Gender Differences in Social Communication in Autism Spectrum Disorder (ASD): Narratives

by

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ABSTRACT

Background: Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterized by deficits in social communication (SC), and the presence of restricted and repetitive interests/behaviours. ASD is diagnosed in 1 in 59 people in a 4:1 male:female ratio. Reasons for this uneven diagnostic ratio are unclear but possibly females may present with a more subtle or unique symptom profile and therefore may be under- or misdiagnosed. Examination of SC abilities of girls' with ASD may provide insight into the female profile, as deficits in SC are universally impaired in ASD. Competence in SC requires synchronous application of social, cognitive and linguistic skill, and is vulnerable to subtle differences in functioning; therefore, sensitive assessment tools are imperative. Narrative analysis is one way to measure SC skills, as it engages a speaker in a complex cognitive-linguistic task embedded in a social context.

Objective: The primary objective was to examine gender differences in SC ability in children with ASD using narrative analysis. The secondary objective was to determine if the gender differences found in participants' with ASD would also be found in matched typically developing (TD) participants.

Methods: Data for the participants with ASD were collected as part of a larger Canadian longitudinal study. Matched TD participants were recruited from Edmonton area. All participants were administered a battery of assessments including a standardized narrative task (Expression Reception and Recall of Narrative Instrument – ERRNI) and follow up Detailed Transcript Analysis (DTA) was conducted on the narratives. DTA focused on how well the basic story was constructed, known as story macrostructure, as well as on story microstructure which includes devices to enhance the story such as adding

descriptive words or phrases, and sources of confusion for a listener, such as examples of incoherence.

To examine if gender differences were present when the participants with ASD were 8-years-old, a series of independent samples *t*-tests was run with gender as the independent variable (IV) and the subtest/index scores (ERRNI, DTA) as the dependent variables (DVs). The second study's aim was to determine the stability and pattern of the gender differences over time. The same participants were re-examined two years later at age 10, using the same measures, and their performance compared to their performance at age 8. For this analysis, a series of repeated measures ANOVAs was run with gender and time as IVs and the subtest/index scores (ERRNI, DTA) as DVs. Finally, in the third study, to determine if the gender differences found in the participants' with ASD were also present in the TD participants, a series of MANOVAs with subtest/index scores (ERRNI, DTA) as DVs and gender and diagnostic group as IVs was run for each age group. Follow up univariate ANOVAs were conducted if MANOVA results were significant, and *t*-tests for the TD group were conducted if univariate ANOVAs were significant for gender.

Results: For the 8-year-olds with ASD, significant gender differences were found on the ERRNI and DTA. The 8-year-old girls with ASD told a story that had significantly more salient plot points compared to the boys with ASD. Detailed analysis revealed that girls semantically enhanced their narratives (by adding details around character intentions), and avoided referencing errors significantly more than boys. On the longitudinal analysis, gender differences were consistently seen in the same areas and followed the same pattern as previously described with one additional difference on the Pragmatic Index of

DTA, where 10-year-old girls with ASD had significantly fewer pragmatic errors than 10-year-old boys with ASD.

When examining the TD group, significant gender differences were seen on measures of DTA only. For the 8-year-olds, significant differences were seen in pragmatic errors (where girls had fewer). For the 10-year-olds, significant differences were seen in pragmatic errors (where girls had fewer), sematic enhancement (girls enhanced more) and referencing errors (girls had fewer).

Conclusion: Results demonstrate narrative skill strength in girls regardless of diagnostic status. This suggests that the girls and boys from this study have differing SC profiles, and in particular the boys and girls with ASD had consistently large significant differences. The girls with ASD demonstrated areas of narrative strength compared to the boys with ASD. This finding and future work may help to expand the understanding of the female presentation of ASD.

PREFACE

This thesis represents original work completed by Olivia Conlon. Data for participants with ASD from chapters 2 and 3 were from an existing database, which forms part of a larger research collaboration, of which Dr. Joanne Volden is a primary investigator. The sample of participants with ASD included in this thesis was a subset of the participants collected as part of the larger study. I was responsible for the detailed transcript coding, data analysis of the Expression Reception and Recall of Narrative Instrument (ERRNI, Bishop, 2004) and preparation of the final documents. Joanne Volden and my thesis supervisory committee assisted in all stages of these projects.

For Chapter 4 of the thesis, I was responsible for the design, data acquisition, data analysis, and preparation of the final documents. Joanne Volden and my supervisory committee assisted me in all of stages of this project.

The following project in this thesis is published:

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"Alone we can do so little, together we can do so much" - Helen Keller

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credit that I have been able to overcome the many challenges and obstacles faced throughout this process. There are not strong enough words to express my gratitude to you, so I will just leave it at thank you.

Finally, I would like to sincerely thank my family. Mom, Dad, and Andrew, I could not have made it to this point without your support, guidance, and unconditional love. I felt your presence and faith in me even though we were many miles apart. This journey has not always been easy for us but I feel lucky to have had the three of you to turn to when times seemed a little dark or uncertain. Andrew, thank you for being a great big brother and for understanding what it is like to be a perpetual student! I love that we connect and understand our similar situations even though our career paths differ. I am so very proud of your perseverance in vet school, but above all else I am proud of the person you are, and am so lucky to call you my brother. Dad, thank you for being the voice of reason and the calm supportive Dad you have always been. You have helped me put my challenges into perspective and have always believed in me no matter what. Thank you for imparting some of your wisdom on me, both academically, and in life. I feel honoured when you tell me you are proud of me and I am so very proud to be your daughter. Mom, thank you for being my wind, my rock, and my eternal light. I always knew I could turn to you in the good times and the bad, and I felt you beside me on every step of this journey. Thank you for understanding me better than I understand myself, and for moving mountains for me. I would not have been able to make it to this point without your constant support. This bumblebee definitely won the lottery when she got you as a mom!

Mom, Dad, and Andrew – thank you so much, I love you forever.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER 1: Introduction and Literature Review

Autism spectrum disorder (ASD) is a neurodevelopmental disorder that has a lifelong impact on social skills, daily living skills, and educational outcomes (Szatmari et al., 2015). ASD has been described as a spectrum because the people that are diagnosed with ASD represent a heterogeneous population, and the diagnosis is often associated with other conditions such as learning difficulties (Fombonne, 2009) and mental health conditions (Leyfer et al., 2006). Although people with ASD represent a heterogeneous population, the most current version of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM–5; American Psychiatric Association, 2013) defines ASD as a dyad of symptoms, which includes persistent deficits in social communication and interaction across a range of contexts. These impairments can be seen in areas such as conversation and emotional reciprocity, non-verbal communication such as eye contact, and relationship difficulties including challenges with developing, maintaining, and understanding relationships. The other core symptom of an ASD diagnosis is the presence of restricted interests and repetitive behaviours. These can manifest in stereotyped or repetitive speech, movement or object use, inflexibility in routines, patterns or rituals, intense restrictive interests, and hyper or hypoactive reaction to sensory input (American Psychiatric Association, 2013).

Current prevalence statistics indicate that ASD is diagnosed in 1 in 59 children and disproportionately impacts males, being found in four males to every female (Baio et al., 2018). Researchers have been interested in understanding the reason(s) behind this uneven ratio, and one possibility is that females may present with a different, possibly more subtle, profile of symptoms and therefore may be under- or misdiagnosed, or

diagnosed when older (Kreiser & White, 2014; Lai, Lombardo, & Baron-Cohen, 2014). Social communication is universally impaired in individuals diagnosed with ASD. Therefore, studying this aspect of ASD might help to clarify the notion of gender-based symptom profiles.

I set out to examine social communication in well-matched school-aged boys and girls with ASD in order to determine if gender differences were present. A secondary issue I wanted to examine was to what extent gender differences were present in the typically developing (TD) population.

1.1 Definitions of Terminology:

1.1.1. "Gender" versus "sex".

One question that arises is whether language differences between boys and girls are considered differences of "sex" or "gender" (Hyde, Bigler, Joel, Tate & van Anders, 2019). Throughout this dissertation, "gender" rather than "sex" will be used to represent the two groups. In doing so I follow the guidelines of the American Psychological Association for using the terms "sex" and "gender" in research (APA, 2017). They recommended that "gender" should be used when studying behavior of boys and girls in social groups. In addition, the term "gender" allows for a more liberal interpretation of the factors contributing to the differences between boys and girls (i.e. social, cultural etc.). Generally, using "sex" to describe differences between males and females has implied that the differences are biological in origin (Lorber & Moore, 2007; Matlin, 2008, Rider, 2005; Unger, 1979) while "gender" has suggested that any differences were learned (Goldberg, 2010; Smith, 2007; Wood,1999). This is an important concept for this research, as I am unable to speak to whether the differences found are purely biological

or if there are other factors such as society and culture that are influential. For these reasons, the differences described between the participants will be referred to as "gender" differences.

1.1.2 Social Communication/Pragmatics: The same, or different.

Before outlining the debate about whether "social communication" or "pragmatics" are the same or different, it is important to define "language". In general terms, "language" includes domains of form, content and use (Bloom & Lahey, 1978). Language "form" refers to the sound system of language, also called phonology; word roots and grammatical endings, also called morphology, and rules governing sentence construction, also known as syntax. The "content" domain is also called "semantics". Traditionally, the domain of language "use" has been labeled "pragmatics".

Pragmatics includes skills like taking appropriate conversational turns, knowing how to maintain or change a topic, requesting clarification in the event of misunderstanding, and modifying one's language based on the needs of the listener (American Speech-Language-Hearing Association, 2016). Competence in pragmatics requires flexible adjustments of communication as circumstances change (Adams, 2002), and impairments in pragmatics can have devastating consequences, as they are important for successful everyday interactions, such as friendships, learning, and acceptance among peers (Hebert-Myers, Guttetag, Swank, Smith & Landry, 2006; Kuo, Orsmond, Cohn, & Coster, 2013; Meier, Diperna & Oster, 2006).

Considering the knowledge and skills that are required for pragmatic competence leads to questions about whether "social communication" and "pragmatics" are separate but related concepts or whether they refer to the same phenomenon. The root of this

debate lies in one's perspective about communication and language. Owens (2014) outlines two theoretical perspectives about the nature of language, termed the "formalist" vs. "functionalist" perspectives (see Figure 1.1).

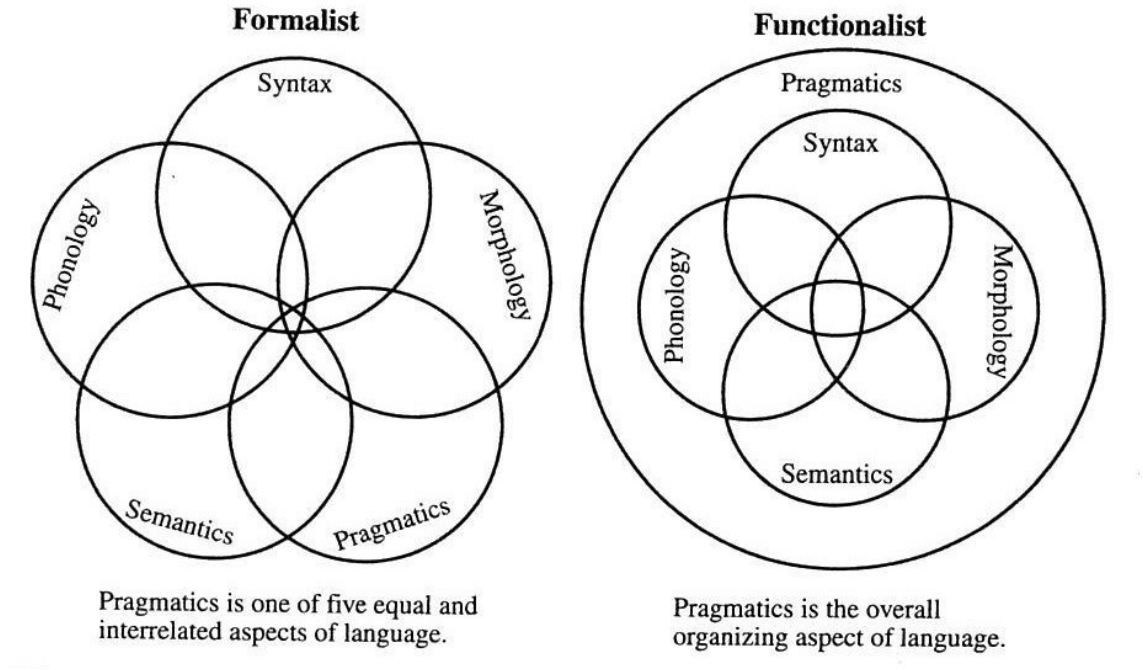

Figure 1.1. Formalist vs. Functionalist perspectives of language. Reprinted from *Language Disorders A Functional Approach to Assessment and Intervention* (p. 6), by R. E. Owens, 2014, Upper Saddle River, NJ: Pearson Education Inc.

In the formalist approach to language, pragmatics is seen as one of five equal features of language (Owens, 2014). Here scholars such as Camarata (1991) and Crystal (1987) describe language as being equally composed of syntax, semantics, morphology, phonology and pragmatics. If one takes this perspective, it is clear that "pragmatics" is a defined component of language that would be narrower in scope than a notion like "social communication". In the functionalist approach, pragmatics is seen as the overarching feature of language that affects, and perhaps determines, all the other elements (syntax,

semantics, morphology, phonology) of language (Owens, 2014). On this view, social interaction is seen as the foundation of language, thus the structure (syntax) and content (semantics) of language are greatly influenced by the social situation or communicative environment and partner (pragmatics) (Bates and McWhinney, 1989). For example, when a mother speaks to her child she might say, "Close the window, please" but when she is asking a stranger to perform the same action, she might adjust her language to be more polite, such as "Do you find it cold in here?" In the functionalist perspective then, the concept of "pragmatics" covers a broad range of activity that might also be described by the term "social communication".

Overall, these competing perspectives have led to confusion about how "pragmatics" and "social communication" are to be defined. Because they both deal with the "use" or "function" of communication, they are agreed to be closely related, but if they are separate concepts, it is not clear which skills belong to one category versus the other.

Russell (2007) argues that pragmatics and social communication are terms that can be used as synonyms. Despite acknowledging that pragmatics is a term that is yet to have a universally agreed upon definition, he contends that "pragmatics" and "social communication" should be used interchangeably since there is no clear definition that partitions them (Russell, 2007). Swineford, Thurm, Baird, Wetherby, & Swedo, (2014) and Adams (2016) also lend their support to the use of social communication and pragmatics as synonyms.

Baird and Norbury (2016), on the other hand, argue that pragmatics is a component of social communication but is not the same thing. Interestingly, Baird and

Norbury's definition of social communication is similar to others' definitions of pragmatics. Baird and Norbury propose that social communication is made up of skills such as topic maintenance, turn taking, providing appropriate amounts of context, and adapting language based on the listener (Baird & Norbury, 2016). This is very similar to Adams (2005) definition of pragmatics where she attributed skills in conversational exchange rules (turn taking), and formal versus informal language (adapting language based on the listener) as pragmatic skills (Adams, 2005). As is illustrated from the literature, there is no clear consensus about what (if any) differences exist between the terms social communication and pragmatics. Due to the lack of clarity around skills that are solely pragmatics versus skills that are exclusively social communication, and with the support of authors using the terms as synonyms (Russell, 2007; Swineford, et al., 2014), I take the viewpoint that social communication and pragmatics are interchangeable terms for the same concept rather than two separate concepts.

1.2 Gender and Communication in ASD.

Researchers that have examined gender differences in language or communication in people with ASD have found mixed results. Many studies did not demonstrate significant differences in language and communication between males and females (Andersson, Gillberg, & Miniscalco, 2013; Harrop et al., 2015; Lawson, Joshi, Barbaro, Dissanayake, 2018; May, Cornish & Reinhart, 2014; Solomon, Miller, Taylor, Hinshaw, & Carter, 2012; Tillmann et al., 2018). Importantly, this lack of differences could be due to confounding factors. For example, most of these studies did not control for nonverbal cognition and/or included participants across a wide age range (e.g., from early childhood to adulthood), which may have obscured developmental differences in pragmatic

development. In addition, the lack of significance might be from the tools used to evaluate social communication. In the above studies, the most commonly used assessments were the Autism Diagnostic Interview (ADI) (Rutter, Le Couteur, & Lord 2003) and the Autism Diagnostic Observation Schedule (ADOS) (Lord et al., 2000). Although these are the current gold standard diagnostic instruments for ASD, neither purports to be a specific or sensitive measure of language or communication.

In contrast to using a single measure, investigations using a battery of assessments seemed to be more fruitful in revealing gender differences in communication in ASD. Lai and colleagues (2011) found that females between 8 and adulthood had better social communication than males and Hiller, Young, and Weber (2014) found that girls were better at engaging in reciprocal conversation, integrating verbal and nonverbal gestures, avoiding inappropriate comments, monitoring vocal volume and initiating friendships. Gillberg and Steffenburg (1987) and McLennan, Lord and Schopler (1993) both found that younger girls had better communication skills than boys, but that teenaged girls struggled more than teenaged boys, particularly in peer relationships.

A recent examination of a large pooled European dataset (Tillman et al., 2018) and a systematic review and meta-analysis of studies from 1943 to 2013 examining gender differences in core ASD symptoms concluded that males and females did not differ in the communication and social behavior domains (Wijngaarden-Cremers et al., 2014). Despite this conclusion, the authors noted that females, especially those with average or above-average intelligence, have been under-represented in the research such that an ascertainment bias might exist. Also due to the fact that descriptions of ASD have been mostly based on male symptomology, Wijngaarden-Cremers et al. (2014) indicate

that females might present with a particular constellation of symptoms. Krieser and White (2014) reiterated this concern as they suggest that socio-cultural expectations regarding gender-appropriate behavior, along with subtle but significant differences in symptomatology in females, might contribute to under-identification of intellectually able females with ASD. Although the above studies measured aspects of language and communication in people with ASD, none specifically examined social communication/pragmatics.

Pragmatics is notoriously challenging to measure as it involves following implicit rules while adjusting to the social demands of the environment (Adams, 2002). Narratives (or story telling) are one way to assess aspects of pragmatics, and analysis of narrative skill provides insight into aspects of pragmatic ability (De Villiers, 2005; Rollins, 2014). In a narrative, the speaker provides a description of a story or an event with the goal of communicating the key elements to the listener. Telling a story also requires a speaker to use sophisticated language skills, beyond the sentence level, in both structural and pragmatic language such as paraphrasing, conveying perspective, and providing clarification. Overall, narratives require the speaker to coordinate their cognitive, linguistic and social skills (Norbury, Gemmell, & Paul, 2014) allowing an avenue of evaluation of pragmatic skill.

This measurement difficulty explains, at least in part, why many studies of social communication in people with ASD fail to employ specific and sensitive measures of pragmatics, relying instead on broad, arguably blunt, social skill measures. Therefore, the inconsistent findings around gender differences in communication in people with ASD may be due to the measurement tools used to capture these data.

1.3 Narratives and ASD.

There is substantial literature on the narrative ability of speakers with ASD. Most work examining narrative ability has centered on detailed analysis of narrative productions in intellectually able children and adolescents with ASD, and has used a typically developing (TD) group as a comparison (Banney, Harper-Hill & Arnott, 2015; King, Dockrell & Stuart, 2013, 2014; Novogrodsky, 2013; Rumpf, Kamp-Becker, Becker, & Kauschke, 2012). Overall, when ASD and TD participants were matched on language level, few differences on "local structure" (Norbury & Bishop, 2003) such as narrative length, sentence structure, or complexity (Diehl, Bennetto & Young, 2006; Kelley, Naigles & Fein, 2010; Norbury & Bishop, 2003; Tager-Flusberg & Sullivan, 1995) have been found.

Where differences have been noted is in overall/global structure and quality of the narratives of speakers with ASD. Global structure refers to the narrator's ability to organize the story in a way that causally links the events of the story (Norbury & Bishop, 2003). Quality of a narrative can also be seen through evaluative comments that help explain causes of events and their consequences, as well as the perceived impact of events on the characters in the story (Norbury & Bishop, 2003).

When examining the literature on global structure, some studies have found that the narratives of speakers with ASD have fewer evaluative devices (Capps, Losh, & Thurber, 2000; Rumpf et al., 2012; Siller, Swanson, Serlin, & George., 2014) and describe fewer causal relations (Diehl et al., 2006; King, Dockrell, & Stuart., 2014; Losh & Capps, 2003, 2006; Tager-Flusberg, 1995; Tager-Flusberg & Sullivan, 1994). Other studies have found no differences in the narrative global structure of participants with

ASD compared to the narratives of matched TD controls (Banney et al., 2015; Capps et al., 2000; King et al., 2013). Discrepancies in the findings may be partially accounted for by methodological differences. For example, wide age ranges, differing language levels, and differing ways of matching for language skill make comparisons between the studies challenging. Therefore, some studies may have drawn conclusions about ability from groups that were not clearly matched, making it difficult to associate the deficit (or lack thereof) specifically to people with ASD.

A deficit in the narrative quality of speakers with ASD has been one area that has been consistently reported. Some authors report this deficit as a tendency to focus on minor details and descriptions, rather than telling a coherent story or communicating the story's "gist" (Capps et al., 2000; Diehl et al.; 2006; Losh & Capps, 2003; Loveland, McEvoy, Tunali, & Kelley, 1990; Norbury et al., 2014). Similarly, Banney et al. (2015) reported that intellectually able children with ASD included fewer important story events in their narratives than language-matched TD controls. Despite the inconsistencies in findings, the above studies have shown that narrative analysis is capable of detecting subtle differences in social communication/pragmatics.

1.4 Gender differences in Narratives of people with ASD.

Along with Conlon et al., 2018 (the first study reported in this dissertation), to my knowledge only two other studies have examined gender differences in narratives of speakers with ASD. Kauschke, van der Beek & Kamp-Becker (2016) examined gender differences in the narratives of 21 (11 male, 11 female) intellectually able participants with ASD. They also had a comparison group of 11 TD girls. These participants were matched on age (ranging from 8-19 years) and full-scale IQ (FSIQ). Narratives were

elicited and coded for aspects of competence such as story length, coherence, cohesion and use of evaluative devices (i.e. number of adjectives and adverbs, character speech and attention getting devices like sound effects). The use of internal state language, such as descriptions of emotions, was also investigated. They found that narrative competence was similar across the 3 groups (girls with ASD, boys with ASD, TD girls). Gender differences were seen on the use of internal state words, such that girls produced higher proportions of words than boys for internal states overall, and specifically in categories describing physiological states such as "sleep", as well as "modality" ("terms for volition, obligation and intentions" such as "want", "must"; Kauschke et al., 2016, p. 845). Furthermore, girls with ASD provided causal links and consequences of internal states more frequently than boys with ASD. In comparison to the TD girls, both ASD groups used fewer emotional words.

Sturrock, Yau, Freed and Adams (2019) also conducted a study examining gender differences in participants with ASD. They used a battery of pragmatic measures, including a narrative task. Participants were matched groups of boys and girls with ASD (n=13 per group) as well as a typically developing control group. The participants were matched on age (range = 9 years – 11.5 years), gender, and IQ. They were asked to tell a narrative using the wordless storybook "A Boy, a Dog and a Frog" (Mayer, 2003), and the narrative was examined for aspects such as story length, number of temporal or causal markers, emotional language, and coherence. Sturrock et al. (2019) found that girls with ASD outperformed boys with ASD on specific pragmatic and semantic tasks, but did not find significant gender differences on their narrative task. They postulated that their lack

of significant findings for gender differences may be due to their small sample sizes limiting the statistical power (Sturrock et al., 2019).

