when engaged in a conversation. Although the overall speech rates of the autistic speakers were not found to be atypical for speakers of English, it is important to note that the slower rate of the autistic speakers may have limited their ability to communicate effectively. If conversational words in English average 1.66 syllables, the autistic individuals in this study would have produced an average of 38.3 fewer words per minute than their neurotypical peers (Nirmaldasan, 2010). Over a 10-minute conversation this difference in the quantity of communication may lower an autistic individual's ability to express their thoughts and needs. An implication of this finding is that society may not hear the voices of autistic individuals, which may be due to their slower speech rate and the high number of interruptions of neurotypical individuals. However, it is unclear if autistic speakers' slower speech rate is due to difficulties with executive functioning, motor production, or other cognitive processes.

Speaker Biological Sex

The second aim of the study was to investigate if the participants' prosodic patterns differ as a function of their biological sex. The current study did not find significant differences across the four prosodic variables as a function of biological sex. This finding is different from the research of Patel et al. (2020), who found that autistic males presented with a slower rate of speech than autistic females. The results of this study may indicate that autistic female speakers don't mask the prosodic features of their speech to the same degree as other autistic characteristics. Thus, prosody may be an effective manner to identify autism in female individuals. However due to the relatively small sample size evaluated in this study any generalization across biological sex should be done with caution.

Communication Partner Familiarity

The third aim of this study was to examine if an autistic or neurotypical speaker's prosodic pattern changes as an individual becomes more familiar (i.e., time in a discussion) with a communication partner. This current research project did not find any significant prosodic differences between both groups, the neurotypical speaker or autistic speaker, as the individual became more familiar with a communication partner. Due to the social communication difficulties associated with autism, the original hypothesis predicted the autistic group would display different prosodic patterns as the interview went on. Current research on the familiarity effect, one's prosodic patterns changing as one becomes more comfortable with the communication partner, is extremely limited. This makes it difficult to evaluate if this finding of no difference is contrary to current research or within normal limits. Clinically, this information is extremely useful for a clinician as they are working on one's prosody. From these findings, it can be implied that an autistic or neurotypical person's prosodic patterns remained constant throughout the conversation, which can influence the course of treatment a clinician may select.

Autism Diagnostic Schedule Measure of Prosody

The fourth aim of this study was to examine if the ADOS-2 (Lord et al., 2012) measure of prosody correlates to any of the prosodic mechanisms measured in this study. When the ADOS-2 is completed, an individual is given a score of 0, 1, or 2 regarding their prosody. A score of 0 indicates within normal limits of prosodic elements, a score of 1 indicates slightly abnormal prosodic elements, and a score of 2 indicates abnormal prosodic elements within their speech. Within this study, only four individuals received a score other than 0 indicating atypical prosodic elements. Three of the four received a score of 1, which indicates there was little variation in their prosody but enough to make the listener question if their prosody was normal. One of the four individuals received a score of 2, indicating the speaker displayed many differences in their prosodic elements of speech.

Considering the significant prosodic differences found through the acoustic and temporal analysis between the neurotypical and autistic participants, it is somewhat surprising that only four individuals were identified as having atypical prosody per the ADOS-2 (Lord et al., 2012). One reason for this lower rate of identification may be due to the autistic profile of the participant group. All participants were drawn from the university community, individuals who may be much higher functioning than other members of the autistic community. In addition, all individuals who had a clinical diagnosis of autism were allowed to participate in the study, regardless of the severity or characteristics of their diagnosis. It may be that the statistically significant acoustic differences were primarily due to the speech patterns of the four individuals identified as having atypical prosody on the ADOS-2. This conclusion is supported by the relatively high variation found in the autistic group compared with the neurotypical participants.

Additionally, this may indicate the ADOS-2 (Lord et al., 2012) prosody scale may not be specific enough to identify prosodic differences in autistic individuals, due to the complex nature of prosody in general. One perceptual-based question does not yield enough information to identify deficits in one's prosodic elements. This impacts one's plan of care when addressing differences in prosody. If a clinician were to complete a screening on the need for prosody therapy and used the ADOS-2 (Lord et al., 2012) prosody scale solely, there is the possibility that individuals would not be identified as having atypical prosodic patterns. Clinicians may consider utilizing a more thorough assessment tool while evaluating someone's prosody.

Study Limitations

This study is limited in scope due to a limited sample size, speech sample, and prosodic measurement tools. The population that was sampled was considered to be a smaller sample size, with time and resources limiting recruitment and participation for this study. Future studies may consider completing the study on individuals through video chat to gather a larger sample size to evaluate prosodic patterns. Considering this study was conducted on 22 individuals, the results may be skewed or invalidated due to the small sample size.

The speech sample in this study was collected through an informal interview format consisting of two interviewers, and one interviewee. It may be of value for future research to evaluate prosodic patterns of autistic individuals across a variety of different speech task types, such as read speech, picture description, or story retell activities. Additionally, due to the complicated nature of prosody not all prosodic elements and patterns could be evaluated and researched at this time. Prosody does not just consist of utterance duration, speech rate, turn-taking latency, and the number of interruptions. Prosody encapsulates many more other elements that contribute to one's prosody and social communication abilities. Utilizing different prosodic measurement tools may have provided more thorough information regarding prosodic patterns in autistic individuals.

Conclusions

Considering these limitations, the findings presented in this study are valuable to further our understanding of utterance duration, speech rate, turn-taking latency, and number of interruptions in neurotypical adults and autistic adults. It adds to the previous research on speech rate and turn-taking latency, while additionally analyzing prosodic elements in autistic adults and furthering investigation of the prosodic differences and social outcomes of the two groups. Such findings may provide valuable understanding and insight regarding the complexity of prosodic elements in autistic adults, which in turn will hopefully help equip clinicians with the ability to provide evidenced-based therapy for autistic adults seeking to create meaningful connections.