Turning to differences between diagnostic groups, results showed that there were main effects of diagnoss on high-level structural expressive language such that TD participants used more complex language and causal markers, and had a wider range of temporal and causal markers than participants with ASD. Furthermore, TD participants produced more coherent narratives (narratives with more goal-driven action sequences) significantly more than participants with ASD. When examining gender differences of the groups of boys and girls (not separated by diagnosis), significant gender effects were found where girls displayed a greater range of causal markers than boys. There were no main effects of gender on narrative coherence and there were no significant interaction effects. Overall, Sturrock et al. (2019) found that all girls (TD and ASD combined) outperformed boys on some specific pragmatic and semantic tasks such as understanding figurative language but did not find significant gender differences on their narrative measure.

1.5 Gender differences in language and communication development in TD.

Society has commonly described differences between male and female communication styles without having empirical evidence to support their claims (Haas, 1979), therefore researchers have been interested in studying this area in order to confirm or "debunk" this stereotype. Generally, studies that have looked at early language development have found that girls acquire language and gestures with communicative intent earlier than boys (Bouchard, Trudeau, Sutton, Boudreault, & Deneault, 2009; Erikkson et al, 2012; Fenson et al, 1994), but by age 5 the differences in the structure of

expressive language have disappeared (Bleses et al., 2008; Bouchard et al, 2009;). In *pragmatic* development, O'Neill (2007) found evidence of differential development of pragmatic functions between boys and girls in her standardization study of the Language Use Inventory (LUI), a parent-report instrument designed to evaluate pragmatic development in preschoolers. As a result, she published the instrument with different norms for boys and girls. Although O'Neill found these gender differences when looking at the LUI's English version, the same differences were not seen when the LUI was translated into Italian (Longobardi, Lonigo, Laghi, & O'Neill, 2017). Using more detailed narrative analysis, Fernandez and Melzi (2008) evaluated narratives in Spanish-speaking children in kindergarten and first grade and found that girls told better stories than boys, such that girls told more complex stories and made more references to character's internal states whereas Umek, Fekonja and Kranjc (2008) found no significant gender differences in narratives produced by 4-, 6, and 8-year olds. Discrepant results may be due to different methods of narrative elicitation and analysis.

When looking more broadly at social interactions, Leaper (1991) found differences in female and male patterns of interaction. He described females' social interactions as more collaborative, while males' interactions were described as more controlling (Leaper, 1991). Ladegaard and Bleses also found differences in language usage in social interactions, with females using polite linguistic forms more often compared to males who were more likely to use instructions or commands (Ladegaard & Bleses, 2003). Although research has been conducted that has examined gender differences in aspects of language and communication in the TD population, empirical evidence is somewhat limited and results are difficult to interpret due to differing study

designs, aspects of language examined, and the age groups of participants (Barbu, et al., 2015).

In summary, when examining gender differences in social communication, it is important to employ sensitive assessment tools as capturing social communication skills are particularly challenging (Adams, 2002). One way to tap into social communication ability it through the use of a narrative task as a narrative requires a speaker to embed higher level language skills within a social context and therefore allows for a unique aspect of social communication to be measured (Norbury et al., 2014). Until recently, examinations of gender differences in social communication in people with ASD have failed to use measures sensitive enough to capture subtle differences in social communication skills. Kauschke et al. (2016) and Sturrock et al. (2019) were some of the first researchers to examine gender differences in the narrative ability of participants' with ASD. They found significant gender differences, specifically in areas of social communicative strength in girls with ASD compared to matched boys. This thesis will add to the literature around gender differences in social communication in ASD by conducting detailed transcript analysis of narratives on a longitudinal cohort of school-aged children with ASD, and by including a TD control group. The aim of this work is to determine if previous gender differences in social communication ability identified in the literature could be further described through detailed transcript analysis, if there is stability in the differences over time, and if the differences are also seen in the TD population.

CHAPTER 2: Gender Differences in Pragmatic Communication in School-Aged Children with Autism Spectrum Disorder (ASD)

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Possible gender differences in manifestations of autism spectrum disorder (ASD) were examined using data on production of narratives. The Expression, Reception and Recall of Narrative Instrument (ERRNI; Bishop, 2004) was administered to a sample of matched 8-year-old intellectually able boys and girls with ASD (13M, 13 F), who had been selected from a large, longitudinal study. In addition, transcripts of the narratives were analyzed in detail. Significant gender differences were found in narrative production. Girls included more salient story elements than boys. On detailed language analysis, girls were also shown to tell richer stories, including more descriptors of planning or intention. Overall, our findings suggest that subtle differences in social communication may exist between intellectually able boys and girls with ASD. If reliably identifiable in young children, such gender differences may contribute to differential diagnosis of ASD. In addition, such differences may pave the way for differential approaches to intervention when the target is effective communication in sophisticated discourse contexts.

2.1 Introduction

Autism spectrum disorder (ASD), characterized by deficits in social communication, restricted interests and repetitive behaviors (American Psychiatric Association, 2013), is found in four males to every female (Baio et al., 2018). One possibility to account for this uneven ratio is that females may present with a different, possibly more subtle, profile of symptoms and therefore may be under- or misdiagnosed, or diagnosed when older (Kreiser & White, 2014; Lai et al., 2014). Pragmatic language, an essential part of social communication (Baird & Norbury, 2016), is universally impaired in ASD (Kim, Paul, Tager-Flusberg & Lord, 2014). Therefore, it seems reasonable to postulate that if gender-based symptom profiles exist, some differences might be found in pragmatic skills. The current study aimed to investigate possible gender differences in the manifestations of ASD through examining pragmatic language in a closely matched school-aged sample of boys and girls with ASD.

Pragmatics encompasses skills such as taking appropriate conversational turns, knowing how to maintain or change a topic, requesting clarification in the event of misunderstanding, and modifying one's language based on the needs of the listener (American Speech-Language-Hearing Association, 2015). Impairments in pragmatics can have devastating consequences, as they are important for successful everyday interactions, such as developing friendships and peer acceptance (Hebert-Myers et al., 2006; Kuo et al., 2013) and learning in school (Meier, et al., 2006). Skills established and honed in the school years lay the foundation for personal success and satisfaction as an adult, both at work and in establishing personal relationships (St. Clair, Pickles, Durkin, & Conti-Ramsden, 2011). Some evidence suggests that pragmatic skills may be more

important for females than for males, as girls' friendships and social activities often occur within smaller, more intimate groups than boys' (Maccoby, 2002) and are characterized by expectations for conversations that focus on interpersonal relationships (Dean et al., 2014).

Pragmatics is notoriously difficult to measure as it involves following implicit rules and flexibly adjusting one's language to meet the demands of shifting social environments (Adams, 2002). This measurement difficulty explains, at least in part, why many studies of social communication in people with ASD fail to employ specific and sensitive measures of pragmatics, relying instead on broad, arguably blunt, social skill measures. To determine whether subtle pragmatic differences differentiate boys and girls, it may be important to use sensitive measures of more sophisticated language (Tillman, et al., 2018). Therefore, the current study compared the narratives of well-matched 8-year-old boys and girls with ASD to determine (a) the presence, and (b) if present, the features of possible gender differences in pragmatic communication.

2.1.1 Gender and Communication in ASD.

Both a recent examination of a large pooled European dataset (Tillman et al., 2018) and a systematic review and meta-analysis of studies from 1943 to 2013 that examined gender differences in core areas of ASD symptomatology (Wijngaarden-Cremers et al., 2014) concluded that males and females did not differ in the communication and social behavior domains. Nonetheless, in each case, the authors noted that females, particularly those with average or above-average intelligence, have been under-represented in the research such that an ascertainment bias might exist. Since descriptions of ASD have been largely based on males and their symptoms, Wijngaarden-

Cremers et al. (2014) also argued that females might present with a particular constellation of symptoms. This concern was echoed by Kreiser and White (2014), who proposed that socio-cultural expectations regarding gender-appropriate behavior, coupled with subtle but significant differences in symptomology in females, might contribute to under-identification of intellectually able (i.e., nonverbal intelligence quotient (NVIQ) $\geq$ 80) females with ASD. For example, a girl who exhibits unusual social behavior or who is withdrawn might be interpreted as "shy" or "immature," whereas a boy exhibiting social difficulty might be construed as "socially impaired" by teachers, clinicians and even parents (Attwood & Grandin, 2006). Some recent research suggests that girls more effectively mask or camouflage their symptoms, presenting as superficially typical in social interactions but with great cognitive and emotional effort and lacking true social connections (Parish-Morris et al., 2017). In addition, young female peers may display nurturing behavior by allowing the girl with ASD to join, although her inability to function flexibly in social contexts may ultimately result in negative feedback from the group (Attwood & Grandin, 2006).

Several studies examining gender and ASD have failed to find significant differences in language and communication (Andersson et al., 2013; Harrop et al., 2015; Lawson et al., 2018; May, Cornish, & Reinhart, 2014; Solomon et al., 2012; Tillmann, et al., 2018,). However, most of these studies did not control for nonverbal cognition and/or included participants across a wide age range (e.g., from early childhood to adulthood), which may have obscured developmental differences in pragmatic development. In addition, none of these studies were designed specifically to measure pragmatics. The most commonly used instruments were the *Autism Diagnostic Interview, Revised* (ADI-

R; Rutter et al., 2003) and the *Autism Diagnostic Observation Schedule* (ADOS; Lord et al., 2000). Neither of these "gold standard" diagnostic measures purports to be a specific or sensitive measure of pragmatic skills.

When investigators have used a battery of tests and/or specifically targeted language assessments, gender differences have been revealed, although not consistently in one direction. Preschool boys did better than preschool girls on language and communication skills in early studies (Carter et al., 2007; Hartley & Sikora, 2009) while girls and women performed better than boys and men in conversational skills in later work (Hiller et al., 2014; Lai et al., 2011). Overall, contradictory evidence may have been the result of studies using older diagnostic criteria. Although the above studies measured aspects of language and communication in people with ASD, none specifically examined pragmatics.

One way to evaluate pragmatic language is through storytelling, or narratives. Narratives are an integral part of daily interaction and are often used in educational settings (Makinen et al., 2014). In a narrative, the speaker describes a story or an event with the goal of having the listener understand what is happening. Understanding and telling stories engages a speaker in a complex cognitive-linguistic task embedded in a social context (Norbury et al., 2014) and provides an index of pragmatic discourse impairments that traditional tests of language may not capture (Botting, 2002; Tager-Flusberg & Sullivan, 1995).

There is a substantial literature on narratives in speakers with ASD. Most recent work has focused on detailed analysis of narrative productions in samples of intellectually able children and adolescents with ASD compared to typically developing

controls (Banney et al., 2015; King et al., 2013, 2014; Novogrodsky, 2013; Rumpf, et al., 2012). Overall, when participants with ASD were carefully matched to controls of similar language level, few quantitative differences have been found in features of "local structure" (Norbury & Bishop, 2003) such as narrative length, sentence structure, or complexity (Diehl et al., 2006; Kelley et al., 2010; Norbury & Bishop, 2003; Tager-Flusberg & Sullivan, 1995).

Differences in overall/global structure and quality of the narratives of speakers with ASD are reported more consistently. Global structure refers to the narrator's ability to organize the story so that causal links between events are made explicit (Norbury & Bishop, 2003). In addition, a narrative's quality may be enhanced by evaluative comments that help explain causes of events and their consequences, as well as the perceived impact of events on the characters in the story (Norbury & Bishop, 2003). Some studies have found that speakers with ASD used fewer evaluative devices (Capps et al., 2000; Rumpf et al., 2012; Siller et al., 2014) and expressed fewer causal relations (Diehl et al., 2006; King et al., 2014; Losh & Capps, 2003, 2006; Tager-Flusberg, 1995; Tager-Flusberg & Sullivan, 1994), whereas others have found that speakers with ASD performed as well as language-matched controls (Banney et al., 2015; Capps et al., 2000; King et al., 2013).

Methodological differences may account, at least in part, for these discrepant findings. In addition to the difficulties that result from a wide participant age range, complications also arise from differing language levels among children with ASD at any age, and the various ways in which investigations matched groups for language skill. Thus, some studies may have compared groups that were not clearly equivalent on

language, making attribution of narrative impairments to ASD versus impoverished language skills difficult.

One consistent finding is that the narrative quality of speakers with ASD is poorer than that of language-matched controls. Some report this reduced quality as a tendency to focus on minor details and descriptions, rather than telling a coherent story or communicating the story's "gist" (Capps et al., 2000; Diehl et al.; 2006; Losh & Capps, 2003; Loveland et al., 1990; Norbury et al., 2014). Similarly, Banney et al. (2015) reported that intellectually able children with ASD included fewer important story events in their narratives than language-matched typically developing controls.

To our knowledge, a single study has examined gender differences in narrative language skills in speakers with ASD. Kauschke and colleagues (2016) compared 11 intellectually able girls with ASD to 11 boys with ASD and 11 typically developing girls, all matched on age (ranging from 8-19 years) and full-scale IQ (FSIQ). Narratives were elicited using a wordless storybook, and were recorded, transcribed and subsequently coded for aspects of narrative competence such as story length, coherence, cohesion and use of evaluative devices such as the number of adjectives and adverbs, character speech and attention getting devices (e.g., sound effects.). The use of internal state language such as terms describing emotions was also investigated. They found that narrative skills were largely comparable across the groups. Gender differences were only found on the use of internal state words, such that girls produced higher proportions than boys of words for internal states overall, and specifically in categories describing physiological states such as "sleep", as well as "modality" ("terms for volition, obligation and intentions" such as "want", "must"; Kauschke et al., 2016, p. 845). In addition, girls with ASD explained the

causes and consequences of internal states more frequently than boys with ASD. Both ASD groups used fewer words describing emotions than the typically developing girls.

Participants in the above study were matched on age and FSIQ and children with known language problems were excluded. Unfortunately, verbal IQ (VIQ) cannot be relied upon as an acceptable proxy for language skills, as shown by studies in which participants with ASD scored as well as the control group on VIQ, but more poorly than controls on measures of structural language (Landa & Goldberg, 2005; Norbury, 2005). To increase confidence that observed differences are not attributable to differences in language ability, it is necessary to match participants on instruments designed specifically to assess language skills. Accordingly, our aim in the current study was to examine narrative skills via a standardized narrative measure in a sample of boys and girls with ASD, within a restricted age sample, who had been closely matched on NVIQ and language.

The *Expression, Reception and Recall Narrative Instrument* (ERRNI; Bishop, 2004) is a measure that examines pragmatic language using narratives. In 2017, Volden et al. examined ERRNI scores of 74 intellectually able 8-year-olds with ASD and found their average performance to be significantly poorer than test norms. They concluded that the ERRNI was a useful measure of narrative skill for children with ASD, but did not investigate gender differences. If boys' and girls' scores on the ERRNI differed, we also wanted to investigate the specific features of those differences. Therefore, we conducted a detailed transcript analysis modeled on that of Norbury et al. (2014). We asked the following research questions: Does ERRNI performance differ significantly between 8-year-old boys and girls with ASD who were matched on nonverbal cognitive skill and

who had similar structural language levels? Following detailed transcript analysis, did boys' and girls' narratives differ significantly in syntactic, semantic, pragmatic features, and/or global macrostructure? To our knowledge, this is the first study to examine gender differences using a standardized narrative measure so we have no basis to make a prediction about differential gender performance. On detailed transcript analysis, following Kauschke et al., (2016), we expected that boys and girls would perform similarly on structural language indices, but more poorly on semantic and pragmatic measures.

2.2 Methods

2.2.1 Participants.

Participants were selected from the Volden et al. (2017) sub-sample of 74 *Pathways in ASD* study participants. *Pathways* is a Canadian multi-site longitudinal study of developmental trajectories of children with ASD (Szatmari et al., 2015). For the Volden et al. (2017) study, additional eligibility criteria were that English was the child's primary language and complete data were available for all of the study measures. Of the 264 children enrolled in the *Pathways* study at age 8-9, 121 completed the ERRNI. The ERRNI was either not attempted or not completed on the remainder, usually because a test of discourse skills was judged to be developmentally inappropriate. Of the 121 that were available, 47 were excluded because one or more relevant scores were missing or the child's primary language was not English, leaving a final sample of 74 (13 girls) in Volden et al. (2017). In order to produce comparable groups, 13 boys were matched with the 13 girls on the basis of NVIQ, as measured by the *Wechsler Intelligence Scale for Children Perceptual Reasoning Index* (WISC-IV PRI; Wechsler, 2003). Boys were

selected whose NVIQ was within two points of participating girls. Matching was done by a research assistant blind to the purposes of the study. Subsequently, Core Language scores (CLS) from the *Clinical Evaluation of Language Fundamentals-4* (CELF-4; Semel, Wiig, & Secord, 2003) were compared to ensure that the boys and girls did not significantly differ in structural language ability. Participant characteristics are shown in Table 2.1.

Table 2.1 Participant characteristics

	Boys' Mean (*SD*)	Girls' Mean (*SD*)	*t*-scores and Probabilities of Group Differences
WISC-IV FSIQ*[1]	88.00 (15.99)	87.46 (16.86)	$t(24) = .084$, $p = 0.93$
WISC-IVPRI*	94.00 (14.93)	94.08 (14.92)	$t(24) = -.013$, $p = .99$
WISC-IV VCI*	91.54 (13.99)	91.54 (13.21)	$t(24) = 0$, $p = 1.00$
CELF-4 CLS*	87.15 (22.99)	91.62 (15.53)	$t(24) = -.580$, $p = .57$
ADOS SA Severity*	6.85 (2.04)	5.46 (2.37)	$t(24) = 1.56$, $p = .12$
ADOS RRB Severity*	8.23 (1.59)	7.08 (2.10)	$t(22.35) = 1.58$, $p = .13$

CA*	104.97 (2.63)	103.63 (2.00)	$t(24) = 1.465$, $p = .16$
VABS-II Socialization*	78.69 (8.14)	81.23 (10.66)	$t(24) = -.683$, $p = .50$
VABS-II Communication*	88.15 (8.66)	90.62 (9.08)	$t(24) = -.707$, $p = .49$

**Wechsler Intelligence Scale for Children, 4th Edition* Full Scale IQ, Verbal Comprehension Index, Perceptual Reasoning Index; *Comprehensive Evaluation of Language, 4th Edition*, Core Language Score; *Autism Diagnostic Observation Schedule*, Social Affect severity metric, Restricted Repetitive Behaviors severity metric; Chronological Age in months; *Vineland Adaptive Behavior Scales*, 2nd Edition Socialization standard score, Communication standard score.

[1] One of our participants, a girl, had an NVIQ of 78; two points lower than our definition of "intellectually able". Her ERRNI Ideas score exceeded the average score of the other female participants, so her data were retained to maximize the number of female participants.

2.2.2 Procedures.

Cognitive and language measures were completed when children were between 8 and 8:11 years. The ADOS (Lord et al., 2000) scores reported here were gathered at school entry (average chronological age (CA): 6 years, 7 months). Most children were evaluated at a university clinic, hospital, or research center; some, depending on site and parent preference, were assessed at home or at school. Parent-report instruments were

provided and completed at the assessment visit or mailed prior to the visit and returned by mail. All tests were administered by qualified research staff.

The first author, who was blind to participant gender, transcribed and scored the ERRNI following the protocol described in the manual (Bishop, 2004). Procedures unique to the current study were detailed transcript analysis of the Ideas-Initial narrative, modeled on Norbury et al. (2014) and described below. Inter-rater agreement for codes in this analysis was established with the second author, based on independent blind coding of 30% of the narratives. Intra-class correlations between the two raters were 0.944, 0.989, 0.941, and 0.988 on the Pragmatic, Semantic, Syntactic, and Formulation indices respectively.

2.2.3 Measures.

2.2.3.1 ***Expression, Reception and Recall of Narrative Instrument.*** (ERRNI; Bishop, 2004).

The ERRNI is a narrative assessment instrument that examines story production and comprehension, providing scores on: (1) the amount of relevant story content (Ideas score); (2) comprehension of salient ideas in the story (Comprehension score); and (3) grammatical complexity of utterances (mean length of utterance in words, MLU_w). The ERRNI Ideas score indicates whether a participant's elicited narrative captures the "gist" of the story, an area impaired in speakers with ASD (Banney et al., 2015; Diehl et al., 2006, Volden et al., 2017).

Participants are given a wordless picture book in which the central character has a false belief. After looking through the pictures, they are asked to generate a narrative while looking at the book. This narrative provides the basis for the Ideas – Initial score.

Following a 10- to 30-minute period during which other assessment activities are completed, participants are asked to retell the story without the pictures. The Ideas-Recall score is generated from this second narrative. Finally, a series of nine questions is asked to assess comprehension of both specific details and ability to make inferences about the narrative. Answers to these questions comprise the Comprehension score. The MLU_w is calculated from both initial and recall narratives.

The ERRNI includes two stimulus stories, only one of which is administered at any assessment. The Fish Story was selected to ensure consistency across *Pathways* sites and to avoid any difficulties in interpretation that might arise from using the slightly different norms established for the alternative Beach story. In the Fish Story, a boy's mother gives him money to buy a fish, so he goes to the pet store and buys one. On the way home, he runs into some friends and while he is away getting ice cream with one of them, the other friend switches the fish for a doll. When the boy gets home, he is surprised to discover a doll rather than a fish in his bag. His mother calls his friends and they return the fish.

The participant's narrative is transcribed and scored according to detailed criteria (Bishop, 2004). Ideas-Initial and Ideas-Recall scores are generated by comparing the participant's narrative to the main ideas for the relevant story, provided on the record form. Full credit (i.e., two points for each idea) is awarded if all of the salient information is expressed in the participant's narrative; a single point is given for partial information. Responses to the Comprehension questions are scored similarly. See Table 2.2 for examples. Raw score point totals were converted to standard scores by means of the normative data provided.

The ERRNI was standardized in the United Kingdom (UK) on 890 people ranging in age from 4 to 90 years, of whom 784 were children below the age of 14. Children whose first language was not English or who were identified with special educational needs were not included in the standardization sample. The standardization sample was similar to the UK population in terms of socioeconomic status, ethnic composition, and geographical distribution and included participants with a variety of parental educational backgrounds. The suitability of UK ERRNI norms for use in another English-speaking country was tested by administering the ERRNI to 146 Australian 6-, 9-, and 12-year-olds. Mean standard scores for the Australian sample were very close to the UK values. These similar levels of performance between the UK and Australia, coupled with an examination of the ERRNI's content and its scoring criteria, led the authors to judge the ERRNI applicable to children in Canada. Norms in the validation sample were not separated by gender; so gender-based comparisons between our sample and the validation sample were not possible.

The ERRNI has good internal consistency (Bishop, 2004). Validity of the ERRNI in the normative sample was demonstrated by Pearson correlations between ERRNI domain scores and CELF-3 receptive language subtest scores. These correlations were relatively weak, demonstrating that the ERRNI measured skills that were largely independent of those measured by a conventional sentence-level test of receptive language.

Table 2.2 Examples of Scoring for the Expression Reception and Recall of Narrative Instrument (Bishop, 2004)

Subtest	Scoring Criteria	Amount of credit/Number of points	Example item on record form	Example of utterance from Data
Ideas	Narrative includes all of relevant information listed on record form	Full/2 points	The boy waves goodbye and goes home	The boy said bye and walked home
	Narrative includes only some of the relevant information listed on the record form	Partial/1 point	As above	The boy goes home
	Narrative does not include relevant information listed on record form	No/ 0 points	As above	The boy has a doll
Comprehension				
	Correct answer as defined in the manual	Full/2 points	How did the boy feel when the girl's came to his house	"Relieved" or "happy because he got his fish back"
	Partially correct/vague answer	Partial/1 point	As above	Better
	Incorrect answer	No/0 points	As above	Surprised

2.2.3.2 *Detailed Transcript Analysis.*

Our follow-up detailed transcript analysis was modeled on Norbury et al. (2014). Detailed coding definitions are available in Appendix A. Each index score was calculated by totaling the number of coded items and dividing the total by the number of utterances in the narrative to obtain a proportion of utterances containing coded items. This information is used to generate a narrative score sheet for each participant (Appendix B).

Pragmatic Index: Higher scores on this index indicated a greater proportion of pragmatic errors. For example, "misattribution" indicates a basic misunderstanding of a key event in the story, such as attributing the doll being in the boy's bag to his picking up the wrong bag rather than the switching of the bags.

Semantic Index: This index indicates semantic enrichment; a higher score indicates elaboration of the story. Examples include the use of emotional words (e.g, "happy,"), mental state words (e.g., "think," "know,"), or "intentional" utterances (demonstrating intention or forethought, e.g., "he was *planning to sneak up*").

Syntactic Index: Syntactic complexity is demonstrated by utterances that have subordinate clauses, or adding modifiers such as "the *big, shiny* fish". Higher scores indicate greater complexity.

Formulation Index: Word-level errors include missing words or ungrammatical use. Utterance-level errors are counted if an utterance has more than one word error or is nonsensical. Higher scores indicate more errors.

Codes were also assigned for story macrostructure, which involves dividing the narrative into categories essential to a story, see Appendix C. Macrostructure includes A) Story Components and B) Cohesion and Referencing.

A: Story Components: Settings, Conflict/Resolution, and Conclusion. The important Fish Story events were divided into the following categories: Settings, Conflict/Conflict Resolution and Conclusion. "Settings" included utterances that set the stage for the characters and the story and included 16 elements (e.g., "The boy gets money from his mother to go buy a fish"). Conflict/ Conflict Resolution included utterances about the main conflict of the story and how it was resolved (e.g., "The boy

tells his mother that he found a doll in his bag"), and "Conclusion" refers to how the story wrapped up (e.g., "The boy gets his fish back"). Four elements per category were available for each of Conflict/ Conflict Resolution and Conclusion.

Each participant's narrative was scored according to the presence and completeness of elements listed within each category, according to the scoring key (Norbury et al., 2014, Appendix C). A score of 0, 1, or 2 was assigned to each element, leading to a perfect score of 48 for the entire story. Points were summed for each category (Settings, Conflict/Conflict Resolution, Conclusion) and divided by the total for that section to produce a proportion, subsequently converted to a percentage. Percentages were used to assign ratings of immature (<33%), emerging (33-75%), or proficient (>75%) in each area.

B) Cohesion and Referencing. Scores for Cohesion and Referencing were global ratings derived from the whole narrative. Cohesion refers to how well the story flowed, whether the major events were emphasized and the story made sense. Referencing is a rating of how well the child referred to the correct characters or events to help reduce confusion. Each narrative received a rating based on the number of mistakes or unclear points. Ratings included "immature" (scores greater than 3), "emerging" (scores of 2 or 3) or "proficient" (scores of 0 or 1).

2.2.4 Analytic Plan.

A series of independent samples *t*-tests was run with gender as the independent variable (IV) and the test standard scores (SS; ERRNI Ideas – Initial, Ideas – Recall, Comprehension, MLU_w) as the dependent variables (DVs). Data generated from the detailed transcript analysis were analyzed in a second series of independent samples *t*-

tests, using gender as the IV and index scores (Pragmatic Index, Semantic Index, Syntactic Index, Formulation Index) as DVs. In each series, alpha levels were set at .0125 following Bonferroni corrections. A third series of independent samples *t*-tests, with gender as the IV and individual semantic enhancement codes as DVs was run post hoc to further investigate differences found on the semantic index. For this, Bonferroni corrections led to an alpha level of .01. To assess gender differences in macrostructure, the numbers of girls versus boys in the "immature" and "emerging" categories were compared to the number of girls versus boys who were rated as "proficient," using Chi-Square. Bonferroni corrections were employed, with a resulting alpha level of .01. Glass' delta is recommended for calculating effect size of differences between two means when sample sizes are the same but standard deviations differ. In all other cases, effect size was calculated using Cohen's d (Cohen, 1988).

2.3 Results

2.3.1 Preliminary Analysis.

As shown in Table 2.1, boys and girls were compared on several measures to assess adequacy of matching. Groups were matched on CA and WISC-IV PRI, but also did not significantly differ on CELF-4 CLS SS, *Vineland Adaptive Behavior Scales-Second Edition*; (VABS-II, Sparrow, Cicchetti, & Balla, 2005) Social and Communication Domains SS, and ADOS Social Affect and Restricted/Repetitive Behaviors severity metrics (Lord et al., 2000).

2.3.2 Composite ERRNI Scores.

In answer to our first research question, whether girls and boys differed in levels of performance on a standardized narrative assessment, results are shown in Table 2.3.

Only the ERRNI Ideas-Initial SS survived correction for multiple comparisons, with girls including more salient story elements than boys [$t(19.888) = -2.775$, $p = .012$]. This difference reflects a large effect size based on Glass' delta of 1.47. The Ideas Recall scores also differed [$t(24) = -2.05$, $p = .05$, $\Delta = 1.21$] but did not survive correction for multiple comparisons. In each case, girls' scores were more variable than boys' as reflected in larger standard deviations.

2.3.3 Detailed Transcript Analysis.

Table 3.3 shows the results of detailed transcript analysis for differences between boys and girls on syntactic, semantic and pragmatic indices of narrative quality, our second research question. Results from the independent samples *t*-tests revealed significant group differences on Semantic Enhancement, with girls enhancing the story more than boys [$t(17.306) = -3.257$, $p = .005$, $\Delta = 2.08$]. Results from a follow-up series of independent sample *t*-tests, with gender as IV and the individual enhancement codes (emotions, mental states, intentionality, adverbs, character speech) as DVs, are shown in Table 3. Alpha was set at .01 following Bonferroni correction. On average, girls in our sample used words indicating "intentionality" (forethought), significantly more often than boys [$t(24)=3.48$, $p =.002$, Glass' delta = 1.49]. No other significant group differences were found. In addition, 12 of the 13 girls used one or more semantic elaboration devices compared to 6 of the 13 boys, yielding a Fisher's Exact probability of .0302.

Groups did not differ on the Pragmatic Index following Bonferroni correction [$t(24) = 2.233$, $p = .035$, Cohen's d = .88], although the difference reflects a large effect size (Cohen, 1988). On further examination, all 13 boys exhibited pragmatic errors in at least half of their utterances, versus 8 of 13 girls (Fisher's Exact $p = .039$). No significant

differences were found for Syntactic Complexity, [$t(24) = -1.113$, $p = .277$] or Formulation, [$t(24) = 1.388$, $p = .178$].

The numbers of boys and girls classified as immature, emerging or proficient in story macrostructure and on global indices of story quality (Cohesion, Referencing) is shown in Table 2.4. None of the participants was classified as "proficient" in story macrostructure but boys and girls did not differ on any of the individual elements following Bonferroni correction (Settings [$\chi^2(1, N = 26) = 0.87$, exact $p = 0.32$], Conflict/Conflict Resolution [$\chi^2(1, N = 26) = 4.73$, exact $p = 0.048$, Conclusion [$\chi^2(1, N = 26) = 0.38$, exact $p = 0.50$]. Only 1 girl was rated as "proficient" on overall story Cohesion with remaining participants rated as "immature" or "emerging", but boys and girls did not differ [$\chi^2(1, N = 26) = 1.04$, exact $p = 0.50$]. On Referencing, however, 8 girls were classified as "proficient" compared to 1 boy, with other participants in each group classified as "immature" or "emerging" [$\chi^2(1, N = 26) = 8.3268$, exact $p = .003$].

Table 2.3 Participant means and standard deviations for Expression Reception and Recall of Narrative Instrument, Detailed Transcript Analysis, and item level analysis of Semantic Enhancement Index

	Boys' Mean (*SD*)	Girls' Mean (*SD*)	*t*-scores and Probabilities of Group Differences
ERRNI Ideas- Initial	71.21 (7.58)	82.38 (12.39)	$t(19.89) = -2.76$, $p = .012$
ERRNI Ideas – Recall	73.13 (8.49)	83.38 (15.95)	$t(24) = -2.05$, $p = .052$

ERRNI Comprehension	87.54 (14.23)	94.31 (14.49)	$t(24)=-1.20$, $p=.241$
ERRNI MLU in Words	91.31 (21.50)	92.30 (7.39)	$t(14.80)=-.17$, $p=.867$
Detailed Transcript Analysis – Pragmatic Index	0.88 (0.23)	0.66 (0.29)	$t(24)=2.23$, $p=.035$
Detailed Transcript Analysis – Semantic Index	0.10 (0.09)	0.28 (0.18)	$t(24)=-3.26$, $p=.003$
Detailed Transcript Analysis – Syntax Index	0.10 (0.11)	0.10 (0.09)	$t(24)=-1.11$, $p=.277$
Detailed Transcript Analysis – Formulation Index	0.78 (0.33)	0.62 (0.26)	$t(24)=1.39$, $p=.178$
Semantic Enhancement item analysis – Emotional Word	0.31 (0.63)	1.08 (1.61)	$t(24)=1.61$, $p=0.121$
Semantic Enhancement item analysis – Mental State Word	1.15(1.82)	2.38(1.85)	$t(24)=1.71$, $p=0.100$
Semantic Enhancement item analysis – Intentional Utterance	0.62 (0.87)	1.92 (1.04)	$t(24)=3.48$, $p=0.002$
Semantic Enhancement item analysis – Adverb	0 (0)	0.23(0.44)	$t(24)=1.90$, $p=0.07$
Semantic Enhancement item analysis – Character Speech	0.23 (0.60)	1.08 (1.44)	$t(24)=1.96$, $p=0.06$

Table 2.4 Number of male (M) and female (F) participants classified as Immature, Emerging and Proficient on Indices of Story Macrostructure

	Immature		Emerging		Proficient	
Settings	M: 5	F: 1	M: 8	F: 12	M: 0	F: 0
Conflict/Conflict Resolution	M: 13	F: 9	M: 0	F: 4	M: 0	F: 0
Conclusion	M: 12	F: 12	M: 1	F: 1	M: 0	F: 0
Cohesion	M: 11	F: 6	M: 2	F: 6	M: 0	F: 1
Referencing	M: 10	F: 4	M: 2	F: 1	M: 1	F: 8

2.4 Discussion

Competent social communication requires synchronous application of cognitive, social and linguistic skills, and is therefore particularly vulnerable to subtle differences in functioning. Our aim was to examine pragmatics via an investigation of narratives in school-aged girls and boys with ASD matched on age, cognitive level, and structural language skill in order to (a) determine whether boys and girls presented different levels of skill in storytelling, and (b) describe the features of any differences.

In this sample, girls told stories that were more complete than those of boys, by including more salient elements in their stories. Findings from the detailed analysis indicated that girls' stories were also richer, describing characters' intentions more than boys. In addition, more girls than boys were skilled at maintaining the referential focus of

the story, resulting in stories that are easier for the listener to understand. It is important to emphasize that these differences were present despite groups being matched on structural language skills and nonverbal intellectual abilities, and on boys and girls having generated stories of similar length and syntactic complexity. It is also important to note that these pragmatic differences were only revealed as a result of detailed language sample analysis. Our findings are similar to those of Kauschke, et al. (2016), in that significant gender differences were not found in narrative structure, expression of irrelevant details, use of character speech, or words to express emotion or cognitive states. We found significant gender differences in the expression of "intentionality", which would have been coded within "modality" in Kauschke et al. (2016). Our findings, like those of Kauschke et al. (2016), highlight the importance of looking beyond traditional sentence-level tests of language competence to understand pragmatic or overall social communication in children with ASD. While we assessed pragmatic communication by analyzing narratives, the difficulties that were revealed may also apply to other communicative contexts. Competence beyond the sentence level is required in most educational and interpersonal situations and techniques that test discourse skills are needed to reveal impairments in these demanding situations (Volden et al., 2017). In addition, detailed language sample analysis was needed in order to further specify pragmatic difficulties. Although a labor-intensive method, language sample analysis was fruitful, revealing gender differences in performance.

Significant gender differences were not found in comprehension and average scores were within normal limits in both groups. This is surprising in light of long-standing evidence of comprehension problems in individuals with ASD (Kim et al.,

2014). Consequently, item-level comprehension performance was further investigated. Six of the nine ERRNI Comprehension questions require the participant to make an inference, either about a character's mental state or a salient element in the story, in order to respond correctly, whereas the remaining three assess the ability to remember story details that are clearly pictured in the story booklet. All of the participants received full or partial credit for the six questions that required an inference, and 11 of the 13 boys and 12 of the 13 girls received full or partial credit for the three questions that relied on recall of a pictured detail. Perhaps the explanation for such high performance on the comprehension section lies in the specific questions that were included as literal comprehension items. On two of the three items, participants are asked a detail about a picture on the next page of the storybook. For example, one item asks, "On the next page, there is a telephone. What color is it?" If participants had neglected to note the specific detail on previous viewings of the storybook, they would be unable to answer the question.

Some concern about our results might arise from a consideration of the ADOS severity scores. Although ADOS Social Affect mean scores did not differ significantly between groups, boys' mean scores were higher than girls' in every domain. To test whether increased severity of ASD symptoms was related to poorer storytelling, we calculated the correlation between ADOS SA algorithm scores and ERRNI Ideas Initial SS. A Pearson's r of -.185, $p = .356$ revealed that the relationship was not statistically significant. Therefore, we would argue that differences in narrative are not likely due to differences in ASD social symptomatology.

Previous research on social communication and narrative ability in people with ASD has been limited by wide age ranges, and diverse methods for characterizing language status. A strength of this study is the tightly controlled sample — participants fell within a narrow age range, were intellectually able (nonverbal IQs in at least the average range), and were well-matched on structural language skills. Yet what was gained in experimental control may be lost in generalizability. Our results may be less applicable to older or younger children with ASD, or to those with intellectual or language disabilities.

Like other studies, our study is limited by its small sample size. Only 13 of the 74 children who participated in Volden et al. (2017) were girls, so we were limited to a total sample of 26. As a result, our study may have been underpowered to detect some true differences in narrative macrostructure. Our findings are also limited by the lack of a control group. Because these data were taken from a larger longitudinal study of development in children with ASD, a control group was unavailable. Indeed, whether there are differences in storytelling between typically developing boys and girls is an open question. Buckner and Fivush (1998) found that girls tended to produce narratives that were more socially related than boys when they generated spontaneous narratives in response to questions that prompted a memory of a personal experience (e.g., "Tell me about a time when …"). However, it is not clear whether this difference would occur in a standardized storytelling task. Most standardized narrative assessments such as the Test of Narrative Language (Gillam & Pearson, 2004) or the Renfrew Bus Story (Cowley & Glasgow, 1994) do not have gender-specific norms. Future research should include a focus on typically developing boys and girls to determine whether significant gender

differences in narrative development are found. Studies focusing on children with disabilities would be strengthened by appropriately matched typically developing control groups.

Our findings echo those of McLennan and colleagues (1993), and Gillberg and Steffenberg (1987), who found that girls outperformed boys in the middle childhood years, albeit on different measures than ours. Future studies should examine whether these gender differences are replicable, persist with development, are evident across cognitive skill levels and degrees of symptom severity, and whether they are ASD-specific or might be evident in children with other developmental disabilities such as Developmental Language Disorder.

Another avenue for future work will be to determine at what age gender differences in social communication arise, and how they may influence the process of diagnosis and the focus of intervention for children with ASD. If reliable gender differences in social communication can be identified at an early age, gender-specific standards for diagnosis may need to be developed. Kopp and Gillberg (2011) compared the *Autism Spectrum Screening Questionnaire* (ASSQ; Ehlers & Gillberg, 1993) to the extended revised version (ASSQ-REV), which included items that were thought to capture "female-specific" ASD traits. They found items that were endorsed significantly more often for girls than for boys with ASD and concluded that closely examining gender differences in symptom presentation will prove essential in accurately describing girls with ASD. If so, the implications for policy makers are profound. If boys and girls display subtle but significantly different symptoms, then eligibility criteria for intervention will also need to reflect those differences. For clinicians, the presence of

relative pragmatic strengths in girls may suggest possible avenues to leverage girls' social and communication development. Similarly, clinicians should be aware that aspects of discourse may be particularly impaired in boys and thus relevant as an area of focus in intervention.

Overall, our findings suggest that subtle differences in social communication may exist between intellectually able boys and girls with ASD, that these differences may be captured by instruments that target particular aspects of social communication, and that their features may be further revealed by detailed language sample analysis. Our results also highlight the need to develop efficient and effective tools to measure sophisticated social-communication skills such as those needed for discourse. As children mature, these skills assume greater importance, as they are essential to establishing relationships, and to gaining and maintaining employment (Roux et al., 2013; Taylor, Henniger & Mailick, 2015).

Chapter 3: Longitudinal Analysis of Gender Differences in Pragmatic Communication in School-Aged Children with Autism Spectrum Disorder (ASD)

3.1 Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by deficits in social communication, and the presence of restricted interests and repetitive behaviors (American Psychiatric Association, 2013). ASD is a condition that has lifelong impacts on social skills, daily living skills, and educational outcomes (Szatmari et al., 2015). Current prevalence statistics indicate that ASD is found in 1 in 59 children with a ratio of four males to every female (Baio et al., 2018). The cause of the uneven ratio of males to females is currently unknown, but one possibility to account for fewer girls is that they may present with a different profile of symptoms and therefore may be under-diagnosed, misdiagnosed, or diagnosed at a later age (Kreiser & White, 2014; Lai et al., 2014).

Pragmatic language, also known as social communication (Swineford, et al., 2014), is universally impaired in ASD (Kim et al., 2014). Therefore, it seems reasonable to postulate that if gender-based different symptom profiles exist, some differences might be found in pragmatic skills. Pragmatics encompasses skills such as taking appropriate conversational turns, knowing how to maintain or change a topic, requesting clarification in the event of misunderstanding, and modifying one's language based on the needs of the listener (American Speech-Language-Hearing Association, 2016). Competence in pragmatics requires flexible adjustments of communication as circumstances change (Adams, 2002). Evaluating pragmatics in the traditional way, via a structured test, is thus rendered difficult.

One aspect of pragmatics is the ability to generate a narrative, that is, to tell a story. Narratives are an integral part of daily interaction as well as often used in educational settings (Makinen, et al., 2014). In a narrative, the speaker describes a story or an event in detail with the goal of having the listener understand what is happening in the story and the key elements of that story or event. Telling a story also requires a speaker to use sophisticated language skills, beyond the sentence level, in both structural and pragmatic language. For example, paraphrasing and conveying another person's perspective are both skills that demonstrate higher-level language. Overall, narratives require the speaker to integrate cognitive, linguistic and social skills (Norbury et al., 2014) and their analysis is one avenue for evaluating pragmatic skill (De Villiers, 2005; Rollins, 2014). Since most traditional standardized tests of structural language don't evaluate skills above the sentence level, narratives allow a unique perspective on pragmatics not seen on traditional language measures (Norbury et al., 2014).

In ASD, research on narratives has largely focused on detailed analysis of narrative productions in intellectually-able children and adolescents (Diehl et al., 2006; Kauschke et al., 2016; Norbury & Bishop, 2003; Novogrodsky, 2013; Rumpf et al., 2012; Siller et al., 2014) but results have been mixed. For example, Losh and Capps (2003) found that the use of evaluative comments was rare in the narratives of speakers with ASD but Banney and colleagues found their use of evaluative comments to be similar to language-matched controls (Banney et al., 2015). Impairments that have been reported more consistently include a reduced number of causal connections (Siller et al., 2014; Tager-Flusberg, & Joseph, 2003) and poorer overall coherence (Rumpf et al., 2012; Tager-Flusberg, & Joseph, 2003). Differences in methodology used for matching groups

and the wide age range of participants (from preschoolers to adolescents or adults) may account for these conflicting findings. Nonetheless, these studies showed narrative analysis to be capable of detecting subtle differences in social communication.

Very few studies have examined gender differences in pragmatic skills in children with ASD. Kauschke et al (2016) compared intellectually able boys and girls with ASD as well as a control group of typically developing girls (n=11 per group). These participants were matched on age (ranging from 8-19) and full scale IQ (FSIQ). Narratives were elicited and coded for aspects of narrative competence (ie length, coherence, cohesion, character speech, internal state language etc.) They found that narrative skills were largely comparable across the groups. Gender differences were only found on the use of internal state words, such that girls produced higher proportions than boys of words for internal states overall, and specifically in categories describing physiological states such as "sleep", as well as "modality" ("terms for volition, obligation and intentions" such as "want", "must"; Kauschke et al., 2016, p. 845). In addition, girls with ASD explained the causes and consequences of internal states more frequently than boys with ASD. Both ASD groups used fewer words describing emotions than the typically developing girls.

In Conlon et al., (2018), we examined gender differences in narrative skills in 8-year-old children diagnosed with ASD (Conlon et al., 2018). Age-, IQ- and language-matched boys and girls (13 per group) were compared on a standardized narrative assessment, the *Expression, Reception and Recall of Narrative Instrument* (ERRNI, Bishop 2004). In addition, detailed transcript analysis was conducted to examine indices of microstructure such as pragmatic errors, semantic enhancement, syntactic complexity,

and formulation errors as well as measures of macrostructure such as overall story cohesion, character referencing, and story structure. (For details of the dimensions of story measurement, consult Conlon et al., 2018). Results from the ERRNI showed that girls told stories including significantly more of the salient story elements than boys. Detailed transcript analysis showed that girls' narratives differed in both microstructure and macrostructure. For microstructure, girls added richness to their stories significantly more than boys by using emotional words, such as angry, happy and joyful, and demonstrating character intentionality such as "the girl took the fish because she *wanted* one of her own". In terms of macrostructure, more girls than boys were able to make clear references to particular characters and events (Conlon et al., 2018).

Sturrock and colleagues (2019) also examined gender differences in children with ASD using a battery of pragmatic measures, one of which was a narrative. Participants were matched groups of boys and girls with ASD (n=13 per group) as well as a typically developing control group. The participants were matched on age (range = 9 years – 11.5 years), gender, and IQ. They were asked to tell a narrative using the wordless storybook "A Boy, a Dog and a Frog" (Mayer, 2003). In this book, a boy and a dog go out to the pond to catch a frog. They are unsuccessful at catching the frog and the boy ends up falling into the pond. Then he goes home and has a bath with the dog and as they are taking a bath the frog shows up in the bathroom to be with the boy and the dog. The authors analyzed the elicited narrative for story length, number of temporal or causal markers, emotional language, and coherence. Girls performed better than boys on some of the specific semantic and pragmatic measures but not on the narrative measure. The

authors cautioned that they might be underpowered due to their small sample size (Sturrock et al., 2019).