References

Adobe. (2003). Adobe Audition (Version 22.2.0.61) [Computer software]. https://www.adobe.com/products/audition/free-trial-download.html

American Psychiatric Association. (2022). Diagnostic and statistical manual of mental disorders (5th ed., text rev.). https://doi.org/10.1176/appi.books.9780890425787

Baron-Cohen, S., & Hammer J. (1997). Parents of children with Asperger syndrome: What is the cognitive phenotype? *Journal of Cognitive Neuroscience, 9*(4)*,* 548–554. https://doi.org/10.1162/jocn.1997.9.4.548

Baron-Cohen, S., & Wheelwright, S. (2004). The empathy quotient: An investigation of adults with Asperger syndrome or high functioning autism, and normal sex differences. *Journal of Autism and Developmental Disorders, 34*(2), 163–175. https://link.springer.com/article/10.1023/B:JADD.0000022607.19833.00

Baron-Cohen, S., Wheelwright, S., Skinner, R., Martin, J., & Clubley, E. (2001). The autism spectrum quotient (AQ): Evidence from Asperger syndrome/high-functioning autism, males and females, scientists and mathematicians. *Journal of Autism and Developmental Disorders, 31*(1), 5–17. https://doi.org/10.1023/a:1005653411471

Boersma, P., & Weenink, D. (2021). Praat (Version 6.3.09) [Computer software]. https://www.fon.hum.uva.nl/praat/

Bottema-Beutel, K., Kapp, S. K., Lester, J. N., Sasson, N. J., & Hand, B. N. (2021). Avoiding ableist language: Suggestions for autism researchers. *Autism in Adulthood*, *3*(1), 18–29. https://doi.org/10.1089/aut.2020.0014

Brian, J. A., Zwaigenbaum, L., & Ip, A. (2019). Standards of diagnostic assessment for autism spectrum disorder. *Pediatrics & Child Health, 24*(7)*,* 444–460. https://doi.org/10.1093/pch/pxz117

Brown, C., & Dunn, W. (2002). *Adolescent/Adult Sensory Profile (AASP)*: *User's manual.* Pearson.

Carmo, J. C., Magyari, L., & Filipe, C. N. (2023). Conversational turn-taking in autism spectrum disorder. https://doi.org/10.31234/osf.io/42e6j

Constantino, J. N., & Gruber, C. P. (2012). *Social Responsiveness Scale-Second Edition (SRS-2)*: *Technical Manual.* Western Psychological Services.

Crystal, D. (1976). *Prosodic Systems and Intonation in English.* Cambridge.

Golan, O., Baron-Cohen, S., Hill, J. J., & Rutherford, M. D. (2007). The 'Reading the Mind in the Voice' test-revised: A study of complex emotion recognition in adults with and without autism spectrum conditions. *Journal of Autism and Developmental Disorders, 37*(6), 1096–1106. https://doi.org/10.1007/s10803-006-0252-5

Kenny, L., Hattersley, C., Molins, B., Buckley, C., Povey, C., & Pellicano, E. (2015). Which terms should be used to describe autism? Perspectives from the UK autism community. *Autism*, *20*(4), 442–462. https://doi.org/10.1177/1362361315588200

Lai, M., Lombardo, M. V., Auyeung, B., Chakrabarti, B., & Baron-Cohen, S. (2014). Sex/gender differences and autism: Setting the scene for future research. *Journal of the American Academy of Child and Adolescent Psychiatry, 54*(1), 11–24. https://doi.org/10.1016/j.jaac.2014.10.003

Lee, J. H., & Humes, L. E. (2012). Effect of fundamental-frequency and sentence-onset differences on speech-identification performance of young and older adults in a competing-talker background. *The Journal of the Acoustical Society of America*, *132*(3), 1700–1717. https://doi.org/10.1121/1.4740482

Lord, C., Rutter, M., DiLavore, P. C., Risi, S., Gotham, K., & Bishop, S. L. (2012). *Autism Diagnostic Observation Schedule, Second Edition (ADOS-2) manual (Part 1): Modules 1– 4: Technical Manual.* Western Psychological Services.

Mann, C. C., & Karsten, A. M. (2022). Assessment and treatment of prosody behavior in individuals with level 1 autism: A review and call for research. *The Analysis of Verbal Behavior*, *37*(2), 171–193. https://doi.org/10.1007/s40616-021-00154-5

McAlpine, A., Plexico, L. W., Plumb, A. M., & Cleary, J. (2014, Spring). Prosody in young verbal children with autism spectrum disorder. *Contemporary Issues in Communication Science and Disorders, 41*, 120–132. https://doi.org/10.1044/cicsd_41_S_120

McConaghie, H. R. (2021). *Correlations between cognitive pause patterns and listener perceptions of communicative effectiveness and likeability for people with aphasia* [Master's Thesis, Brigham Young University]. BYU ScholarsArchive.

Micai, M., Ciaramella, A., Salvitti, T., Fulceri, F., Fatta, L. M., Poustka, L., Diehm, R., Iskrov, G., Stefanov, R., Guillon, Q., Rogé, B., Staines, A., Sweeney, M. R., Boilson, A. M., Leósdóttir, T., Saemundsen, E., Moilanen, I., Ebeling, H., Yliherva, A., … Schendel, D. (2021). Intervention services for autistic adults: An ASDEU study of autistic adults, carers, and professionals' experiences. *Journal of Autism and Developmental Disorders*, *52*(4), 1623–1639. https://doi.org/10.1007/s10803-021-05038-0

Nirmaldasan. (2010, March 13). *Syllable, word and sentence length*. Readability Monitor. https://strainindex.wordpress.com/2010/03/13/syllable-word-and-sentence-length/

Nissen, S. L., Randle, Q. B., Johnson, J. L., & Lynes, J. (2020). Prosodic elements for content delivery in broadcast journalism: A quantitative study of vocal pitch. *Electronic News, 14*(2) 63–77. https://doi.org/10.1177/1931243120933356

Patel, S. P., Nayar, K., Martin, G. E., Franich, K., Crawford, S., Diehl, J. J., & Losh, M. (2020). An acoustic characterization of prosodic differences in autism spectrum disorder and first-degree relatives. *Journal of Autism and Developmental Disorders*, *50*(8), 3032–3045. https://doi.org/10.1007/s10803-020-04392-9

Roach, P. (1998). Some languages are spoken more quickly than others. In L. Bauer and P. Trudgill (Eds.), *Language myths*, (pp.150–159). Penguin.

Robertson, A. E., & Simmons, D. R. (2012). The relationship between sensory sensitivity and autistic traits in the general population. *Journal of Autism and Developmental Disorders, 43*(4), 775–784. https://doi.org/10.1007/s10803-012-1608-7

Röhl, M., & Uppenkamp, S. (2012). Neural coding of sound intensity and loudness in the human auditory system. *Journal of the Association for Research in Otolaryngology*, *13*(3), 369–379. https://doi.org/10.1007/s10162-012-0315-6

Roth, R. M., Isquith, P. K., & Gioia, G. A. (2005). *Behavior Rating Inventory of Executive Function – Adult Version (BRIEF-A): Technical manual.* Psychological Assessment Resources.

Scattoni, M. L., Micai, M., Ciaramella, A., Salvitti, T., Fulceri, F., Fatta, L. M., Poustka, L., Diehm, R., Iskrov, G., Stefanov, R., Guillon, Q., Rogé, B., Staines, A., Sweeney, M. R., Boilson, A. M., Leósdóttir, T., Saemundsen, E., Moilanen, I., Ebeling, H., . . . Schendel, D. (2021). Real-world experiences in autistic adult diagnostic services and post-diagnostic support and alignment with services guidelines: Results from the ASDEU study. *Journal of Autism and Developmental Disorders, 51*(11), pp. 4129–4146. https://doi.org/10.1007/s10803-021-04873-5

Schoper, E., Van Bourgondien, M. E., Wellman, G. J., & Love, S. R. (2010). *Childhood Autism Rating Scale, Second Edition (CARS-2): Technical manual.* Western Psychological Services.

Werling, D. M., & Geschwind, D. H. (2013). Sex differences in autism spectrum disorders. *Current Opinion in Neurology*, *26*(2), 146–153. https://doi.org/10.1097/wco.0b013e32835ee548

Yoshimura, Y., Kawahara, K., & Kikuchi, M. (2020). Turn-taking in children with autism spectrum disorder: discussion regarding ne and backchannel interjections. https://web.stanford.edu/group/cslipublications/cslipublications/ja-ko-contents/JK26/Yoshimura.pdf

Zellner, B. (1994). *Pauses and the temporal structure of speech*. In E. Keller (Ed.), *Fundamentals of speech synthesis and speech recognition.* (pp. 41–62). Chichester: John Wiley.

APPENDIX A

Annotated Bibliography

Baron-Cohen, S., & Hammer J. (1997). Parents of children with Asperger syndrome: What is the cognitive phenotype? *Journal of Cognitive Neuroscience, 9*(4), 548–554. https://doi.org/10.1162/jocn.1997.9.4.548

Objective: This study analyzed two cognitive anomalies that often occur in autism, superiority on the embedded figures tasks and a lack in "theory of mind." This study looked at the parents of children with Asperger syndrome (AS) to see if a mild variant of these anomalies was present. *Methods:* Each participant in the study participated in two cognitive tests, the Embedded Figures Test and the Reading in the Mind in the Eyes Test. Thirty parents were in each group, one group of parents of a child with AS, and one group of parents of children that do not have AS. *Results:* The participants in the group of parents of children that do not have AS were significantly faster than the control group on the embedded figures task. However, the parent group was less accurate at interpreting photographs of the visual field of the face and identifying the mental state. *Conclusions:* Overall, the findings of this study found that the subtle deficit on the Reading the Mind in the Eyes test may be linked to mind blindness that is found in autism. *Relevance to current study:* This study outlined some cognitive characteristics of individuals of AS. These characteristics were critical to acknowledge throughout various testing that was completed throughout this current study.

Behrman, A. (2023). *Speech and Voice Science* (4th ed.). Plural Publishing.

Objective: Behrman's book covers and provides an updated explanation on various topics such as prosody (suprasegmental features), dialects, voice source, and vocal tract contributions to speech production, and bias in perception of speaker identity. *Relevance to current study:* Through reading Behrman's book, the definition of duration was obtained and used throughout this study.

Boersma, P., & Weenink, D. (2021). Praat (Version 6.3.09) [Computer software]. https://www.fon.hum.uva.nl/praat/

Objective: Praat software is a free computer software program used for speech analytics. Praat is used to edit and analyze various aspects of an acoustic signals, such as intensity, pitch height, speech rate, and duration of formats. *Relevance to current study:* Praat software was utilized to analyze speaker's pauses, rate, rhythm, and intensity.