These three studies document gender differences in pragmatic language in speakers with ASD, but none of the above studies examined the stability of these measures over time. The aim of the current study was to determine if the gender differences found in previous work (Conlon et al., 2018) would still be present in the same sample of children, two years later at the age of 10. The following research question was asked: (1) Do 10-year-old NVIQ- and language-matched boys and girls with ASD display differences in their storybook narratives and if so, are these differences the same as those displayed at age 8? Based on the findings from Conlon et al., 2018, I expect girls to enhance the story and have more proficient referencing and story structure skills than boys at age 10.

3.2 Methods

3.2.1 Participants.

Participants were 21 (10 M, 11 F) of the 26 (13M, 13F) participants from Conlon et al., 2018. These data were taken from a longer longitudinal study (*Pathways in ASD*, Szatmari et al., 2015). Three males and two females from the previous study were unavailable for assessment at age 10. See Table 3.1 for participant characteristics.

Table 3.1 Participant Characteristics

	Boys' Mean (*SD*) at age 8 (Conlon et al., 2018) *n* = 10	Girls' Mean (*SD*) at age 8 (Conlon et al., 2018) *n* = 11	Boys' Mean (*SD*) at age 10 *n* = 10	Girls' Mean (*SD*) at age 10 *n* = 11

CA	105.12 (2.53)	104.52 (2.42)	127.53 (1.91)	127.96 (2.62)
VABS-II communication	88.15 (8.66)	90.62 (9.08)	89.44 (16.20)	89.73 (15.06)
ERRNI MLUw	93.56 (22.35)	92.55 (7.93)	99.78 (20.80)	99.00 (11.38)
WISC-IV PRIQ	94.92 (3.79)	95.31 (13.92)	N/A	N/A
CELF-4 CLS	93.92 (12.33)	92.85 (13.24)	N/A	N/A

Note. VABS-II Communication = *Vineland Adaptive Behavior Scales, 2nd Edition Socialization* standard score, Communication standard score; CA = Chronological Age in months; ERRNI MLUw = *Expression Reception and Recall of Narrative Instrument Mean Length of Utterances in Words* Standard Score; WISC-IV PRI = *Wechsler Intelligence Scale for Children, 4th Edition Perceptual Reasoning Index* and CELF-4 CLS = *Clinical Evaluation of Language Fundamentals, 4th Edition*, *Core Language Score*.

Participants were originally matched on the *Wechsler Intelligence Scales for Children Perceptual Reasoning Index* (WISC PRI, Wechsler, 2003) ($t(24) = 0.071$, $p = 0.944$), the *Clinical Evaluation of Language Fundamentals Core Language Score* (CELF CLS, Semel et al., 2003) ($t(24) = 0.215$, $p = 0.832$), and chronological age ($t(24) = 0.620$, $p = 0.541$). Because the *Pathways* protocol did not collect cognitive and language measures at age 10, current cognitive and language scores were not available, but *Vineland Adaptive Behavior Scales*-2, (VABS-II, Sparrow et al., 2005) *Communication standard scores* (SS) were stable from age 8 to age 10 (ANOVA IV: Age, DV: VABS Comm SS, Boys $F(1,8) = 0.637$, $p = 0.451$, Girls: $F(1,9) = 0.001$, $p = 0.977$), as were ERRNI MLUw scores, a rough index of syntax (ANOVA IV: Age, DV: MLU, Boys: $F(1,8) = 0.135$, $p = 0.725$, Girls: $F(1,9) = 2.50$, $p = 0.145$).

3.2.2 Procedures.

A battery of assessments was administered at two time points, once when the children were between 8:0 and 8:11 (see results from that analysis in Conlon et al., 2018) and once when the participants were between 10 and 10:11 as prescribed by the Pathways protocol. Of those measures, I used the data from the ERRNI (Bishop 2004), and the VABS-II (Sparrow et al., 2005).

The above assessments were administered and scored. The ERRNI was transcribed and scored following the protocol described in the manual (Bishop, 2004). The same procedure for detailed transcript analysis that was conducted in Conlon et al. (2018) and modeled on Norbury et al. (2014) was used in the current study. This detailed transcript analysis is described following the description of measures below.

3.2.3 Measures.

3.2.3.1 ***Vineland Adaptive Behaviors Scales Second Edition.*** (Sparrow et al., 2005)

The *Vineland Adaptive Behaviors Scales* is a measure that examines adaptive behavior, from birth to 90, across multiple domains including Communication, Daily Living Skills, Socialization, and Motor Skills. The version used for this study was the Survey Interview form, which was conducted with the parent or caregiver of the participant. The current study used scores from the Communication and Socialization domains.

3.2.3.2 ***ERRNI.*** (Bishop, 2004).

Participants are given a wordless picture book in which the central character has a false belief. After looking through the pictures, they are asked to generate a narrative while looking at the book. This narrative provides the basis for the Ideas – Initial score.

Following a 10- to 30-minute period during which other assessment activities are completed, participants are asked to retell the story, this time without the pictures. The Ideas-Recall score is generated from this second telling of the narrative. Finally, a series of nine questions is asked to assess comprehension of both specific details and ability to make inferences about the narrative. Answers to these questions comprise the Comprehension score. The MLU_w is calculated from both initial and recall narratives.

The test includes two stimulus stories, only one of which is administered at any assessment. The Fish Story was selected for the *Pathways in ASD* study in order to ensure consistency across *Pathways* sites and to avoid any difficulties in interpretation that might arise from using the slightly different norms established for the alternative Beach story. In the Fish Story, a boy's mother gives him money to buy a fish, so he goes to the pet store and buys one. On the way home, he runs into some friends and while he is away getting ice cream with one of them, the other friend switches the fish for a doll. When the boy gets home, he is surprised to discover a doll rather than a fish in his bag. His mother calls his friends and they return the fish.

The participant's narrative is transcribed and scored according to detailed criteria (Bishop, 2004). Ideas-Initial and Ideas-Recall scores are generated by comparing the participant's narrative to the main ideas for the relevant story, provided on the record form. Full credit (i.e., two points for each idea) is awarded if all of the salient information is expressed in the participant's narrative; a single point is given for partial information. Responses to the Comprehension questions are scored similarly: two points are awarded for a correct response containing all the relevant information, whereas a single point is awarded for reasonable responses that omit some salient information, and incorrect or

vague responses receive no points. In this section, a negative score is possible if the response to the question is "outlandish" (Bishop, 2004, p. 34) and unrelated to the story. Raw score point totals are converted to standard scores by means of the normative data provided. For details on norms and standardization of the ERRNI see Conlon et al., (2018).

3.2.3.3 *Detailed transcript analysis (DTA).*

Following the same procedures as in Conlon et al. (2018), follow-up detailed transcript analysis modeled on Norbury et al. (2014) was conducted. Each index score was calculated by totaling the number of coded items and dividing the total by the number of utterances in the narrative in order to obtain a proportion of utterances containing coded items (See Appendix A for scoring breakdown, and Appendix B for narrative score sheet).

Pragmatic Index: Higher scores on this index indicated a greater proportion of pragmatic errors. One example of a pragmatic error is "misattribution", which indicates a basic misunderstanding of a key event in the story, such as stating the boy gave the fish to the girl rather than the girl switching the items in the bags so she now has the fish and he has the doll. Another example of a pragmatic error is "irrelevant detail", such that literal descriptions of pictures are included rather than describing than how the picture contributes to the story.

Semantic Index: This index indicates semantic enrichment; a higher score indicates elaboration of the story. Examples of items that would earn credit include the use of emotional words (e.g.," scared," "mad"), mental state words (words that express knowledge, desire, or belief, e.g., "wish," "think," "wonder"), or "intentional" utterances

(utterances demonstrating that character's intention or forethought, e.g., "he *wanted to buy a fish so he asked his mother for money so he could go to the store to buy one*").

Syntactic Index: Syntactic complexity is demonstrated by utterances that have subordinate clauses such as adverbial clauses (i.e., clauses introduced with conjunctions such as "if," "because," or "when"), infinitive clauses (i.e., those headed by "to" and a verb, such as "to go to the store"), or propositional clauses (e.g., those marked by cognitive verbs like "think," "guess," or "know," such as "the girl thinks she has tricked the boy"). Syntactic complexity can also be demonstrated by noun phrase elaborations such as two or more modifiers preceding the noun (e.g., "the little orange fish"). Higher scores indicate greater syntactic complexity.

Formulation Index: Errors at the word and utterance level are counted in this index. A word used ungrammatically or an instance of a word missing from an utterance is counted as an error at the word level. An error at the utterance level is counted if an utterance has more than one-word error or is nonsensical. Higher scores indicate more formulation errors.

Codes were also assigned for story macrostructure, which involves dividing the narrative into categories that were essential to a story (Appendix C). Macrostructure includes A) Story Components and B) Cohesion and Referencing.

A: Story Components: Settings, Conflict/Resolution, and Conclusion. The important events of the ERRNI Fish Story were divided into categories. "Settings" included utterances that set the stage for the characters and the story (e.g., "The boy buys the new fish"). The Settings category had 16 elements. Conflict/ Conflict Resolution included utterances about the main conflict of the story and how it was resolved (e.g.,

"The shows his mother the doll in his bag"), and "Conclusion" refers to how the story wrapped up (e.g., "The girl is happy to have her doll back"). Four elements per category were available for each of Conflict/ Conflict Resolution and Conclusion.

Each participant's narrative was scored according to the presence and completeness of elements listed within each category, according to the scoring key. A score of 0, 1, or 2 was assigned to each element in each category, leading to a perfect score of 48 for the entire story. For example, in the "Settings" element of "The boy asks his mother for money," a score of 2 was awarded if the participant included the elements of the boy, the mother, and a request for money. A score of 1 was awarded if one or more elements were missing, and 0 was awarded if none of the salient elements were included. Points were summed for each category (Settings, Conflict/Conflict Resolution, Conclusion) and divided by the total for that section to produce a proportion, subsequently converted to a percentage.

B) Cohesion and Referencing. Scores for Cohesion and Referencing are global ratings derived from the whole narrative. Cohesion refers to how well the story flowed, whether the major events were emphasized and the story made sense. Referencing is a rating of how well the child referred to the correct characters or events to help reduce confusion. Each narrative received a rating based on the number of mistakes or unclear points.

3.2.4 Analytic Plan.

A series of repeated measures ANOVAs was run with gender and time as independent variables (IV) and the test scores (ERRNI Ideas – Initial, Ideas – Recall, Comprehension, MLU_w) as the dependent variables (DVs). Data generated from DTA

were analyzed in another series of repeated measures ANOVAs using gender and time as the IVs and index scores (Pragmatic Index, Semantic Index, Syntactic Index, Formulation Index) as DVs. Due to the multiple comparisons, Bonferroni corrections were applied and an alpha level of 0.0125 was set for significance. Effect size was calculated using partial eta squared. A third series of repeated measures ANOVAs was used to analyze macrostructure data, with time and gender as the IVs and macrostructure index scores (Settings, Referencing, Conflict/Conflict Resolution, Cohesion, Conclusion) as DVs. Due to the multiple comparisons, Bonferroni corrections were applied and an alpha level of 0.01 was set for significance. Effect size was calculated using partial eta squared (η_p^2). In general, $\eta_p^2 < 0.06$ is considered to be a small effect, η_p^2 of 0.06 - 0.14 is considered to be a medium effect, and $\eta_p^2 > 0.14$ is considered to be a large effect (Lakens, 2013).

3.3 Results

For the ERRNI Ideas - Initial SS, there were large main effects of both time ($F(1) = 9.605$, $p = 0.006$, $\eta_p^2 = 0.336$) and gender ($F(1) = 8.159$, $p = 0.010$, $\eta_p^2 = 0.300$) (Figure 3.1) where both groups got better over time and girls told a more complete story than boys. There was no significant interaction effect ($F(1) = 2.063$, $p = 0.167$). For the ERRNI Ideas - Recall SS, Comprehension SS, and MLUw SS there were no significant main effects of time or gender, and no significant interaction effects. See Table 3.2.

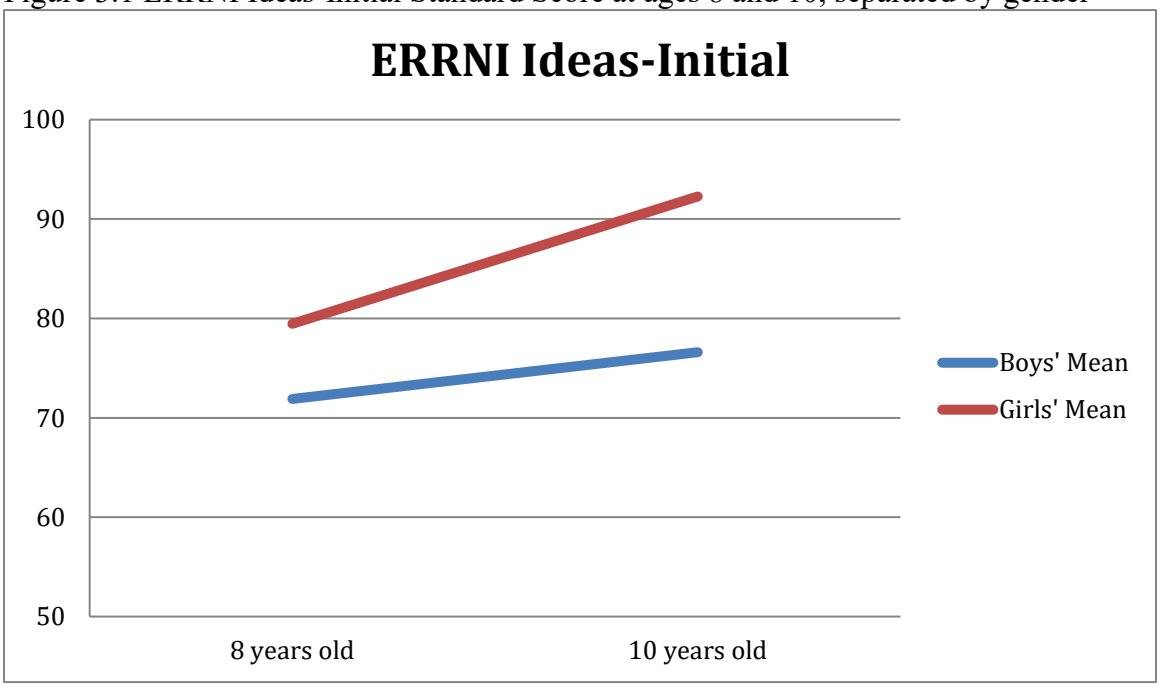
Table 3.2 ERRNI scores by gender and time

ERRNI Standard Score	Boys' Mean (*SD*) at age 8	Girls' Mean (*SD*) at age 8	Boys' Mean (*SD*) at age 10	Girls' Mean (*SD*) at age 10	Repeated Measures ANOVA and *p* values for within	Repeated Measures ANOVA and *p* values for between

					group (time)	group (gender)
Ideas-Initial*	71.90 (8.28)	79.45 (10.89)	76.60 (12.46)	92.27 (12.96)	$F(1) = 9.61$, $p = 0.006$	$F(1) = 8.12$, $p = 0.010$
Ideas-Recall	74.60 (9.14)	80.73 (15.97)	77.60 (13.14)	89.45 (9.21)	$F(1) = 2.75$, $p = 0.114$	$F(1) = 5.01$, $p = 0.037$
Comprehension	92.00 (14.15)	91.91 (14.38)	89.44 (25.55)	91.64 (10.62)	$F(1) = 0.11$, $p = 0.747$	$F(1) = 0.03$, $p = 0.866$
Mean Length of Utterance in words	93.56 (22.35)	92.55 (7.93)	99.78 (20.80)	99.00 (11.38)	$F(1) = 1.42$, $p = 0.249$	$F(1) = 0.03$, $p = 0.858$

Note. * = significant difference of $p \leq 0.0125$

Figure 3.1 ERRNI Ideas-Initial Standard Score at ages 8 and 10, separated by gender



Results of the DTA are shown in Table 3.3. On the Pragmatic Index, there were large main effects of both time ($F(1) = 14.234$, $p = 0.001$, $\eta_p^2 = 0.428$) and gender (Figure

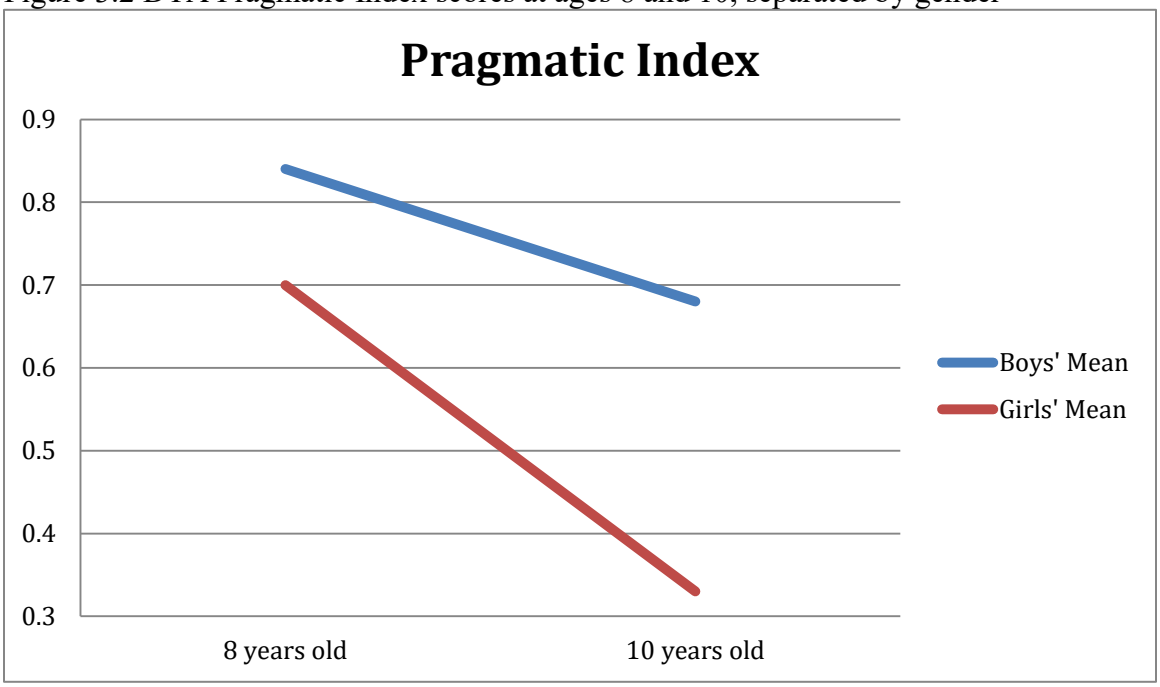
3.2) ($F(1) = 8.159$, $p = 0.010$, $\eta_p^2 = 0.271$) where both groups made fewer errors over time and girls made fewer errors than boys. There was no significant interaction effect ($F(1) = 2.123$, $p = 0.161$).

Table 3.3 Index scores from DTA by gender and time

DTA index score	Boys' Mean (*SD*) at age 8	Girls' Mean (*SD*) at age 8	Boys' Mean (*SD*) at age 10	Girls' Mean (*SD*) at age 10	Repeated Measures ANOVA and *p* values for within subject (time)	Repeated Measures ANOVA and *p* values for between subject (gender)
Pragmatic Index	0.84 (0.24)	0.69 (0.30)	0.68 (0.20)	0.33 (0.29)	*$F(1) = 14.23$, $p = 0.001$	*$F(1) = 8.16$, $p = 0.010$
Semantic Index	0.12 (0.20)	0.29 (0.20)	0.25 (0.05)	0.35 (0.07)	$F(1) = 7.09$, $p = 0.015$	*$F(1) = 13.46$, $p = 0.002$
Syntactic Complexity Index	0.10 (0.12)	0.14 (0.10)	0.19 (0.18)	0.30 (0.19)	*$F(1) = 7.92$, $p = 0.011$	$F(1) = 2.58$, $p = 0.124$
Formulation Index	0.70 (0.25)	0.66 (0.25)	0.62 (0.21)	0.47 (0.24)	$F(1) = 4.56$, $p = 0.046$	$F(1) = 1.21$, $p = 0.284$

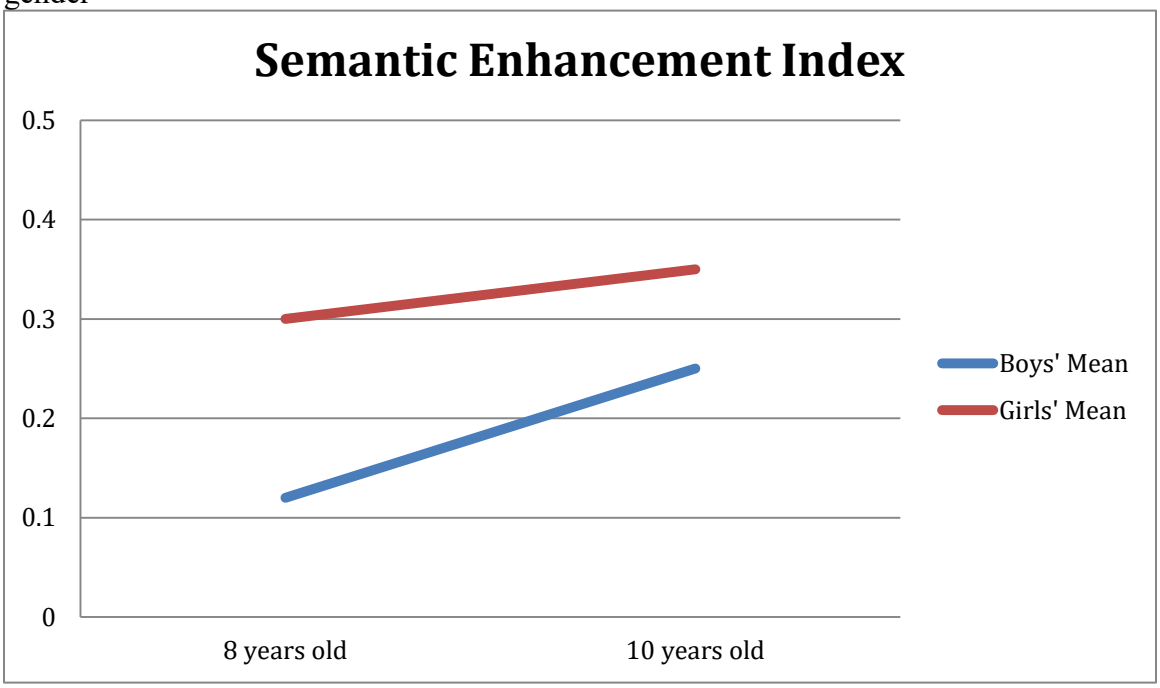
Note. * = significant difference of $p \leq 0.0125$

Figure 3.2 DTA Pragmatic Index scores at ages 8 and 10, separated by gender



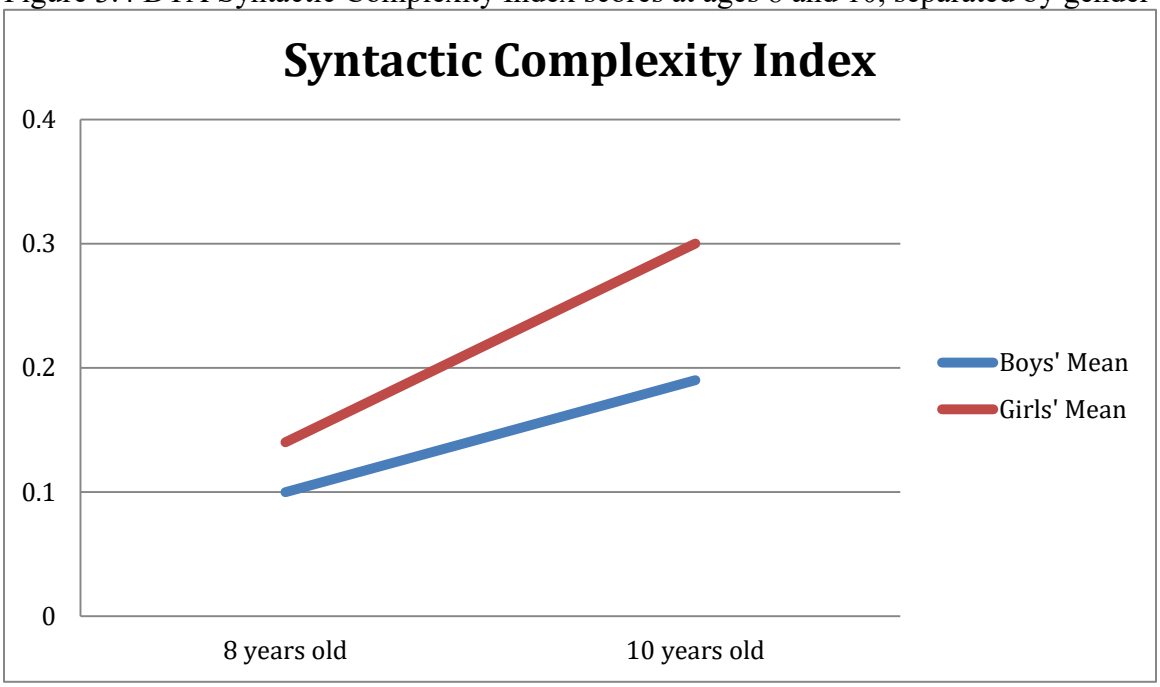
On the Semantic Enhancement Index of DTA, there was a large main effect of gender ($F(1) = 13.462$, $p = 0.002$, $\eta_p^2 = 0.415$) , but not of time ($F(1) = 7.093$, $p = 0.015$) as it did not survive correction (Figure 3.3). Girls enriched their stories more than boys. There was no significant interaction effect ($F(1) = 1.186$, $p = 0.290$).