Brian, J. A., Zwaigenbaum, L., & Ip, A. (2019). Standards of diagnostic assessment for autism spectrum disorder. *Pediatrics & Child Health, 24*(7)*,* 444–460. https://doi.org/10.1093/pch/pxz117

Objective: This study analyzes who should diagnose autism spectrum disorder (ASD), the timing of this diagnosis, and why the timing is crucial for treatment. Brian, Zwaigenbaum, and Ip provide the standards needed in order to complete a diagnostic assessment for ASD. *Methods:* Three approaches of diagnosing ASD were analyzed. The first approach utilized a primary care provider, such as a pediatrician, using clinical judgment and with or without data from a diagnostic tool such as the DSM-5. The second approach analyzed the shared care model. This model takes into account a specialist's perspective (e.g. a psychologist) and a pediatrician. The third approach is a team-based approach that utilizes an interdisciplinary or multidisciplinary team to make a diagnosis. *Results:* Approach 1 indicated that the core domains were most heavily used, which can indicate misdiagnosis or referral to outside sources. Approach 2 indicated appropriate diagnosis of ASD, however referrals would need to be made if sensory or motor functioning displayed deficits. Approach 3 demonstrated a full comprehensive evaluation and intervention planning for the individuals with ASD. *Conclusions:* Age, sex, culture, language, rural, and remote regions all are variables that were difficult to account for in this study. However, using a multidisciplinary team proved to provide the most accurate evaluation and intervention plan. *Relevance to current study:* In this study diagnosing autism heavily relies on what methods are used to obtain a diagnosis of ASD. This study reviews the different approaches one can use to diagnoses ASD.

Brown, C., & Dunn, W. (2002). *Adolescent/Adult Sensory Profile (AASP)*: *User's manual.* Pearson.

Objective: The Adolescent/Adult Sensory Profile manual measures sensory processing patterns and the effect on performance. This is based on asking individuals how they generally respond to different sensory stimuli. *Relevance to current study:* The Adolescent/Adult Sensory Profile (AASP) was used throughout the study to quantify specific ASD characteristics.

Cole, J., Baek, S., & Mo, Y. (2010). The role of syntactic structure in guiding prosody perception with ordinary listeners and everyday speech. *Language and Cognitive Processes*, *25*(7-9), 1141-1177. https://doi.org/10.1080/01690960903525507

Objective: This study examined the influence syntax may have on prosody production, if acoustic duration affects listeners' perception of prosodic boundaries, and if boundary perception is directly impacted by syntax. *Methods:* In the study, 36 speakers and 97 untrained listeners participated. Speakers read excerpts and listeners transcribed, marking where they felt there were noticeable "chunks" of speech. Every word received a probabilistic Boundary score or B-score based on the number of transcribers out of the whole group who perceived a prosodic boundary after the word. *Results:* It was found that boundary perception is systematic, at least in part. Syntactic context and acoustic cues guided listeners in their perception of prosody. Strong correlations were discovered between the three elements of vowel duration, syntactic category information, and the perceived prosodic boundaries. *Conclusions:* Speakers' prosody production is linked to their syntactic structure in conversational and spontaneous speech. Typical listeners are able to perceive prosodic boundaries in real time and do so using perceived syntactic structure and prosodic boundaries. *Relevance to current study:* It is important to understand how normal listeners perceive speech of typical speakers in order to compare to listeners' perception of speech in people with autism.

Kaland, C., Swerts, M., & Krahmer, E. (2013). Accounting for the listener: Comparing the production of contrastive intonation in typically-developing speakers and speakers with autism. *The Journal of the Acoustical Society of America*, *134*(3), 2182–2196. https://doi.org/10.1121/1.4816544

Objective: This study investigated what motivates and drives the prosodic marking of contrastive information. The main questions addressed in this paper investigated whether contrastive intonation is produced due to the listener's perspective, or the speaker's production. This study also investigates the production of contrastive intonation in autistic individual and neurotypical individuals. *Methods:* To elicit the speech samples that gathered contrastive information, speakers participated in a referential communication task, these were performed in Dutch. *Results:* Neurotypical and autistic individuals both produce functionally similar contrastive intonation. However,

neurotypical developing speakers do demonstrate a larger pitch range and are perceived more dynamically than speakers with ASD. Contrary to expectations, typically developing speakers and speakers with autism produce functionally similar contrastive intonation as both groups account for both their own and their listener's perspective. However, typically developing speakers use a larger pitch range and are perceived as speaking more dynamically than speakers with autism, suggesting differences in their use of prosodic form. *Conclusion:* Specific prosodic elements may be more affected than other elements, such as pitch. *Relevance to current study:* This current study presents with evidence that there are prosodic element differences within individuals with ASD.

Lai, M., Lombardo, M. V., Auyeung, B., Chakrabarti, B., & Baron-Cohen, S. (2014). Sex/gender differences and autism: Setting the scene for future research. *Journal of the American Academy of Child and Adolescent Psychiatry, 54*(1), 11–24. https://doi.org/10.1016/j.jaac.2014.10.003