Figure 3.3 DTA Semantic Enhancement Index scores at ages 8 and 10, separated by gender



On the Syntactic Complexity Index of DTA, there was a large main effect of time ($F(1) = 7.913$, $p = 0.011$, $\eta_p^2 = 0.294$) but not of gender (Figure 4.4) ($F(1) = 2.584$, $p = 0.124$). Both groups used more complex sentences over time, but girls did not differ significantly from boys. There was no significant interaction effect ($F(1) = 0.778$, $p = 0.389$). On the Formulation Index of DTA, there were no main effects of time or gender. There was no significant interaction effect.

Figure 3.4 DTA Syntactic Complexity Index scores at ages 8 and 10, separated by gender



For story macrostructure (See Table 3.4), a repeated measures ANOVA on the Referencing index showed a large significant main effect of gender ($F(1) = 18.08$, $p = 0.001$, $\eta_p^2 = 0.488$) (Figure 3.5) where girls made significantly fewer character and event referencing errors than boys. There was no significant main effect of time and no interaction effect. There were no significant main effects or interaction effects for the Settings, Conflict/Conflict Resolution, Cohesion, or Conclusion indices of story macrostructure.

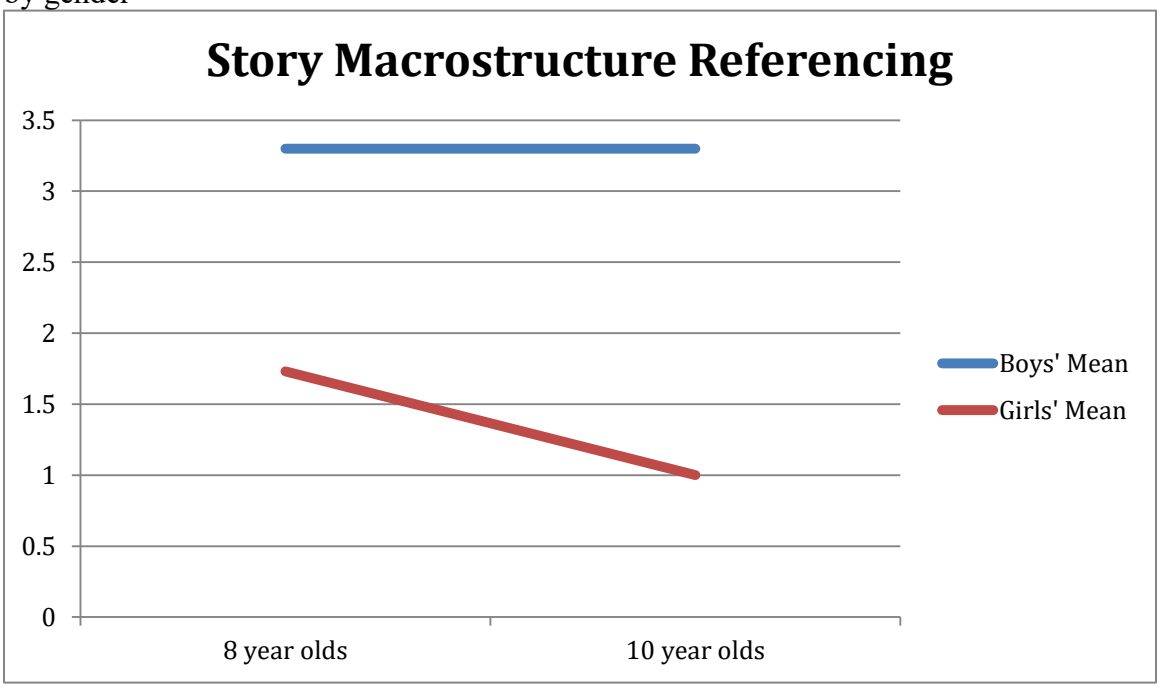
Table 3.4 Story Macrostructure Indices by gender and time

	Boys' Mean (*SD*) at age 8	Girls' Mean (*SD*) at age 8	Boys' Mean (*SD*) at age 10	Girls' Mean (*SD*) at age 10	Repeated Measures ANOVA and *p* values for within subject	Repeated Measures ANOVA and *p* values for between subject

					(time)	(gender)
Settings (percent of elements correct)	40.80 (15.28)	47.00 (18.88)	34.60 (12.24)	44.36 (16.49)	$F(1) = 0.80$, $p = 0.382$	$F(1) = 2.60$, $p = 0.124$
Referencing (raw number of errors)	3.30 (1.95)	1.73 (1.56)	3.30 (1.25)	1.00 (1.34)	$F(1) = 0.54$, $p = 0.473$	$^{*}F(1) = 18.08$, $p = 0.001$
Conflict/Conflict Resolution (percent of elements correct)	26.10 (5.97)	26.27 (9.72)	26.80 (9.95)	38.27 (22.22)	$F(1) = 2.68$, $p = 0.118$	$F(1) = 1.65$, $p = 0.215$
Cohesion (raw number of errors)	3.60 (0.97)	4.00 (1.27)	3.70 (0.82)	2.63(1.43)	$F(1) = 3.09$, $p = 0.095$	$F(1) = 0.87$, $p = 0.364$
Conclusion (percent of elements correct)	23.00 (11.26)	25.91 (13.84)	32.80 (12.78)	32.45 (18.09)	$F(1) = 2.90$, $p = 0.105$	$F(1) = 0.10$, $p = 0.753$

Note. * = significant difference of $p \leq 0.01$

Figure 3.5 Story Macrostructure Referencing number of errors at ages 8 and 10, separated by gender



3.4 Discussion

I set out to examine if the gender differences found in previous work (Conlon et al., 2018) were still present two years later when the participants were between 10:0 and 10:11. Furthermore if gender differences were present, I wanted to know if the differences would be similar in nature to the differences found when the participants were 8 years old. Overall, the gender differences that were demonstrated at age 8 were still present at age 10. In addition, both boys and girls improved on some indices over time.

Results showed that the participants' narrative skills improved as they developed. For the ERRNI Initial Ideas SS, there was a significant difference of time, where the narratives that the participants produced at 10 years old had significantly more story elements than their narratives at 8 years old. As the participants aged, their narratives further approached average performance. At age 8, the mean of the Ideas SS for all participants was 75.68 whereas at age 10 the mean of the same score was 84.55. In other

words, at age 10, the participants, on average, are just below one standard deviation from the mean whereas at age 8, their average score was more than 1.5 standard deviations from the mean. Average comprehension and length of utterance did not improve from age 8-10 although in both cases average scores were already very close to the average mean of 100 at age 8. Turning to DTA, both boys and girls had narratives with fewer pragmatic errors such as including irrelevant details or misunderstandings of the story. They also used significantly more complex language in their narratives at age 10 then at age 8. The two indices that didn't show significant improvement over time were the Formulation index, where there was no significant change in the participants' number of grammatical errors within the narrative, and the Semantic Enhancement Index, which although very close to significant, did not survive correction for multiple comparisons.

In terms of gender differences, as at age 8, the results demonstrated that there was a significant difference on the ERRNI Initial Ideas SS, where girls had a narrative that included significantly more salient story elements than boys. The Ideas Recall, Comprehension, and MLUw SS did not show significant differences between the genders, consistent with the findings at age 8. Results from the DTA also revealed the same trends found in Conlon et al., (2018). Girls enhanced the story more by adding details such as describing the thoughts of the character or describing character intentions. There were no gender differences on syntactic complexity or the number of sentence formulation errors, as in Conlon et al., (2018). For story macrostructure, as seen at age 8, girls continue to produce narratives with significantly fewer referencing errors than boys, but there were no differences between boys and girls on the Setting, Conflict/Conflict Resolution, Conclusion, or Cohesion areas of macrostructure. These results support my

prediction that a significant gender difference would still be present and, in general, that the nature of that difference would still be the same.

Interestingly, the Pragmatic Index showed results that differed from those seen in previous work, such that the significantly fewer pragmatic errors demonstrated by girls survived correction for multiple comparisons at age 10. This may indicate that girls' better social communication skills are becoming more evident over time. This may also be true in the typically developing population. Perhaps this finding represents a difference that is typically seen at this point in development. Unfortunately pragmatic errors in 10-year-olds (either TD or with developmental concerns) are not well studied so the query about whether the difference found is potentially a typical developmental variation remains unanswered. To answer this question, future research should examine differences in pragmatic errors in narratives of TD 10-year-olds to determine if this is a unique finding (and therefore may be related to ASD rather than gender) or if this is a typical developmental discrepancy.

These results support my previous work and the work of Kauschke et al. (2016). Despite the use of different scoring systems, findings in both studies are similar. Both studies examined narratives of speakers with ASD and demonstrated that girls with ASD have stronger narrative skills in certain areas. For example, Kauschke et al. (2016) found that girls produced narratives with a greater proportion of words describing "modality" (i.e., intention obligation, or volition, e.g. "want, "must") and "causality" (i.e. proportion of utterances that explained the *cause* or *consequence* of an internal state). In Conlon et al. (2018), and in the current study, use of terms to describe such acts, acts involving intention, planning and forethought, were included in the category of Semantic

Enhancement which was one of my consistent findings of better narrative performance by girls. Although there was no standard system for narrative evaluation, the common trend that was demonstrated through the work of these researchers was that girls were better at producing narratives where characters have intentions to complete a goal. Future investigations should pursue whether girls with ASD continue to be better than boys with ASD at planning for coherence in less structured situations, such as conversation, and whether boys close this gender gap as they develop further.

This study is the first to examine the stability of gender differences in narratives in children with ASD over two time points, when the participants were 8 and 10, but a more accurate trajectory of development can only be plotted when three or more observation points are available. In this sample, all children with ASD improved on their narrative story telling ability, but girls continued to demonstrate better story telling skills (i.e., including more elements, avoiding pragmatic errors etc.) than boys over a two-year period. Gender differences that were apparent at age 8 persisted at age 10. Overall, these girls had better story-telling skills than carefully matched boys. These findings add support to the notions that girls employ better social communication skills in general (Mulac, Bradac, & Gibbons, 2006; Newman, Groom, Handelman, & Pennebaker, 2008) and that they may present with a unique phenotype (Kreiser & White, 2014; Lai et al., 2014). For example, it is worthwhile to consider whether the difficulties in planning (Harris, 1993) that have been described as characteristic of ASD, are more evident generally in boys than girls with ASD.

While the Ideas score on the ERRNI documented girls' better narratives, the nature of the differences became apparent only following a fine-grained analysis of the

participants' narratives. Fine-grained analysis revealed significant differences and large effect sizes in specific areas of the narratives, and pragmatics overall. These areas may be of particular interest to clinicians as they may be areas to target for intervention. Although standardized test scores also revealed significant differences, without the fine-grained analysis, the exact nature of how boys' and girls' narratives differ would not be clear. Therefore, despite the statistical findings, the clinical implications of these findings might be too subtle to be detected on standardized test instruments, and only evident through detailed transcript analysis (Volden, 2004).

One of the limitations of this study is my small sample of intellectually able and verbally fluent participants. Although this rigorous matching has allowed me to closely compare the narratives of these boys and girls, results may not be generalizable to cognitively impaired children or those who have limited structural language skills. Furthermore, although every effort was made to gather data from all participants at both time points, a few participants were unavailable for follow-up. Although these participants did not have an overall impact on characteristics of the sample, the exclusion of their data decreased my sample size potentially reducing the power of the findings.

In summary, if these results are replicated, and other subtle differences in social communication are demonstrated, it may be important to consider gender-specific interventions for social communication. In the future, examining if these gender differences exist within the typically developing population would be beneficial to help us understand if the differences seen here are specific to the ASD population, or are connected to differences in gender-specific language development overall.

CHAPTER 4: Comparison of Gender Differences in Pragmatic Communication in School-Aged Children with Autism Spectrum Disorder (ASD) and Typical Development (TD)

4.1 Introduction

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder that is more commonly diagnosed in males than females. Males outnumber females approximately four: one (Baio et al., 2018). The reason for this uneven ratio is currently unknown but one possibility is that there may be a "female phenotype" where girls with ASD present with a unique symptom profile. If so, girls with ASD may be mis- or under diagnosed (Gould & Ashton-Smith, 2011; Kopp & Gillberg, 2011). To understand the presentation of ASD symptoms in girls with ASD, some research has focused on comparing boys and girls with ASD on the core aspects of the diagnosis; that is, deficits in social communication plus the presence of restricted interests and repetitive behaviours (American Psychiatric Association, 2013).

Social communication, also termed pragmatics (Swineford, et al., 2014) is described as the "use" of language and includes skills such as turn taking, topic maintenance, conversational repairs, and modifying language to meet listener needs (American Speech-Language-Hearing Association, 2016). Since social communication is universally impaired in people diagnosed with ASD, examining this area is one avenue that researchers have taken in order to understand if differences exist between males and females.

Results from studies examining gender differences in social communication in ASD have been mixed. Many have found no significant difference in communication

between males and females with ASD (Andersson et al., 2013; Auyeung et al., 2009; Harrop et al., 2015; Holtmann, Bolte, & Poustka, 2007; Mandy et al., 2012; May et al., 2014; Pilowsky, Yirmiya, Shulman, & Dover, 1998; Rivet & Matson, 2011; Solomon et al., 2012; Wijngaarden-Cremers et al., 2014). Still, many of these included participants across a wide age range, so developmental differences in social communicative/pragmatic development may have been obscured. Also, many studies failed to match their male and female participants on nonverbal cognitive skill, making meaningful comparison difficult. In addition, a lack of significant differences might result from the tools used to evaluate social communication. In the above studies, the most commonly used assessments were the *Autism Diagnostic Interview* (ADI) (Rutter et al., 2003) and the *Autism Diagnostic Observation Schedule* (ADOS) (Lord et al., 2000). Although these assessments are the gold standard for diagnostic purposes, neither purports to be a specific or sensitive measure of language or communication.

On the other hand, some investigations, often by using a battery of assessments rather than a single measure, did reveal significant gender differences in communication in participants with ASD. For example, Lai and colleagues (2011) found that girls between 8 and adulthood had better social communication than boys as measured by the ADOS (Lord et al., 2000) and Hiller et al (2014) found that girls were better at engaging in reciprocal conversation, integrating verbal and nonverbal gestures, avoiding inappropriate comments, monitoring vocal volume and initiating friendships. Gillberg and Steffenburg (1987) and McLennan et al (1993) both found that younger girls had better communication skills than boys, but that teenaged girls struggled more than teenaged boys, particularly in peer relationships.

Recently, gender differences in social communication in ASD have been more consistently reported when using tools specifically designed to examine specific aspects of social communication. One possibility to evaluate social communication is to use a narrative. Narratives are an integral part of daily interaction as well as often used in educational settings (Makinen, et al., 2014). In a narrative, the speaker describes a story or an event with the goal of having the listener understand what is happening in the story and the key elements of that story or event. Telling a story also requires a speaker to use sophisticated language skills, beyond the sentence level, in both structural and pragmatic language. For example, reasoning, paraphrasing and conveying another person's perspective are all skills that demonstrate higher-level language. Overall, narratives require the speaker combine cognitive, linguistic and social skills (Norbury et al., 2014) and analysis of narratives is one way to evaluate pragmatic skill (Johnston, 2008). Since most traditional standardized tests of structural language don't evaluate skills above the sentence level, narratives allow a unique perspective on pragmatics not seen on traditional language measures (Norbury et al., 2014).

There are many studies of narrative skills in speakers with ASD (Banney et al., 2015; Conlon et al., 2018; Kauschke et al., 2016; King et al., 2013, 2014; Novogrodsky, 2013; Rumpf et al., 2012; Sturrock et al., 2019) but very few that examined gender differences. Kauschke and colleagues (2016) compared 11 intellectually able girls with ASD to 11 boys with ASD and 11 typically developing (TD) girls, ranging in age from 8 to 19 years, matched on age and IQ. They found that narrative competence (i.e., grammar, length, etc.) was similar between the boys and girls with ASD but girls used more "internal state" words and provided more explanations of causes and consequences

of internal states than boys. They also found group differences (i.e., ASD-F vs TD-F) in the use of words describing emotions, where TD girls used significantly more words to describe emotions than girls with ASD. There were no significant differences, between girls with ASD and TD girls, on indices of narrative competence (story length, coherence etc.). A comparison group of TD boys was not included so they were unable to determine if gender differences were present in the TD population.

Sturrock and colleagues (2019) also used a narrative task to examine gender differences in IQ-matched children with ASD and TD controls. Their study included four groups of participants, aged between 9 and 11: (a) girls with ASD (b) boys with ASD (c) TD girls and (d) TD boys. The participants were matched on age and gender and were administered a battery of language and communication assessments, one of which was a narrative task. Results showed that there were main effects of diagnostic group on expressive language where TD participants had more complex language, used more causal markers and a wider range of temporal and causal markers than children with ASD. There was also a significant diagnostic group main effect on narrative coherence such that TD participants produced narratives with more goal- directed action sequences than participants with ASD. A goal directed action was defined as a sequence that included an action, reaction and conclusion in order to meet a defined goal, for example the boy decided wanted to go search the pond for frogs, so he put on his boots and got his net and walked to the pond. Significant gender main effects were found such that girls displayed a greater range of causal markers than boys. There were no main effects of gender on narrative coherence and there were no significant interaction effects. Overall, Sturrock et al. (2019) found that girls outperformed boys on some specific pragmatic and

semantic tasks such as understanding figurative language but did not find significant gender differences on their narrative measure. They cautioned that small sample sizes may have limited their statistical power to find significant differences and that some of their specific tasks were novel and unvalidated in the larger population. I also note that the Sturrock et al. (2019) study, by virtue of the large number of instruments administered, is limited in the ability to draw conclusions due to multiple statistical comparisons.

Conlon et al. (2018) also examined gender differences on a narrative task in age-, IQ-, and language-matched 8-year-old children diagnosed with ASD. Results showed that girls told better stories than boys. They included more of the salient story elements and included more descriptions of characters' emotions and intentions. In addition, more girls than boys were able to make clear references to particular characters and events (Conlon et al., 2018). In a second study (see Chapter 3), I examined the narratives of these same participants at age 10. These gender differences remained when the same narrative task was completed two years later (See Chapter 3). At age10, these girls also demonstrated significantly fewer pragmatic errors compared to the 10-year-old boys with ASD. This difference was also noted at age 8, but did not survive correction for multiple comparisons at that point. One question that remains however is whether these subtle gender differences in storytelling would also be seen in the typically developing population or whether such differences were unique to ASD. Therefore, the current study included typically developing control groups to help answer the above question.

4.1.1 Gender differences in Language/communication development in TD.

Differences between men's and women's communication styles are commonly accepted as evidenced by such popular books as *Men are from Mars; Women are from Venus* (Gray, 2002). Despite the popular stereotype that boys lag behind girls in language development, empirical evidence is somewhat limited and results are difficult to interpret due to a variety of study designs, language domains examined and populations studied (Barbu, et al., 2015). In general, studies looking at early language development have found that girls acquire language and communicative gestures earlier than boys (Bouchard et al., 2009; Erikkson et al, 2012; Fenson et al, 1994), but by age 5 the differences between boys and girls for expressive structural language are no longer present (Bleses et al., 2008; Bouchard et al, 2009). In terms of *pragmatic* development, O'Neill (2007) found evidence of differential development of pragmatic functions in her standardization study of the Language Use Inventory (LUI); a parent-report instrument designed to evaluate pragmatic development in preschoolers, and published the instrument with different norms for boys and girls. In a subsequent study, evaluating the LUI's translation into Italian, a similar gender effect was not found (Longobardi et al., 2017). Another example of conflicting results is that Fernandez and Melzi (2008) evaluated narratives in Spanish-speaking children in kindergarten and first grade and found that girls told better stories than boys, such that girls told more complex stories and made more references to character's internal states whereas Umek et al (2008) found no significant gender differences in narratives produced by 4-, 6, and 8-year olds. Discrepant results may be due to different methods of narrative elicitation and analysis.

Looking more broadly at social interaction, Leaper found gender differences, where females' interactions were more collaborative and males' interactions were more

controlling (Leaper, 1991). This gender difference was echoed by Ladegaard and Bleses who found that females were more likely to use polite forms of language whereas males were more likely to give commands or instructions (Ladegaard & Bleses, 2003). Although some research has been conducted in the area of gender differences in language and interaction in the TD population, differences in research questions, methodology, and participants have made the findings hard to interpret and generalize (Barbu, et al., 2015).

4.1.2 Comparison of gender differences in language/communication in ASD and TD.

Most previous studies examining gender differences in social communication in the population with ASD have generally not included a comparison group of typically-developing participants. Thus, when differences were found, it was not clear whether those differences were specific to ASD or would also be present in the TD population. To date, the only two studies that have examined gender differences in narratives with ASD and also included a comparison group of matched TD controls were the previously reported studies by Kauschke, et al., (2016) and Sturrock, et al. (2019).

In the current study, my intent was to further examine gender differences in both ASD and TD populations by employing the standardized narrative measure and detailed analysis of the narratives produced. Having found that gender differences in the ASD population were both significant and stable over a two-year period (Conlon et al., 2018; Conlon, Chapter 3), I sought to determine whether this pattern was specific to the population with ASD or whether it reflected gender differences in social communication in the population as a whole. Also, at the age of 10, I compared performance of girls and boys with ASD to TD girls and boys on additional measures of pragmatic skill; the

Pragmatic Judgment, *Inference* and *Non-literal Language* subtests of the *Comprehensive Assessment of Spoken Language* (CASL; Carrow-Woolfolk, 1999).

The following questions were asked:

1. Are there significant diagnostic group and gender differences on the *Expression Reception and Recall of Narrative Instrument* (ERRNI; Bishop, 2004) in 8-year-olds with TD and 8-year-olds with ASD?
2. Are there significant group and gender differences on the story macrostructure and microstructure, as revealed by detailed transcript analysis of the narratives produced by 8-year-olds with TD and 8-year-olds with ASD?
3. Are there significant group and gender differences on the *Expression Reception and Recall of Narrative Instrument* in 10-year-olds with TD and 10-year-olds with ASD?
4. Are there significant group and gender differences on the story macrostructure and microstructure, as revealed by detailed transcript analysis of the narratives produced by 10-year-olds with TD and 10-year-olds with ASD?
5. Are there significant group and gender differences on the *Pragmatic Judgment*, *Inference*, and *Non-literal Language* subtests of the *Comprehensive Assessment of Spoken Language* in 10-year-olds with TD and 10-year-olds with ASD?

4.2 Methods

4.2.1 Participants.

Participants with ASD were the 26 8-year-olds (13M, 13F) from Conlon et al. (2018). Of those, 21 (10M, 11F) were available for data collection two years later at age 10. Two TD groups of children (27 8-year-olds, 14M, 13F; 24 10-year-olds, 12M, 12F)

were recruited to act as comparisons to the participants with ASD. The 8-year-old TD group was matched to the 8-year-olds with ASD on chronological age (CA), nonverbal intelligence quotient (NVIQ), and language level. 10-year-old TD participants were matched to the 10-year-old participants with ASD on CA only. As previously described (Conlon, Chapter 3), language level standard scores (SS) and NVIQ were not available for the ASD participants at age 10, but *Vineland Adaptive Behavior Scales-2*, (VABS-II, Sparrow et al., 2005) *Communication* SS were stable from age 8 to age 10 (ANOVA IV: Age, DV: VABS Comm SS, Boys $F(1,8) = 0.637$, $p = 0.451$, Girls: $F(1,9) = 0.001$, $p = 0.977$), as were ERRNI MLUw scores, a rough index of syntax (ANOVA IV: Age, DV: MLU, Boys: $F(1,8) = 0.135$, $p = 0.725$, Girls: $F(1,9) = 2.50$, $p = 0.145$). The 10-year-old TD participants' IQ and language level scores were within normal limits and considered to be roughly comparable to the participants with ASD because of the stability demonstrated between ages 8 and 10. All TD participants were also administered the *Autism Diagnostics Observation Schedule* (ADOS; Lord et al., 2000) to ensure that they did not exceed the cut-offs for ASD symptoms, that is overall severity scores greater than 7 (Lord et al., 2000) on this measure. Participant characteristics are shown in Table 4.1.

Table 4.1. Participant Characteristics

	TD 8-year-olds' Mean (*SD*) *n* = 27	ASD participants at 8-years-old Mean (*SD*) *n* = 26	TD 10-year-olds' Mean (*SD*) *n* = 24	ASD participants at 10-years-old Mean (*SD*) *n* = 21
CA*	101.85 (3.82)	104.30 (2.32)	126.13 (3.53)	127.75 (2.27)
WISC-IV PRIQ*	99.48 (9.75)	95.12 (13.57)	91.63 (9.84)	N/A
CELF-4 CLS*	93.48 (9.40)	93.38 (12.55)	95.00 (12.47)	N/A
ADOS Overall severity* +	2.52 (1.74)	N/A	2.71 (2.01)	9.75 (4.78)

* Chronological Age in months; *Wechsler Intelligence Scale for Children, 4th Edition Perceptual Reasoning Index* (Wechsler, 2003); *Clinical Evaluation of Language Fundamentals, 4th Edition, Core Language Score* (Semel et al., 2003); *Autism Diagnostic Observation Schedule*, Overall severity metric (Lord et al., 2000).

+ Significant difference of $p \leq 0.001$

4.2.2 Procedures.

Data for the group of participants with ASD were taken from a larger longitudinal study (*Pathways in ASD*, Szatmari et al., 2015). As per the *Pathways in ASD* research study, a battery of assessments was administered when the participants were between 8:0 and 8:11, and again when they were between 10:0 and 10:11. For the 8-year-olds, I used data collected from the *Wechsler Intelligence Scale for Children, 4th edition* (WISC-IV; Wechsler, 2003), the *Clinical Evaluation of Language Fundamentals, 4th edition* (CELF-4; Semel et al., 2003), and the ERRNI. For the 10-year-olds, I used data collected from the *Autism Diagnostic Observation Schedule* (ADOS), the *Comprehensive Assessment of Spoken Language* (CASL), and the ERRNI. Due to the *Pathways* protocol, the participants at age 8 were not administered the CASL or the ADOS and at age 10 were not administered the WISC-IV or the CELF-4.

Ethics approval was obtained (Appendix D) and typically developing participants were recruited through flyers (Appendix E) circulated through the Catholic School System in Edmonton, Alberta and surrounding areas (Appendix F). Participants had to be between 8:0 - 8:11 or 10:0 - 10:11with no uncorrected sensory impairments. Participants also had to be fluent in English, as all assessments were conducted in English. Most of the assessments took place in the participant's home over two sessions. In the first session, the WISC-IV, CELF-4, and ADOS were administered. In the second session a research assistant who was blind to the purposes of the study administered the ERRNI and CASL. The same research assistant also transcribed the narratives so that the author could code and subsequently analyze the transcripts and remain blind to participant gender. Detailed transcript analysis (DTA) modeled on Norbury et al. (2014) and

described in Conlon et al. (2018) was used in the current study. Measures and DTA are described below.

4.2.3 Measures.

4.2.3.1 *Wechsler Intelligence Scale for Children, 4th edition.* (WISC-IV; Wechsler, 2003)

The WISC-IV is an assessment used to assess intelligence in children between 6:0 and 16:11. Composite scores are computed that represent different cognitive domains. For this study, participants were administered the Perceptual Reasoning Index as a measure of nonverbal intelligence. The WISC-IV PRI has good reliability with an inter-rater reliability of 0.90. It also demonstrates good validity, as it has a correlation of 0.89 with other global measures of intelligence.

4.2.3.2 *Clinical Evaluation of Language Fundamentals, 4th edition.* (CELF-4; Semel et al., 2003)

The CELF-4 is a standardized assessment that examines language and communication in people aged 5 to 21. The Core Language score (CLS) is derived by administering 4 subtests (Concepts and Following Directions, Word Classes (examinees aged 9-21)/Word Structure (examinees aged 5-8), Recalling Sentences, and Formulated Sentences) and can be used to evaluate general language ability. The CLS of the CELF-4 demonstrates good inter-rater reliability with $r = 0.96$ and acceptable validity as it has a correlation of 0.87 with other language measures.

4.2.3.3 *Comprehensive Assessment of Spoken Language.* (CASL; Carrow-Woolfolk, 1999)

The CASL is a standardized assessment that examines oral language. It examines four key areas of oral language: Lexical/Semantic, Syntactic, Supralinguistic, and Pragmatic. The participants in this study were administered subtests from both the Supralinguistic and Pragmatic categories. The Supralingusitic category measures understanding of complex language where the meaning of the statement has to be derived by considering more than just the meaning of the individual words. For example, understanding that the sentence "the teacher said he wanted all eyes on the board" means that he wanted the students to pay attention. The Pragmatic category measures the appropriate use of language in differing situations. For example, knowing how to greet your teacher when you arrive at school. The CASL demonstrates good inter-rater reliability, with r-values ranging from 0.78 to 0.92 for the subtests administered. When examining validity against other measures of oral language, the CASL demonstrates a strong correlation of 0.80.

4.2.3.4 ***Autism Diagnostic Observation Schedule.*** (ADOS; Lord et al., 2000)

The ADOS is a standardized semi-structured play-based assessment that examines communication, social interaction, imagination/play/creativity, and restricted and repetitive behaviours. This tool, along with expert clinical judgment, is one of the current "gold standard" observational assessments used for ASD diagnosis. This assessment employs standardized social activities, which were developed to elicit behaviours that are relevant to an ASD diagnosis. There are both structured and unstructured situations in which behaviours are observed. Behaviours are scored from 0-3. In general, a 0 code is assigned when the behaviour does not demonstrate abnormality. A 1 code is assigned when the behaviour is slightly abnormal. A 2 code is assigned when the behaviour is

definitely abnormal and a 3 code is assigned when the behaviour is so abnormal that is interferes with completing the activity or assessment. Subscale scores are summed and compared with cut-off scores that classify participants as either “non-spectrum” “autism spectrum” or “autism”. The ADOS demonstrates acceptable psychometric properties, with inter-rater reliability of r=0.96 and a validity of r = 0.70.

4.2.3.5 ***Expression, Reception, and Recall of Narrative Instrument.*** (ERRNI; Bishop, 2004)

The ERRNI is a standardized measure that tests a participant’s ability to relate, remember and understand a story. Participants are given a wordless picture book and are asked to generate a narrative after looking through the pictures. This narrative makes up the Ideas – Initial score. Following a 10- to 30-minute period away from the story, the participants are asked to retell the story from memory, which is used to generate the Ideas-Recall score. Afterwards, the Comprehension score is derived from a series of nine questions asked to the participants. The MLU_w is calculated from both initial and recall narratives. Two stories are available, *The Beach Story* and *The Fish Story* The Fish Story was selected for the Pathways in ASD study and therefore was used for the current study so comparisons across groups could be made. In *The Fish Story*, a boy’s mother gives him money to buy a fish, so he goes to the pet store and buys one. On the way home, he runs into some friends and while he is away getting ice cream with one of them, the other friend switches the fish for a doll. When the boy gets home, he is surprised to discover a doll rather than a fish in his bag. His mother calls his friends and they return the fish. For details on scoring procedure, norms, and standardization, see Conlon et al., 2018.

4.2.3.6 ***Detailed transcript analysis*** (DTA)**.**

Following the same procedures as in Conlon et al. (2018), follow-up detailed transcript analysis modeled on Norbury et al. (2014) was conducted. Each index score was calculated by totaling the number of coded items and dividing the total by the number of utterances in the narrative in order to obtain a proportion of utterances containing coded items.

Pragmatic Index. Higher scores on this index indicated a greater proportion of pragmatic errors such as misattributions or irrelevant details.

Semantic Index. This index indicates semantic enrichment; a higher score indicates elaboration of the story such as describing emotions or intentions of characters.

Syntactic Index. Syntactic complexity is demonstrated by utterances that have subordinate clauses such as an adverbial or relative clause. Higher scores indicate greater syntactic complexity.

Formulation Index. Grammatical errors at the word and utterance level are counted in this index. Higher scores indicate more formulation errors.

Codes were also assigned for story macrostructure, which involves dividing the narrative into categories that were essential to a story. Macrostructure includes (A) Story Components and (B) Cohesion and Referencing.

A: Story Components: Settings, Conflict/Resolution, and Conclusion. The important events of the ERRNI Fish Story were divided into categories. "Settings" included utterances that set the stage for the characters and the story (e.g., "The shopkeeper puts the fish in the boy's bag"). The Settings category had 16 elements. Conflict/ Conflict Resolution included utterances about the main conflict of the story and how it was resolved (e.g., "The boy tells his mother that he found a doll in his bag"), and

"Conclusion" refers to how the story wrapped up (e.g., "The boy gets his fish back"). Four elements per category were available for each of Conflict/ Conflict Resolution and Conclusion.

Each participant's narrative was scored according to the presence and completeness of elements listed within each category, according to the scoring key. Points were summed for each category (Settings, Conflict/Conflict Resolution, Conclusion) and divided by the total for that section to produce a proportion, subsequently converted to a percentage.

B) Cohesion and Referencing. Scores for Cohesion and Referencing are global ratings derived from the whole narrative. Cohesion refers to how well the story flowed, whether the major events were emphasized and the story made sense. Referencing is a rating of how well the child referred to the correct characters or events to help reduce confusion. Each narrative received a rating based on the number of mistakes or unclear points.

4.2.4 Analytic Plan.

To determine if there were group and gender differences on the ERRNI, a MANOVA with ERRNI SS (Initial Ideas, Ideas Recall, Comprehension, and MLUw) as DVs and gender and diagnostic group as IVs was run for each age group (i.e., comparing all 8-year-olds separately from all 10-year-olds). Follow up univariate ANOVAs were conducted if MANOVA results were significant. Because effects of gender are of particular interest in this set of studies, and in order to determine if significant gender effects are apparent in both typically developing and ASD groups, if univariate ANOVAs

were significant for gender, follow-up *t*-tests were conducted for the TD group. Gender differences within the group with ASD were previously reported in Chapters 3 and 4.

Data generated from DTA were also analyzed using a MANOVA to examine group and gender differences. DTA index scores (Pragmatic, Semantic, Syntactic, Formulation) were the DVs and gender and diagnostic group were the IVs. Again these were run separately for each age group and follow up univariate ANOVAs and *t*-tests were conducted where warranted. For Story Macrostructure, a MANOVA with story components (settings, conflict/conflict resolution, conclusion, cohesion, referencing) as DVs and gender and group as IVs was run to determine if any differences were present at each age group. Follow up univariate ANOVAs and *t*-tests were also conducted.

To examine if gender and group differences were present on the CASL, a MANOVA with CASL subtest SS (Non-literal language, Inference, Pragmatic Judgment) as DVs and gender and diagnostic group as IVs was run for the 10-year-old participants only, as the 8-year-old participants with ASD were not administered the CASL.

Effect size was calculated using partial eta squared (η_p^2). In general, $\eta_p^2 < 0.06$ is considered to be a small effect, η_p^2 of 0.06 - 0.14 is considered to be a medium effect, and $\eta_p^2 > 0.14$ is considered to be a large effect (Lakens, 2013).

4.3 Results

4.3.1 Considerations of Statistical Analysis.

The number of participants in this study was chosen to match the number of participants with ASD in Conlon et al. (2018), and Conlon, Chapter 3. This limited our sample size to approximately 24 participants per group (12 M, 12 F), as this was what was available for the ASD cohort. Although this might be considered a small sample,

results from Conlon et al. (2018) had large effect sizes even with the small *n,* which demonstrate how substantially different the boys and girls are. Using the means and standard deviations from Conlon et al. (2018), sample size calculations with power set at 0.80 and $\alpha = 0.05$ were run and the results indicated that $n = 12$ (therefore group total of $n = 24$) would be sufficient to examine differences. Although many statistical measures were run on these data, at each point Bonferroni corrections were applied to account for the multiple comparisons. By applying Bonferroni corrections based on the number of comparisons run I was able to reduce the chance of reporting a type I error.

4.3.2 8-Year-Olds.

4.3.2.1 *Standardized narrative test results*.

For the ERRNI at 8-years-old, there was a large statistically significant difference of diagnostic group ($F(4,46) = 8.453$, $p < 0.001$; Wilks' $\Lambda = 0.576$, $\eta_p^2 = 0.42$) but not of gender. There was no significant interaction effect. Follow up ANOVAs for the ERNNI SS were conducted to determine where significant differences were (Table 4.2). Due to the multiple comparisons, a Bonferroni correction was applied and $\alpha \leq 0.0125$ was set as significant. Analysis of Ideas-Initial SS indicated that there was a large main effect of diagnostic group ($F(1) = 17.030$, $p < 0.001$, $\eta_p^2 = 0.258$) (Figure 4.1) where typically developing 8-year-olds had significantly higher scores than 8-year-olds with ASD. For the ERRNI Ideas-Recall SS, there was a large main effect of diagnostic group ($F(1) = 32.427$, $p < 0.001$, $\eta_p^2 = 0.398$) (Figure 4.2) where typically developing 8-year-olds had significantly higher scores than 8-year-olds with ASD. There was no significant difference between diagnostic groups for the ERRNI Comprehension SS (Figure 4.3). For the ERRNI MLUw SS there was a large main effect of diagnostic group ($F(1) = 8.595$, p

= 0.005, η_p^2 = 0.149) (Figure 4.4) where typically developing 8-year-olds had significantly higher scores than 8-year-olds with ASD.

Table 4.2 ERRNI scores of 8-year-olds by diagnostic group

ERRNI Standard Score	TD participants' Mean (*SD*)	ASD participants' Mean (*SD*)	TD Boys' Mean (*SD*)	TD Girls' Mean (*SD*)	ASD Boy's Mean (*SD*)	ASD Girls' Mean (*SD*)	ANOVA and *p* values for diagnostic group
Ideas-Initial	92.41 (16.37)*	76.69 (11.68)*	90.93 (17.14)	94.00 (16.04)	71.00 (7.78)^	82.38 (12.39)^	$F(1) = 17.03$, $p < 0.001$
Ideas-Recall	99.26 (13.92)*	78.12 (13.70)*	98.00 (15.70)	100.62 (12.20)	72.92 (8.70)	83.31 (16.04)	$F(1) = 32.43$, $p < 0.001$
Comprehension	98.30 (11.99)	90.85 (14.56)	97.21 (10.06)	99.46 (14.12)	87.38 (14.39)	94.31 (14.49)	$F(1) = 4.19$, $p = 0.046$
MLUw	102.26 (9.82)*	91.85 (15.76)*	98.93 (8.54)	105.85 (10.15)	91.31 (21.50)	92.38 (7.39)	$F(1) = 8.60$, $p = 0.005$

Note. * = significant diagnostic group difference of $p \leq 0.0125$

^ = significant ASD gender difference of $p \leq 0.0125$, see Conlon et al. 2018.

Figure 4.1 ERRNI Ideas-Initial standard scores in 8-year-olds, by diagnostic group

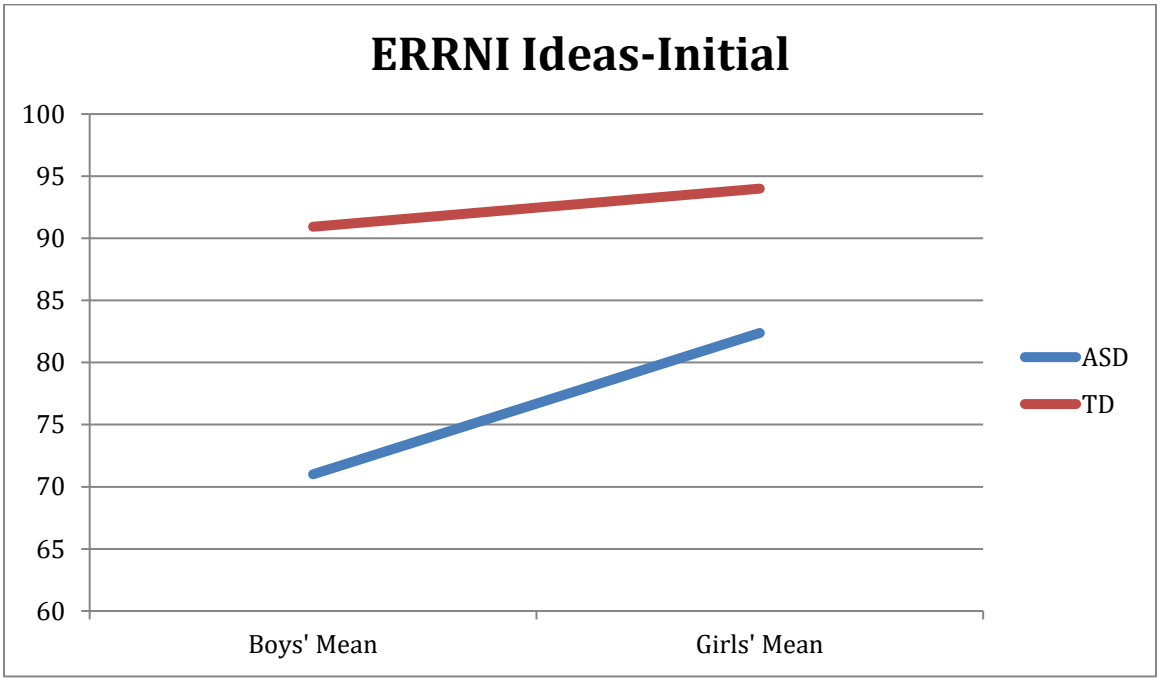


Figure 4.2 ERRNI Ideas-Recall standard scores in 8-year-olds, by diagnostic group

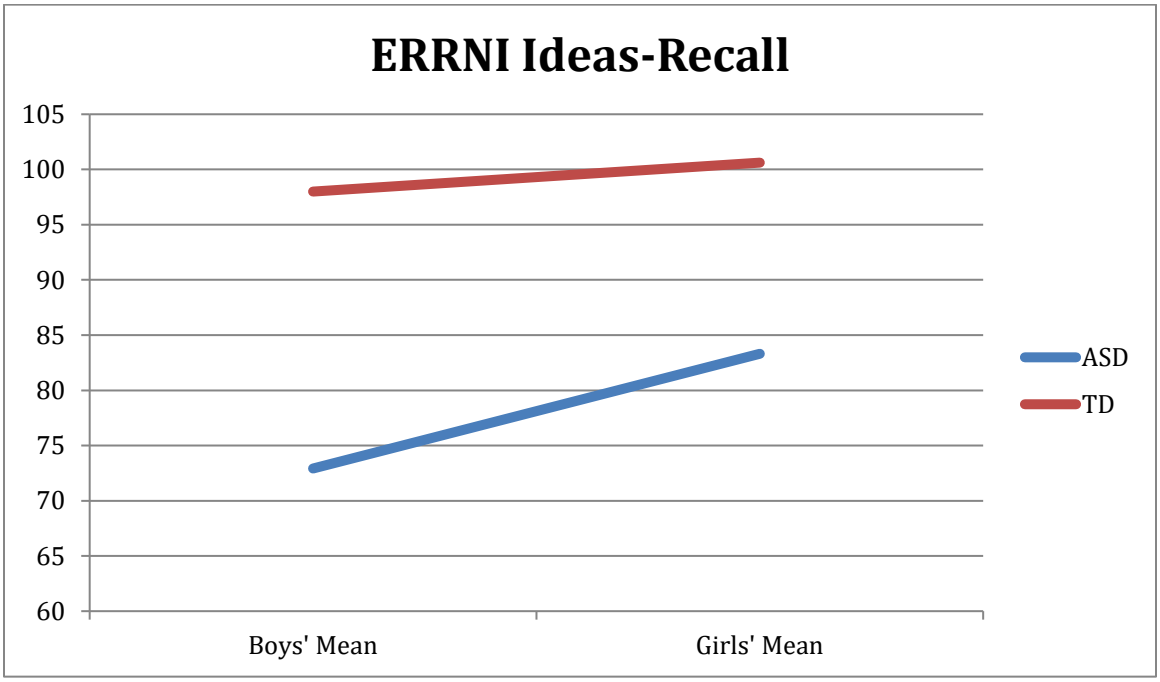


Figure 4.3 ERRNI Comprehension standard scores in 8-year-olds, by diagnostic group