Objective: Lai and colleagues examined the relationship between sex/gender differences in autism spectrum disorder. A 4-level conceptual framework was created to outline the themes founded within the study. *Method:* A systematic review was conducted through searching PubMed for publications before September 2014. Search terms such as "sex OR gender OR females AND autism" were searched. Researchers screened 1,906 total articles for relevance, however only 329 articles were reviewed. *Results:* Four levels of different themes were discovered. The following was found through Lai and colleagues (2014): "Nosological and diagnostic challenges," concerns the question, "How should autism be defined and diagnosed in males and females?" Level 2, "Sex/gender-independent and sex/gender-dependent characteristics," addresses the question, "What

are the similarities and differences between males and females with autism?" Level 3, "General models of etiology: liability and threshold," asks the question, "How is the liability for developing autism linked to sex/gender?" Level 4, "Specific etiological–developmental mechanisms," focuses on the question, "What etiological–developmental mechanisms of autism are implicated by sex/gender and/or sex/gender differentiation?" *Conclusion:* Due to the four levels outlining the four main themes, findings of the differences between females and males are easier to understand and connect. Future research topics and methodology is also suggested due to the lack of research that was found in specific areas. *Relevance to Current Study:* This study provided specific characteristics that were found in autistic females and males. One purpose of this study is to examine if prosody influenced one's ADOS-2 score, Lai's study provided a framework of what ASD looks like in females versus males.

Lee, J. H., & Humes, L. E. (2012). Effect of fundamental-frequency and sentence-onset differences on speech-identification performance of young and older adults in a competing-talker background. *The Journal of the Acoustical Society of America*, *132*(3), 1700–1717. https://doi.org/10.1121/1.4740482

Objective: This study examined the benefits of different sentences in fundamental frequency and temporal onset in sentence pairs among different listener groups that are differing in age and hearing sensitivity. *Relevance to current study:* Due to this current study not focusing on pitch and intensity, and on different aspects of prosody, this study provided a brief overview of what pitch and intensity are to help give the reader a better grasp on what these prosodic elements are. *Methods:* Within this study there were sixty listeners, which consisted of 4 groups of 15 listeners that participated in the first experiment. All participants demonstrated normal middle-ear status with normal tympanograms and a score of at least 25 out of 30 on the Mini-Mental Status Exam. Participants needed to also have a score of 9 or greater on the auditory forward and backward digit-span test from the Weschler Adult Intelligence Scale. *Results:* Experiment 1 demonstrated that the fundamental frequency were beneficial to both the color-number identification performance and cue-word detection. In experiment 2 the results were duplicated from experiment 1, however in experiment 2 all older adults performed worse than young adults with normal hearing, regardless of whether the older adults had normal or impaired hearing. *Conclusion:* Overall, this study provided insight on that across listener groups, there was no difference between the group's abilities to detect the cue word "baron." Additionally, there was little to no difference in fundamental frequency or onset between the CRM sentences, all listeners demonstrated difficulty correctly identifying the target-message content.

Mann, C. C., & Karsten, A. M. (2022). Assessment and treatment of prosody behavior in individuals with level 1 autism: A review and call for research. *The Analysis of Verbal Behavior*, *37*(2), 171–193. https://doi.org/10.1007/s40616-021-00154-5

Objective: This study analyzed the current state of the literature regarding prosody in ASD individuals, while also providing recommendations for future research. *Methods:* Articles were found through searching PsychInfo, Google Scholar, and PubMed. The terms used were "high-functioning autism," "Asperger's," and "autism," while also applying the terms of "conversation," "prosody," "conversation deficits," "conversation behavior," "social communication," "voice volume," "intonation," "tone," "pitch," "resonance," "affective responding," "affect," and "speech pattern." Fifteen total articles

were included in this review article. *Results:* Nine out of 15 studies targeted *temporal dimensions* of conversations, such as latency to respond. This review also indicated there is not a concrete definition of prosody when compared across multiple sources. *Relevance to current study:* Mann and Karsten's review provided not only a baseline of current knowledge of pauses and rate within ASD individuals, but also provided additional articles regarding prosody and ASD.

McAlpine, A., Plexico, L. W., Plumb, A. M., & Cleary, J. (2014, Spring). Prosody in young verbal children with autism spectrum disorder. *Contemporary Issues in Communication Science and Disorders, 41*, 120–132. https://doi.org/10.1044/cicsd_41_S_120 *Objective:* The purpose of this study was to examine the expressive prosody of young children with ASD. *Method:* Researchers examined the speech samples of 14 children between 24 and 68 months of age through the Prosody Voice-Screening Profile (PVSP). Seven of the children had ASD and 7 of the children were typically developing regarding expressive language abilities. *Results:* Both groups did not show any differences between production of rate, pitch, or loudness. However, the ASD group produced atypical stress patterns more than the typically developing group. This was especially seen through a misplacement of stress in multisyllabic words or reduced stress. *Conclusion*: This study emphasized how important it is to examine prosody, especially misplaced stress, when working with young children with ASD. *Relevance to Current Study*: This study provided a firm definition of what prosody is and a base knowledge of what to look for when examining prosody in ASD individuals.

McConaghie, H. R. (2021). *Correlations between cognitive pause patterns and listener perceptions of communicative effectiveness and likeability for people with aphasia* [Master's Thesis, Brigham Young University]. BYU ScholarsArchive.

Objective: This study analyzed the influence of atypical speech pause on listener perceptions of speaker likability and communicative effectiveness.

Methods: Forty adult listeners listened to 30-second samples of speech from four individuals with moderate aphasia and two individuals with mild aphasia. After listening to the speech samples, each adult listener rated each speech sample using a visual analog scale. *Results:* Across all listeners, the majority of listeners were not as sensitive to between-utterance pauses, they were more sensitive to within-utterance pauses greater than one second. A strong positive correlation was also found between the listener ratings of communicative effectiveness and likability. *Conclusion:* Overall, the results indicated the location and the length of pauses in speech impacted listeners' perceptions. *Relevance to current study:* McConaghie provided a framework of methodology on how to analyze different pauses and identified what different types of pauses look like in a variety of speakers.