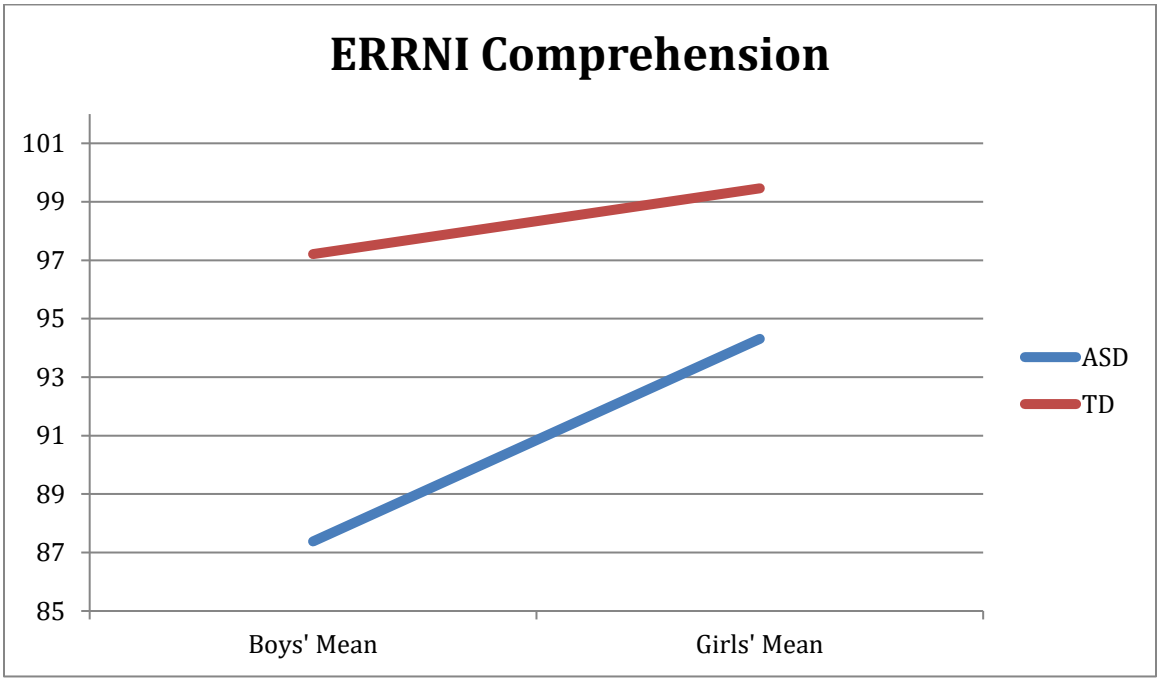
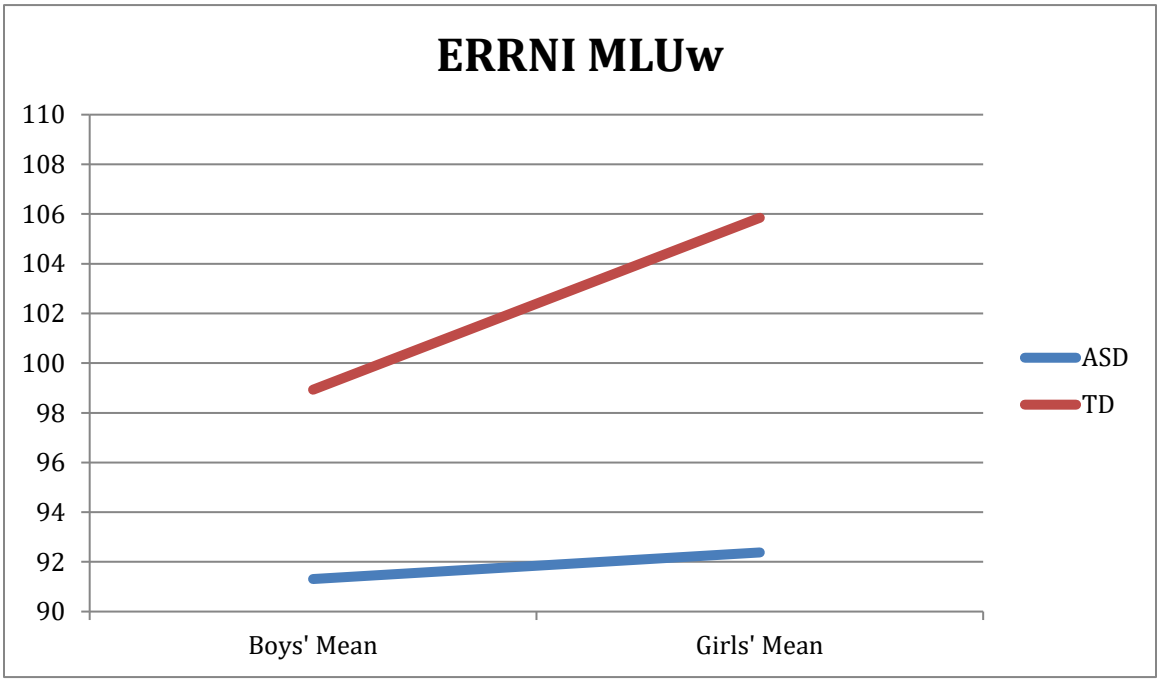


Figure 4.4 ERRNI MLUw standard scores in 8-year-olds, by diagnostic group



4.3.2.2 *Detailed transcript analysis – microstructure.*

Results from the DTA analysis are shown in Table 4.3. There was a large

statistically significant difference of diagnostic group ($F(4,46) = 13.469$, $p < 0.001$; Wilks' $\Lambda = 0.461$, $\eta_p^2 = 0.54$) and of gender ($F(4,46) = 4.549$, $p = 0.004$; Wilks' $\Lambda = 0.717$, $\eta_p^2 = 0.28$). There was no significant interaction effect. Due to the multiple comparisons, a Bonferroni correction was applied and $\alpha \leq 0.0125$ was set as significant. When examining the Pragmatic Index, univariate ANOVAs showed a large main effect of both diagnostic group ($F(1) = 49.68$, $p < 0.001$, $\eta_p^2 = 0.503$) and gender ($F(1) = 11.684$, $p = 0.001$, $\eta_p^2 = 0.193$) (Figure 4.5) where typically developing 8-year-olds had significantly fewer pragmatic errors than 8-year-olds with ASD and girls had significantly fewer errors than boys. There was no significant interaction effect. To further examine the presentation of the gender differences, a *t*-test was run comparing the TD boys and girls on the Pragmatic Index with significance set at $\alpha \leq 0.025$ due to running multiple *t*-tests. Results indicated that there was a large significant difference between the TD boys and girls on the Pragmatic Index ($t(25) = 2.843$, $p = 0.009$, $d = 1.09$) where TD girls had significantly fewer pragmatic errors than TD boys. This is in contrast to the ASD group, where although approaching significance, the Pragmatic Index did not survive correction (see Conlon et al., 2018).

For the Semantic Enhancement Index, there was a large main effect of both diagnostic group ($F(1) = 18.866$, $p < 0.001$, $\eta_p^2 = 0.278$) and gender ($F(1) = 12.093$, $p = 0.001$, $\eta_p^2 = 0.198$) (Figure 4.6) where typically developing 8-year-olds enhanced their stories significantly more than 8-year-olds with ASD and girls enhanced their stories significantly more than boys. There was no significant interaction effect. TD girls and boys were not significantly different on this index, in contrast to our previous findings in ASD (Conlon et al., 2018). For the Syntactic Complexity Index (Figure 4.7) there were

no main effects of diagnostic group or gender and there was no significant interaction effect. For the Formulation Index there was a large main effect of diagnostic group ($F(1) = 8.619$, $p = 0.005$, $\eta_p^2 = 0.150$) but not of gender (Figure 4.8) where typically developing 8-year-olds avoided formulation errors significantly more than 8-year-olds with ASD. There was no significant interaction effect.

Table 4.3 DTA scores of 8-year-olds by diagnostic group and gender

DTA	TD participants' Mean (*SD*)	ASD participants' Mean (*SD*)	TD Boys' Mean (*SD*)	TD Girls' Mean (*SD*)	ASD Boys' Mean (*SD*)	ASD Girls' Mean (*SD*)	ANOVA and *p* values for diagnostic group	ANOVA and *p* values for gender	*t*-test and *p* values for gender in TD group
Pragmatic Index*	0.35 (0.19)	0.77 (0.28)	0.44 (0.15)$^{+}$	0.26 (0.18)$^{+}$	0.89 (0.23)	0.66 (0.30)	$F(1) = 49.68$, $p < 0.001$	$F(1) = 11.68$, $p = 0.001$	$t(25) = 2.84$, $p = 0.009$
Semantic Index*	0.35 (0.12)	0.20 (0.16)	0.31 (0.11)	0.39 (0.12)	0.11 (0.09)$^{\wedge}$	0.28 (0.18)$^{\wedge}$	$F(1) = 18.87$, $p < 0.001$	$F(1) = 12.09$, $p = 0.001$	$t(25) = 1.65$, $p = 0.111$
Syntactic Complexity Index	0.18 (0.13)	0.12 (0.10)	0.14 (0.19)	0.21 (0.17)	0.10 (0.11)	0.14 (0.09)	$F(1) = 3.40$, $p = 0.071$	$F(1) = 2.93$, $p = 0.093$	N/A

Formulation Index	0.50 (0.17)*	0.70 (0.30)*	0.51 (0.18)	0.49 (0.17)	0.78 (0.33)	0.62 (0.26)	$F(1) = 8.62$, $p = 0.005$	$F(1) = 1.89$, $p = 0.176$	N/A

Note. * = significant difference of $p \leq 0.0125$

$^{+}$ = significant difference of $p \leq 0.025$

^ = significant ASD gender difference of $p \leq 0.0125$, see Chapter 4

Figure 4.5 DTA Pragmatic Index scores in 8-year-olds, by diagnostic group

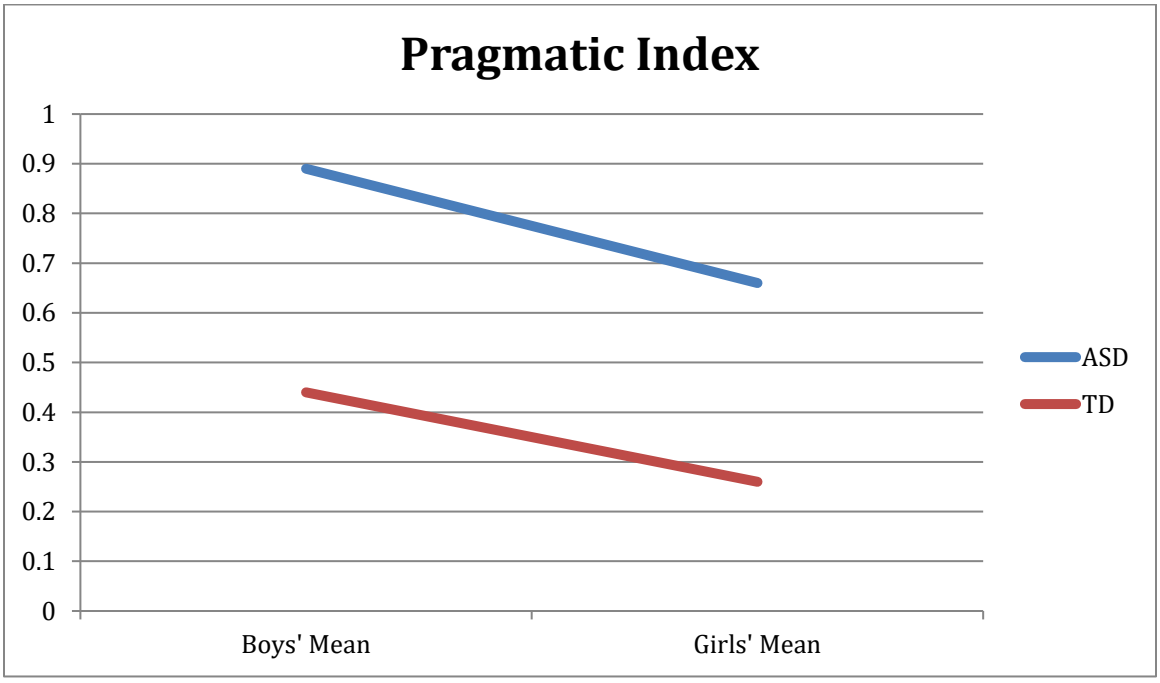


Figure 4.6 DTA Semantic Index scores in 8-year-olds, by diagnostic group

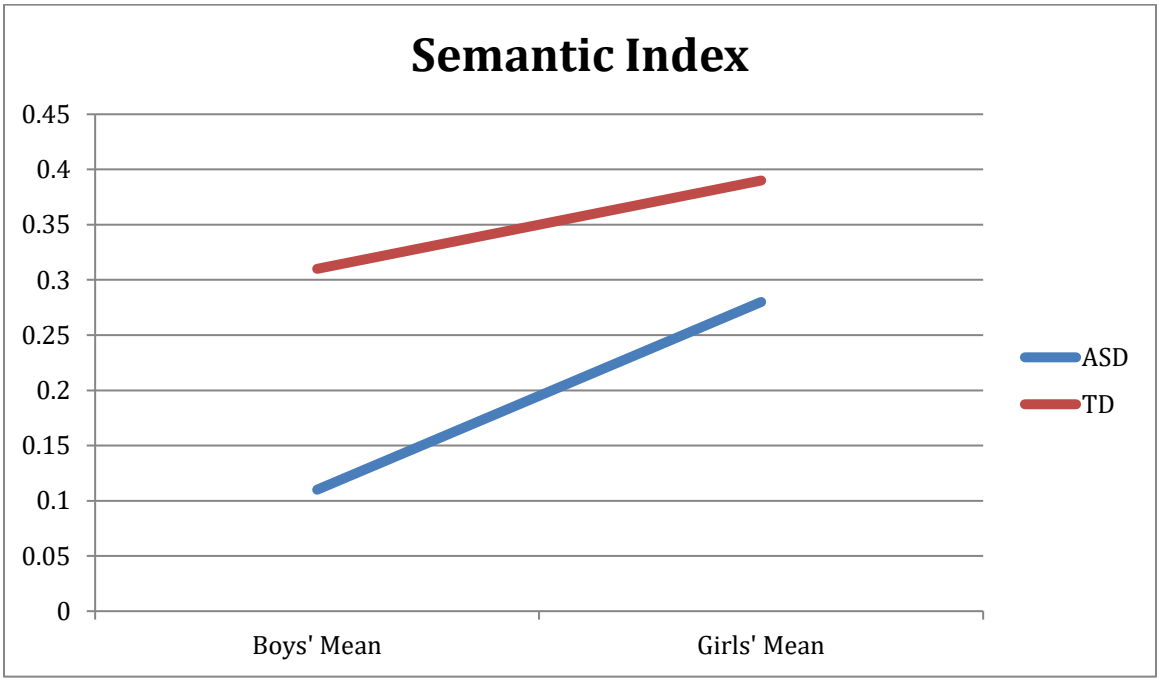


Figure 4.7 DTA Syntactic Complexity Index scores in 8-year-olds, by diagnostic group

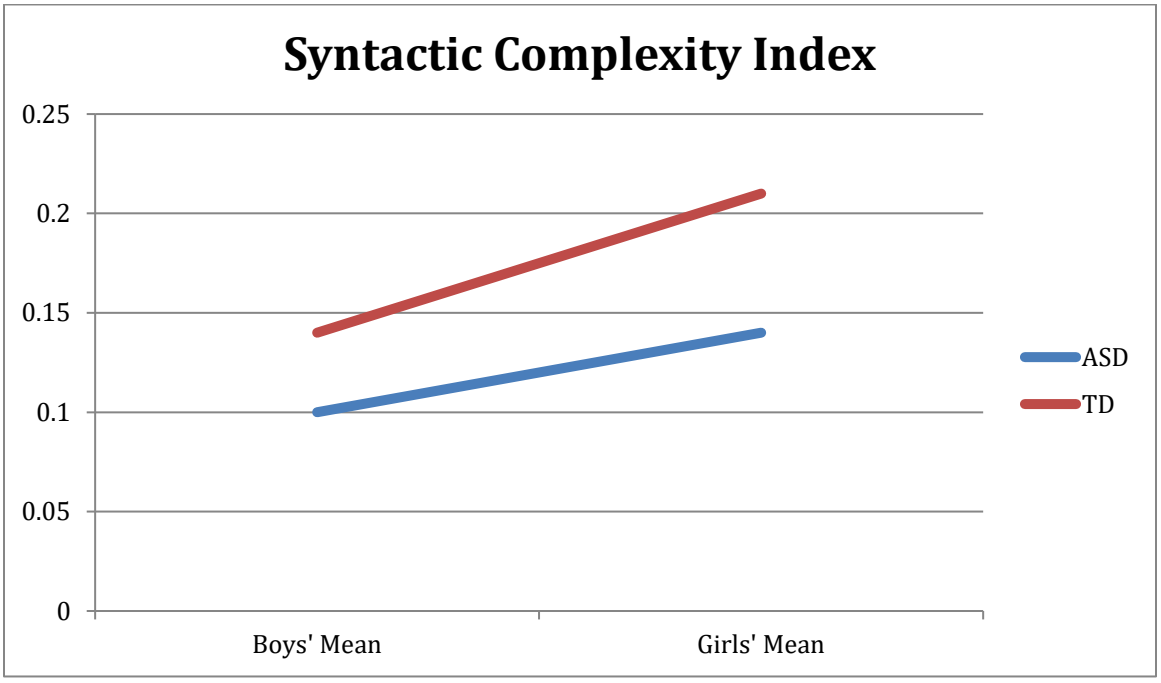
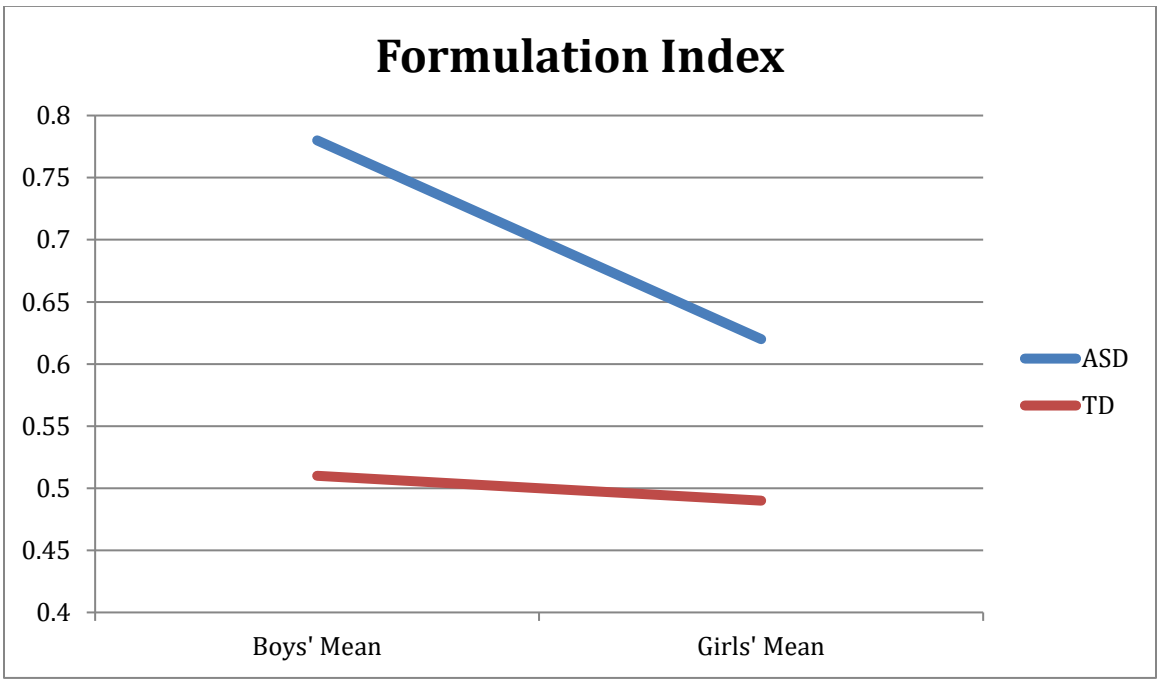


Figure 4.8 DTA Formulation Index scores in 8-year-olds, by diagnostic group



4.3.2.3 *Detailed transcript analysis – macrostructure.*

For story macrostructure, as shown in Table 4.4, there was a large statistically

significant difference of diagnostic group ($F(5,45) = 13.444$, $p < 0.001$; Wilks' $\Lambda = 0.401$, $\eta_p^2 = 0.60$) and of gender ($F(5,45) = 2.862$, $p = 0.025$; Wilks' $\Lambda = 0.759$, $\eta_p^2 = 0.24$). There was no significant interaction effect. Due to the multiple comparisons in the follow up ANOVAs, a Bonferroni correction was applied and $\alpha \leq 0.01$ was set.

Main effects for group were found for all of the macrostructure categories: Settings, Referencing, Conflict/Conflict Resolution, Cohesion, and Conclusion. Main effects for gender were found only found on the Referencing category. There were no significant interaction effects. The Settings category showed a large main effect of diagnostic group ($F(1) = 11.538$, $p = 0.001$, $\eta_p^2 = 0.191$) but not gender (Figure 4.9) where typically developing 8-years-olds had significantly more story elements than 8-year-olds with ASD. For the Referencing category there was a large main effect of both diagnostic group ($F(1) = 8.183$, $p = 0.006$, $\eta_p^2 = 0.143$) and gender ($F(1) = 8.648$, $p = 0.005$, $\eta_p^2 = 0.150$) (Figure 4.10) where typically developing 8-year-olds had significantly fewer referencing errors than 8-year-olds with ASD and girls had significantly fewer errors than boys. To further examine the presentation of the gender differences, a *t*-test was run comparing the TD boys and girls on the Referencing category. Results indicated that there was no significant difference between the TD boys and girls on the Referencing category, so the significant gender difference was driven by the previously described (Conlon et al., 2018) differences in ASD. For the Conflict/Conflict Resolution category there was a large main effect of diagnostic group ($F(1) = 27.362$, $p < 0.001$, $\eta_p^2 = 0.358$) but not of gender (Figure 4.11) where typically developing 8-year-olds had significantly more conflict/conflict resolution story elements than 8-year-olds with ASD. For the Cohesion category there was a large main effect of diagnostic group ($F(1) = 27.115$, $p <$

0.001, $\eta_p^2 = 0.357$) but not of gender (Figure 4.12) where typically developing 8-year-olds made significantly fewer cohesive errors compared to 8-year-olds with ASD. For the Conclusion category of story macrostructure there was a large main effect of diagnostic group ($F(1) = 25.206$, $p < 0.001$, $\eta_p^2 = 0.340$) but not of gender (Figure 4.13) where typically developing 8-year-olds included significantly more conclusion story elements than 8-year-olds with ASD.