McCrimmon, A., & Rostad, K. (2013). Test review: Autism diagnostic observation schedule, Second edition (ADOS-2) manual (part II): Toddler module. *Journal of Psychoeducational Assessment*, *32*(1), 88–92. https://doi.org/10.1177/0734282913490916

Objective: The ADOS-2 is a standardized semi-structured assessment that measures communication, social interaction, restricted and/or repetitive behaviors, and play/imagination. Clinically the ADOS-2 is considered the "gold standard" regarding observational assessment for autism. *Relevance to current study:* The ADOS-2 was used throughout this study to determine what prosodic elements may influence the ADOS-2 prosody score. The ADOS-2 was also used as a verification to ensure the ASD individual was diagnosed with ASD. A score of 0 indicated normal prosodic elements, a score of 1 indicated somewhat abnormal prosodic characteristics, and a score of 2 indicated abnormal prosodic characteristics. This scale was used throughout the study through the data analysis portion.

Micai, M., Ciaramella, A., Salvitti, T., Fulceri, F., Fatta, L. M., Poustka, L., Diehm, R., Iskrov, G., Stefanov, R., Guillon, Q., Rogé, B., Staines, A., Sweeney, M. R., Boilson, A. M., Leósdóttir, T., Saemundsen, E., Moilanen, I., Ebeling, H., Yliherva, A., … Schendel, D. (2021). Intervention services for autistic adults: An ASDEU study of autistic adults, carers, and professionals' experiences. *Journal of Autism and Developmental Disorders*, *52*(4), 1623–1639. https://doi.org/10.1007/s10803-021-05038-0

Objective: The purpose of this study was to examine local services' regarding the experiences of autistic adults, professionals, and caretakers of autistic adults. *Method:* A survey was created using guidelines and recommendations focused on intervention for autistic adults; 697 individuals completed the survey. *Results:* The majority of the 697 individuals indicated that psychosocial interventions were the most common type of intervention provided. *Relevance to current study:* Overall, this study provided a framework that outlined treatment options that are available to autistic adults, and what options are being used the most and the least.

Patel, S. P., Nayar, K., Martin, G. E., Franich, K., Crawford, S., Diehl, J. J., & Losh, M. (2020). An acoustic characterization of prosodic differences in autism spectrum disorder and first-degree relatives. *Journal of Autism and Developmental Disorders*, *50*(8), 3032–3045. https://doi.org/10.1007/s10803-020-04392-9

Objective: This study analyzed prosodic characteristics of individuals with ASD and their parents during a narration. *Method:* A subset of speech samples were processed through a low-pass filter and separated due to differences in intonation, speech rate, and rhythm. *Results:* Using acoustical analysis, more utterance-final fundamental frequency excursion size and a slower speech rate were found within the ASD group. The ASD parent group also displayed a slower rate as well. *Conclusion:* There were overlapping prosodic elements and differences in ASD and the ASD parent group, this may indicate that these prosodic differences may lead to a phenotype that contributes to ASD features and genetic liability to ASD among immediate family members. *Relevance to current study:* This study provided a baseline of what to expect when examining ASD individual's speech rate. Patel and colleagues also provided a framework for future methodology that was used in this current study.

Paul, R., Shriberg, L. D., McSweeny, J., Cicchetti,D., Klin, A., & Volkmar, F. (2005). Brief report: Relations between prosodic performance and communication and socialization ratings in high functioning speakers with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, *35*(6), 861-869. https://doi.org/10.1007/s10803-005-0031-8

Objective: This study analyzes associations among prosody voice variables and ratings of social communication capabilities between autistic individuals and neurotypical individuals. *Methods:* Thirty high functioning autistic male adults were interviewed and videotaped to acquire a speech sample to analyze through Prosody Voice Screening

Profile (PVSP; Shriberg et al., 1990). *Results:* There were no significant predictors were found that correlated with the ADOS-2 socialization score. *Conclusions:* Although correlations were found, the relationship was determined not significant or strong. Phrasing errors did occur, however this study emphasized these errors did not make a significant impact on how the listener perceived their social capabilities. However, stress and resonance errors did appear to have some effect on how listeners perceived someone's social capabilities. *Relevance to current study*: This study is looking into pause and speech rate, and indicates there was no real impact on social perceptions regarding speech pauses.

Röhl, M., & Uppenkamp, S. (2012). Neural coding of sound intensity and loudness in the human auditory system. *Journal of the Association for Research in Otolaryngology*, *13*(3), 369–379. https://doi.org/10.1007/s10162-012-0315-6

Objective: This study analyzed how and at what stage of the auditory pathway one perceived loudness, the perceptual correlate of sound intensity. *Method:* Categorical loudness scaling, a psychoacoustical scaling procedure, was used to assess loudness sensation. Researchers studied 45 young normal-hearing individuals. Functional magnetic resonance imaging (fMRI) was utilized to investigate where neural activation in the auditory cortex, inferior colliculi, and medial geniculate bodies occurred. *Results:* There was an almost a linear increase of percent signal change from baseline and perceived loudness. *Conclusion:* The slope of the growth function of perceived loudness was correlated with the slope of the growth function for the percent signal change from baseline within in the auditory cortex, but not in the subcortical structures. *Relevance to* *current study:* This study provided a functional definition of loudness and intensity and how these two correlate within the structure of the auditory pathway.

Roth, R. M., Isquith, P. K., & Gioia, G. A. (2005). *Behavior Rating Inventory of Executive Function – Adult Version (BRIEF-A): Technical manual.* Psychological Assessment Resources.

Objective: The Behavior Rating Inventory of Executive Function is a standardized measure that illustrates an adult's executive functioning or self-regulation in their day-to-day life. *Relevance to current study:* The Behavior Rating Inventory of Executive Functioning Adult Version (BRIEF-A) was used throughout the study to quantify specific ASD characteristics.

Scattoni, M. L., Micai, M., Ciaramella, A., Salvitti, T., Fulceri, F., Fatta, L. M., Poustka, L., Diehm, R., Iskrov, G., Stefanov, R., Guillon, Q., Rogé, B., Staines, A., Sweeney, M. R., Boilson, A. M., Leósdóttir, T., Saemundsen, E., Moilanen, I., Ebeling, H., . . . Schendel, D. (2021). Real-world experiences in autistic adult diagnostic services and post-diagnostic support and alignment with services guidelines: Results from the ASDEU study. *Journal of Autism and Developmental Disorders, 51*(11), pp. 4129–4146. https://doi.org/10.1007/s10803-021-04873-5

Objective: An online survey was conducted to evaluate the gaps in adult autistic diagnostic evaluation and post diagnostic support services. *Methods:* The survey was developed using questions from a variety of published guidelines and recommendations for autistic adults. There were three forms of the survey; one each for autistic adults, family/caregivers of autistic adults, and administration/professionals/service providers for adults. The survey was distributed in 11 languages: English, Spanish, French, Polish, Icelandic, German, Finnish, Italian, Romanian, and Danish. Portuguese was developed for the professional version of the survey. The survey was administered to 667 autistic adults, 591 carers of autistic adults, and 751 professionals. *Results:* For the purposes of this study, it was found that 67% of autistic adults did not experience any of the recommended treatments. *Conclusions:* The results of this study can help guide future intervention programs that are offered to autistic adults. *Relevance to current study:* Statistics from this study emphasized the need for intervention for autistic adults and for more accurate diagnoses of autism spectrum disorder within the adult population.

Werling, D. M., & Geschwind, D. H. (2013). Sex differences in autism spectrum disorders. *Current Opinion in Neurology*, *26*(2), 146–153. https://doi.org/10.1097/wco.0b013e32835ee548

Objective: This study evaluated the strong male bias in ASD and investigated possible reasons this bias exists. Overall, this study evaluated the current status of genetic, epidemiological, neuroendocrinological work that addresses ASD prevalence in males and females. *Results*: A sex difference in phenotypic presentation was found, as well as fewer restricted and repetitive behaviors and externalizing behaviors were found in females as well. *Conclusions:* Overall, ASD affects females less than males. This may be due to sex-differential genetic and hormonal factors. *Relevance to Current Study:* Werling and Geschwind’s work help outline specific differences between males and females, while also providing future research questions to consider that are relevant to this study.

Zellner, B. (1994). *Pauses and the temporal structure of speech*. In E. Keller (Ed.), *Fundamentals of speech synthesis and speech recognition.* (pp. 41–62). Chichester: John Wiley.

Relevance to current study: Zellner provided a framework on what temporal structures in speech look like, specifically pauses. Zellner's outline provided clear definitions of different types of pauses that would be further analyzed throughout this study.

APPENDIX B

Institutional Review Board Approval Letter

Memorandum

To: Garrett Cardon

Department: BYU - EDUC - Communications Disorders

From: Sandee Aina, MPA, HRPP Associate Director

Wayne Larsen, MAcc, IRB Administrator

Bob Ridge, Ph.D., IRB Chair

Date: September 22, 2022

IRB#: IRB2022-340

Title: Sensory processing, prosody, and emotion in autism

Brigham Young University's IRB has approved the research study referenced in the subject heading as expedited level, categories 6 and 7. This study does not require an annual continuing review. Each year near the anniversary of the approval date, you will receive an email reminding you of your obligations as a researcher. The email will also request the status of the study. You will receive this email each year until you close the study.

The IRB may re-evaluate its continuing review decision for this decision depending on the type of change(s) proposed in an amendment (e.g., protocol change that increases subject risk), or as an outcome of the IRB's review of adverse events or problems.

The study is approved as of 09/22/2022. Please reference your assigned IRB identification number in any correspondence with the IRB.

Continued approval is conditional upon your compliance with the following requirements:

1. A copy of the approved informed consent statement and associated recruiting documents (if applicable) can be accessed in iRIS. No other consent statement should be used. Each research subject must be provided with a copy or a way to access the consent statement.
2. Any modifications to the approved protocol must be submitted, reviewed, and approved by the IRB before modifications are incorporated into the study.
3. All recruiting tools must be submitted and approved by the IRB prior to use.
4. All data, as well as the investigator's copies of the signed consent forms, must be retained for a period of at least three years following the termination of the study.
5. In addition, serious adverse events must be reported to the IRB immediately, with a written report by the PI within 24 hours of the PI's becoming aware of the event. Serious adverse events are (1) the death of a research participant; or (2) serious injury to a research participant.
6. All other non-serious unanticipated problems should be reported to the IRB within 2 weeks of the first awareness of the problem by the PI. Prompt reporting is important, as unanticipated problems often require some modification of study procedures, protocols, and/or informed consent processes. Such modifications require the review and approval of the IRB.

APPENDIX C

Consent to be a Research Subject

Consent to be a Research Subject

Title of the Research Study: Sensory processing, emotion, and prosody in autistic adults
Principal Investigator: Garrett Cardon
IRB ID#: IRB2022-340

Introduction

This research study is being conducted by Professor Garrett Cardon and research staff at Brigham Young University to determine the relationships between emotion, tone of voice, and understanding of sound and other sensory signals in autistic individuals. You were invited to participate because you are between the ages of 18-26, have a diagnosis of autism, and have no history of neurological disorder (including traumatic brain injury).

Procedures

If you choose to participate in this study, you will be asked to do the following:

- Answer questions about your emotions and how you deal with and understand sounds, sights, smells, tastes, and other sensory inputs.
- Have a short conversation with one of our team members. During this conversation, you will be video and audio recorded.
- Listen to recordings of other people reciting short sentences and answer questions about these recordings.

All research activities will take place at the John Taylor Building on the BYU campus in the principal investigator's laboratory. We anticipate that your research appointment will last approximately 1 hour, but some participants may take longer to complete all testing. You will be given as much time as you need to familiarize yourself with the building, room, and personnel involved in the study, as well as breaks during the research activities.

Risks/Discomforts

There are no known significant risks involved in this research study, but there is always a possibility a small, unknown risk may exist to this or any test (i.e., discomfort related to questions or activities). However, we believe that we have taken reasonable precautions to ensure your safety. None of the questions we will ask are overtly distressing or meant to cause discomfort or offense. If you have any questions about your safety in this experiment, please feel free to discuss them with us at any time.

There is a risk that people outside of the research team will see your research information. We will do all that we can to protect your information.

Benefits

There will be no direct benefits to you. However, this study is designed for the researcher to learn more about the social interaction styles of young adults. This study is not designed to treat any illness or to improve your health. We will not release any clinically un-interpretable results.

Confidentiality

Brigham Young University and the research team have rules to protect information about you. Federal and state laws including the Health Insurance Portability and Accountability Act (HIPAA) also protect your privacy. This part of the consent form tells you what information about you may be collected in this study and who might see or use it. We cannot do this study without your permission to see, use and give out your information. You do not have to give us this permission. If you do not, then you may not join this study.

We will see, use, and disclose your information only as described in this form. We will do everything we can to keep your records a secret. It cannot be guaranteed.

The use and disclosure of your information has no time limit. Data will always be stored on password protected computers, in filing cabinets in locked offices on the BYU campus, and/or with a secure cloud storage service (Box). You can cancel your permission to use and disclose your information at any time by writing to the study's Primary Investigator, at the name and address listed below. If you do cancel your permission to use and disclose your information, your part in this study will end and no further information about you will be collected. Your cancellation would not affect information already collected in this study.

Garret Cardon

Brigham Young University

Department of Communication Disorders

1190 N 900 E 130 TLRB

Provo, UT 84604

Both the research records that identify you and the consent form signed by you may be looked at by others who have a legal right to see that information. The participant's name will immediately be replaced with an identifying code in order to protect your confidentiality. Other identifying information will only be used to make calculations (such as chronological age) or contact you, if you provide permission (see below), but will never be used in any publication, presentation, or other form of communication with anyone other than you.

Federal offices such as the Food and Drug Administration (FDA) that protect research subjects like you. People at the Brigham Young University Institutional Review Board (BYUIRB), the study investigator and the rest of the study team.

Information about you that will be seen, collected, used, and disclosed in this study:

- Name and Demographic Information (age, sex, ethnicity, address, phone number, etc.)
- Research Visit and Research Test records
- Diagnoses that have been given to you or your close family members, such as anxiety, Autism Spectrum Disorder (ASD), or Attention Deficit Hyperactivity Disorder (ADHD)

What happens to Data that is collected in this study?

The scientists on the research team work to discover new information about autism. The data collected from you during this study is important to this study and to future research. If you join this study:

- Both the investigators and any sponsor of this research may study your data
- Any product or idea created by the researchers working on this study will not belong to you.
- There is no plan for you to receive any financial benefit from the creation, use or sale of such a product or idea.

Data Sharing

We will keep the information we collect about you during this research study for analysis and for potential use in future research projects. If the study data contain information that directly identifies subjects: Your name and other information that can directly identify you will be stored securely and separately from the rest of the research information we collect from you.

De-identified data from this study may be shared with the research community, with journals in which study results are published, and with databases and data repositories used for research. We will remove or code any personal information that could directly identify you before the study data are shared. Despite these measures, we cannot guarantee anonymity of your personal data, though the above risks are likely more hypothetical than realistic.

Compensation

You will $10/hour via cash for your participation in this study. There will be no monetary cost to you for participating in this study.

<u>Participation</u>
Participation in this research study is voluntary. You have the right to withdraw at any time or refuse to participate entirely without any risk to you whatsoever.

<u>Questions about the Research</u>
If you have questions, concerns, or complaints, you can contact the Principal Investigator, Garrett Cardon, 303-241-6666, garrett.cardon@byu.edu or Annika Henderson, annika.slight@gmail.com

<u>Questions about Your Rights as Research Participants</u>
If you have questions regarding your rights as a research participant contact Human Research Protections Program by phone at (801) 422-1461; or by email: BYU.HRPP@byu.edu.

Statement of Consent
I have read, understood, and received a copy of the above consent and desire of my own free will to participate in this study.

Name (Printed): ______________ Signature ______________ Date: ______________ ______________

PERMISSION TO CONTACT FOR FUTURE RESEARCH STUDIES: Sometimes after a research project is finished, there are new questions that researchers need to ask and new research studies that need to be done. We would like your permission to contact you for participation in future studies that you may qualify for. We will not contact you unless you give us your permission.

_____ I agree to be contacted for future research studies that I/my children might be eligible for.

_____ I do not wish to be contacted in the future for any additional research studies.

If you agree to be contacted, please list an address, phone number, and email address where you can be reached:

Phone:____

Email:____