Table 4.4 Story Macrostructure scores of 8-year-olds by diagnostic group and gender

Story macrostructure component	TD participants' Mean (*SD*)	ASD participants' Mean (*SD*)	TD Boys' Mean (*SD*)	TD Girls' Mean (*SD*)	ASD Boys' Mean (*SD*)	ASD Girls' Mean (*SD*)	ANOVA and *p* values for diagnostic group	ANOVA and *p* values for gender	*t*-test and *p* values for gender in TD group
Settings (percent correct)	56.81 (12.59)*	43.23 (16.44)*	56.79 (12.21)	56.85 (13.48)	38.85 (14.76)	47.62 (17.42)	$F(1) = 11.54$, $p = 0.001$	$F(1) = 1.28$, $p = 0.275$	N/A
Referencing (number of errors)*	1.37 (1.33)	2.54 (1.90)	1.57 (1.34)	1.15 (1.34)	3.54 (1.76)^	1.54 (1.51)^	$F(1) = 8.18$, $p = 0.006$	$F(1) = 8.65$, $p = 0.005$	$t(25) = 0.81$, $p = 0.427$
Conflict/Conflict Resolution (percent	48.00 (15.40)*	29.00 (11.49)*	43.21 (13.44)	53.15 (16.21)	27.31 (6.02)	30.69 (15.25)	$F(1) = 27.36$, $p < 0.001$	$F(1) = 3.30$, $p = 0.075$	N/A

correct)									
Cohesion (number of errors)	2.33 (0.92)*	3.81 (1.10)*	2.36 (0.93)	2.31 (0.95)	3.77 (0.93)	3.85 (1.28)	$F(1) = 27.12, p < 0.001$	$F(1) = 0.002, p = 0.961$	N/A
Conclusion (percent correct)	41.67 (9.19)*	25.50 (13.92)*	43.21 (11.70)	40.00 (5.39)	22.15 (10.07)	28.85 (16.66)	$F(1) = 25.206, p < 0.001$	$F(1) = 0.29, p = 0.590$	N/A

Note. * = significant difference of $p \leq 0.01$

^ = significant ASD gender differences of $p \leq 0.01$, see Conlon et al. 2018.

Figure 4.9 Story Macrostructure percentage of correct elements in Settings category in 8-year-olds, by diagnostic group

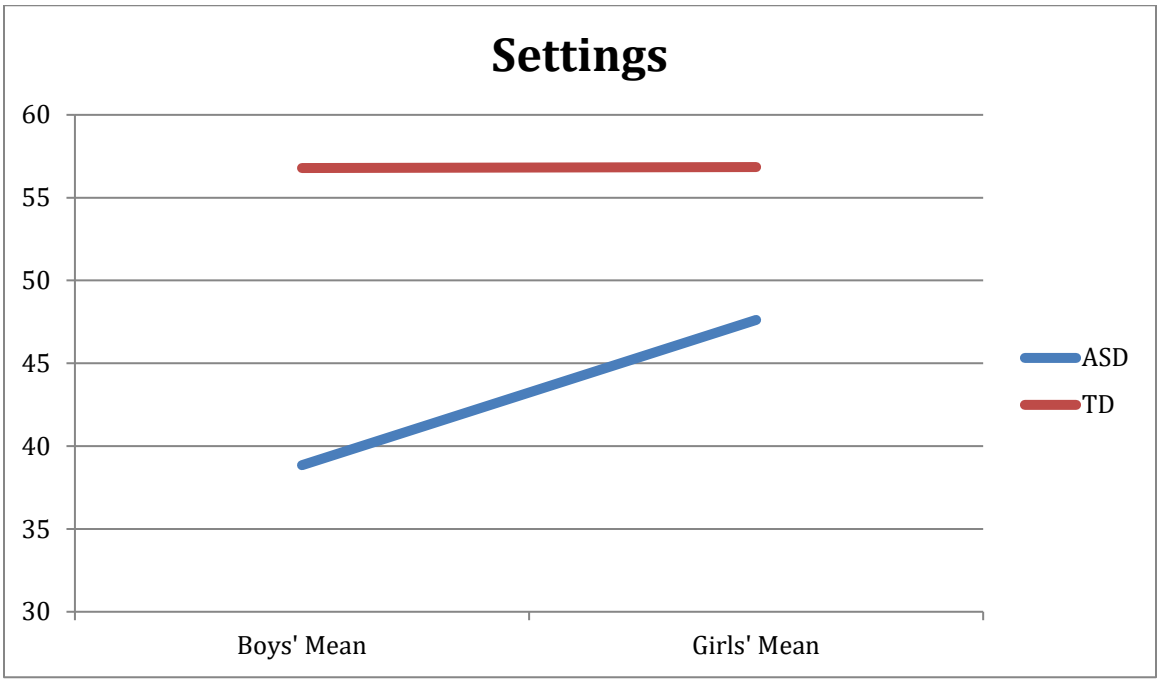


Figure 4.10 Story Macrostructure number of errors in Referencing category in 8-year-olds, by diagnostic group

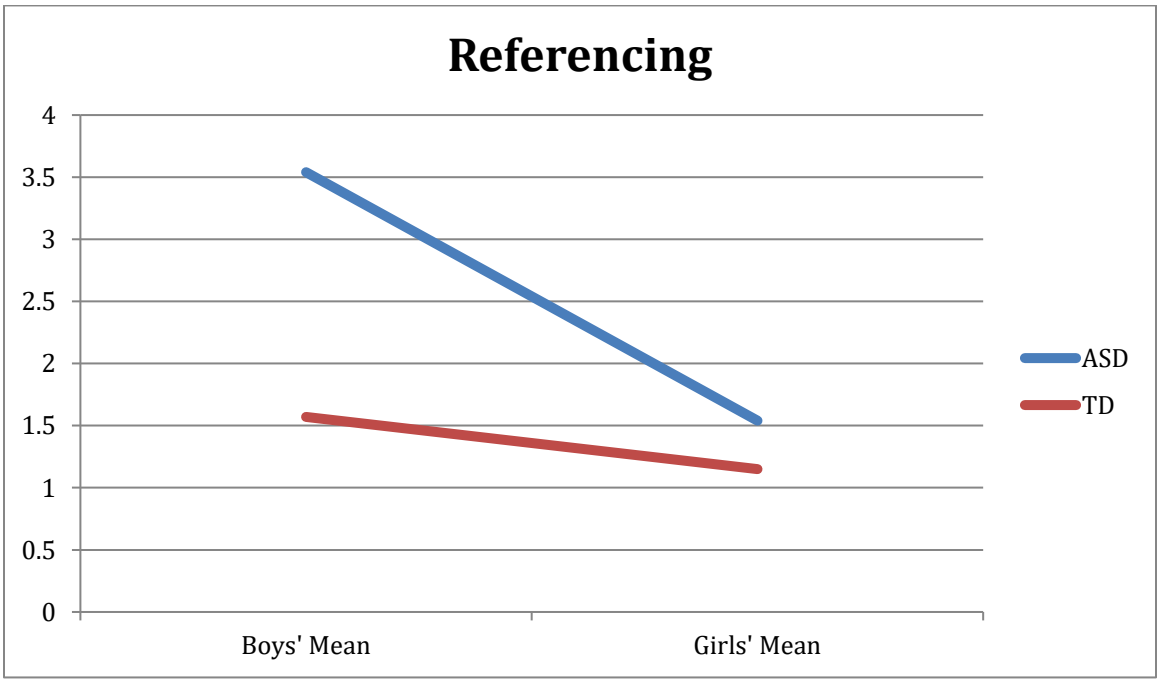


Figure 4.11 Story Macrostructure percentage of correct elements in Conflict/Conflict Resolution category in 8-year-olds, by diagnostic group

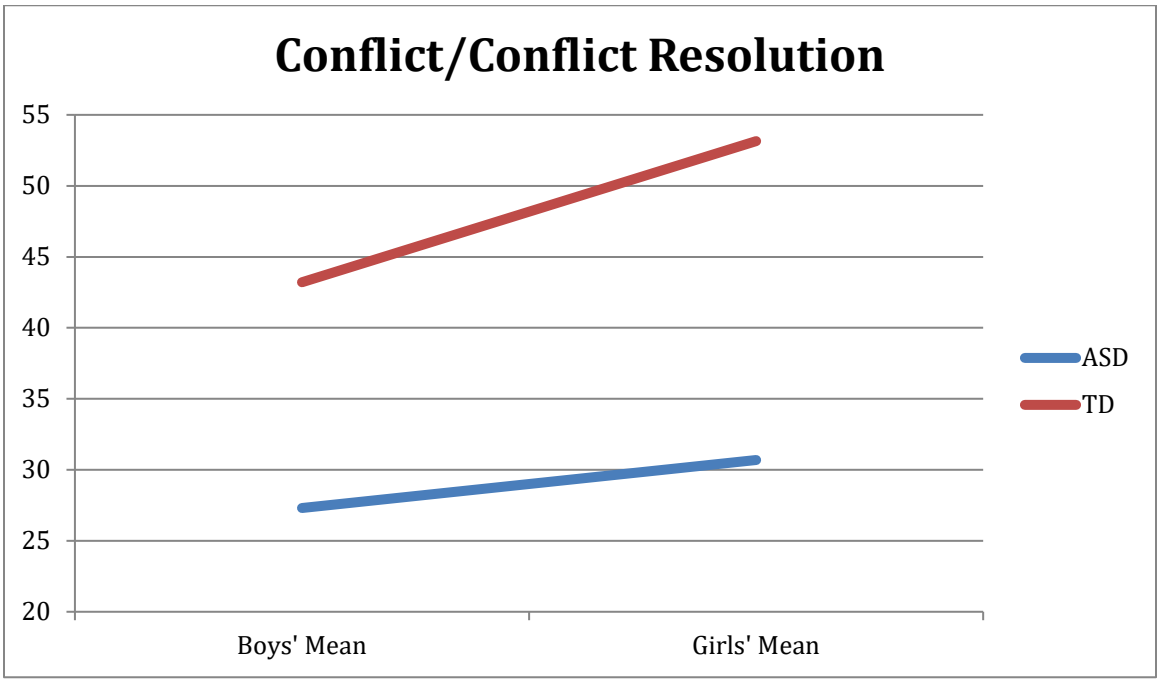


Figure 4.12 Story Macrostructure number of errors in Cohesion category in 8-year-olds, by diagnostic group

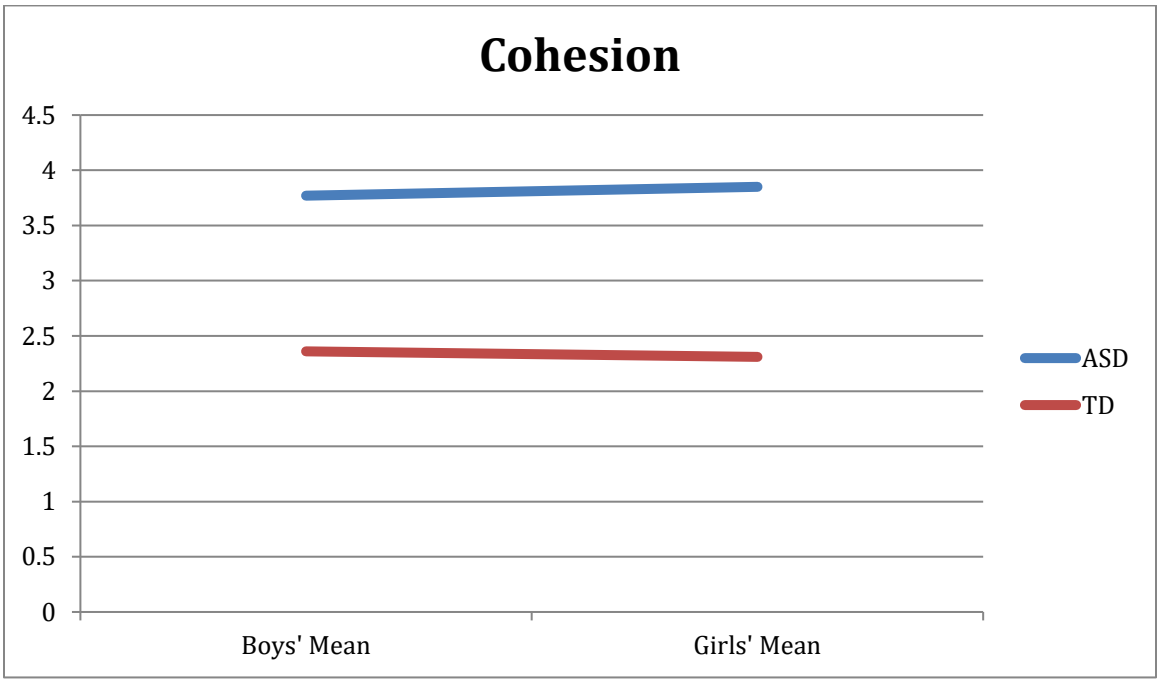
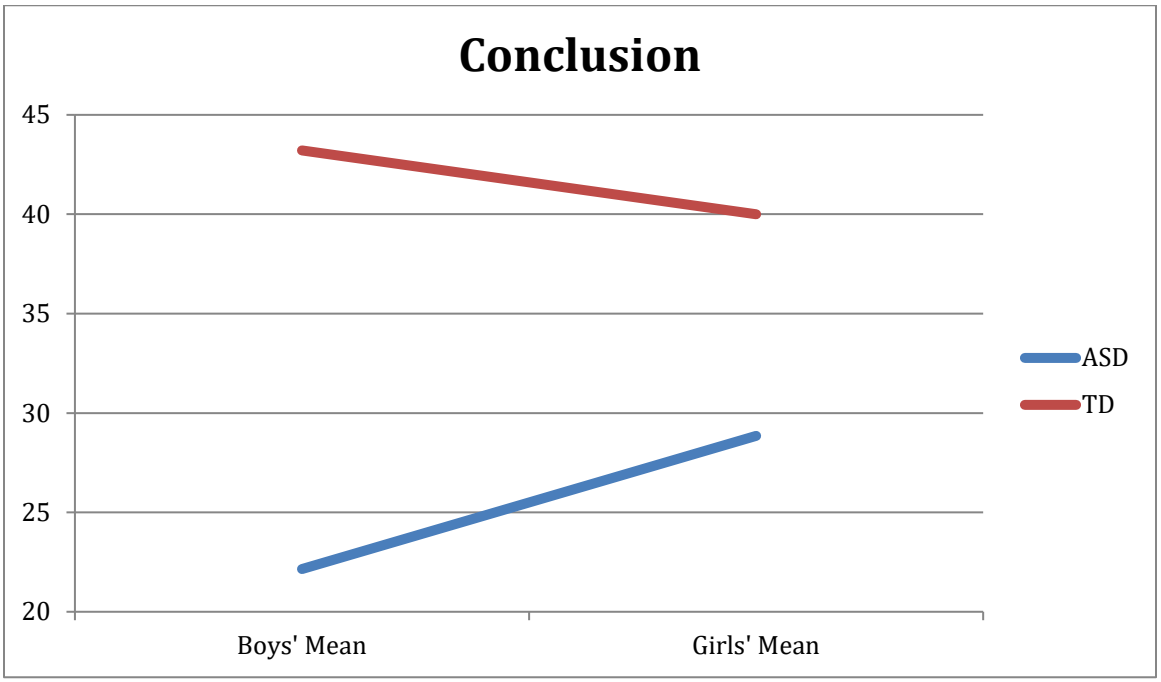


Figure 4.13 Story Macrostructure percentage of correct elements in Conclusion category in 8-year-olds, by diagnostic group



4.3.3 10-Year-Olds.

4.3.3.1 *Standardized narrative test results*.

When examining the ERRNI, in the 10-year-old cohort, there was a large statistically significant difference of diagnostic group ($F(4,36) = 7.882$, $p < 0.001$; Wilks' $\Lambda = 0.533$, $\eta_p^2 = 0.47$) but not for gender. There was no significant interaction effect. Due to the multiple comparisons of the follow up ANOVAs, a Bonferroni correction was applied and $\alpha \leq 0.0125$ was set as significant. Results are shown in Table 4.5. Follow up univariate ANOVAs revealed a large group difference ($F(1) = 26.90$, $p < 0.001$, $\eta_p^2 = 0.408$) on the Ideas-Initial SS (Figure 4.14) where typically developing 10-year-olds had significantly higher standard scores than 10-year-olds with ASD. For the ERRNI Ideas-Recall SS, there as a large main effect of diagnostic group ($F(1) = 27.090$, $p < 0.001$, $\eta_p^2 = 0.410$) (Figure 4.15) where typically developing 10-year-olds had significantly higher

standard scores than 10-year-olds with ASD. For the ERRNI Comprehension (Figure 4.16) and MLUw (Figure 4.17) SS, the groups were not significantly different.

Table 4.5 ERRNI scores of 10-year-olds by diagnostic group and gender

ERRNI Standard Score	TD participants' Mean (*SD*)	ASD participants' Mean (*SD*)	TD Boys' Mean (*SD*)	TD Girls' Mean (*SD*)	ASD Boys' Mean (*SD*)	ASD Girls' Mean (*SD*)	ANOVA and *p* values for diagnostic group
Ideas-Initial	102.57 (9.28)*	85.75 (14.50)*	99.73 (12.11)	105.17 (4.86)	77.78 (12.61)^	92.27 (12.96)^	$F(1) = 26.90$, $p < 0.001$
Ideas-Recall	100.00 (8.70)*	84.50 (12.44)*	101.27 (9.40)	98.83 (8.23)	78.44 (13.65)	89.45 (9.21)	$F(1) = 27.09$, $p < 0.001$
Comprehension	99.17 (13.41)	90.65 (18.32)	98.27 (13.08)	100.00 (14.23)	89.44 (25.55)	91.64 (10.62)	$F(1) = 2.98$, $p = 0.092$
MLUw	102.04 (9.16)	99.35 (15.83)	98.27 (8.21)	105.50 (8.90)	99.78 (20.80)	99.00 (11.38)	$F(1) = 0.41$, $p = 0.525$

Note. * = significant difference of $p \leq 0.0125$

^ = significant ASD gender difference of $p \leq 0.0125$, see Chapter 3.

Figure 4.14 ERRNI Ideas-Initial standard scores in 10-year-olds, by diagnostic group

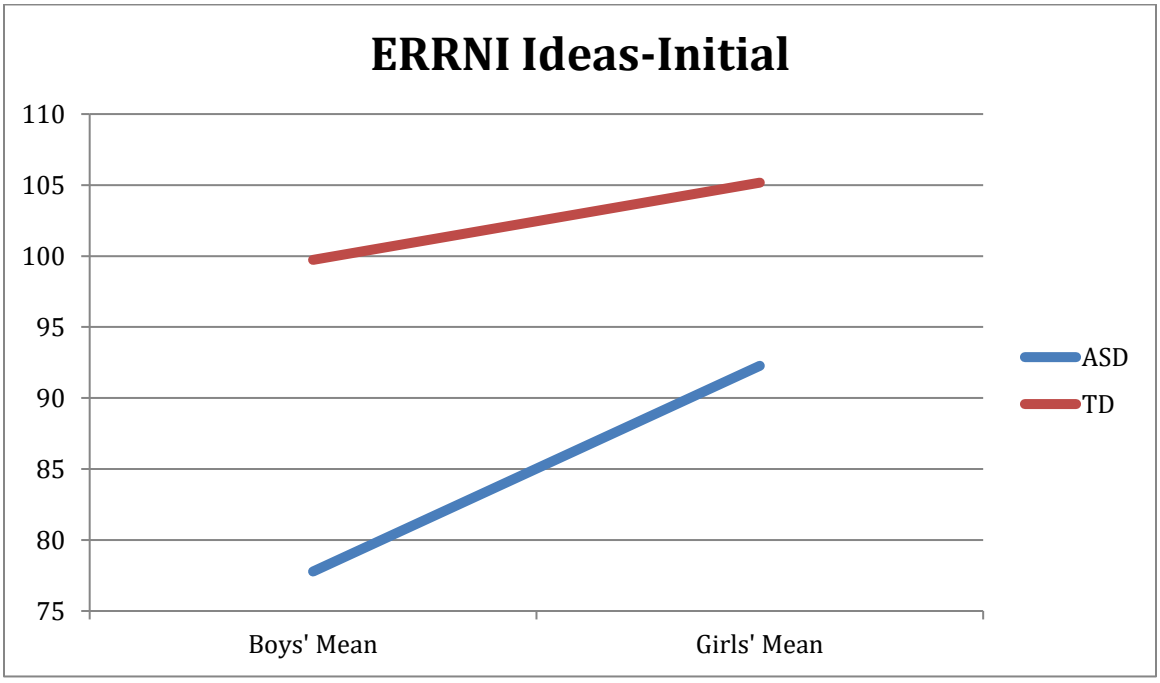


Figure 4.15 ERRNI Ideas-Recall standard scores in 10-year-olds, by diagnostic group

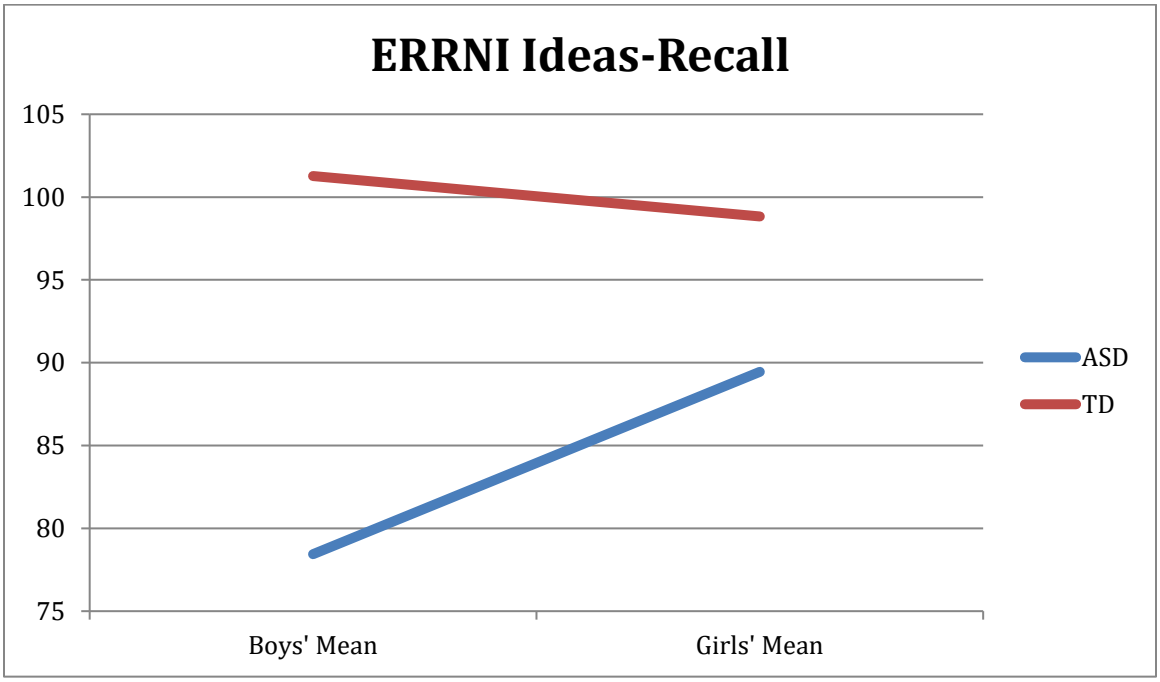


Figure 4.16 ERRNI Comprehension standard scores in 10-year-olds, by diagnostic group

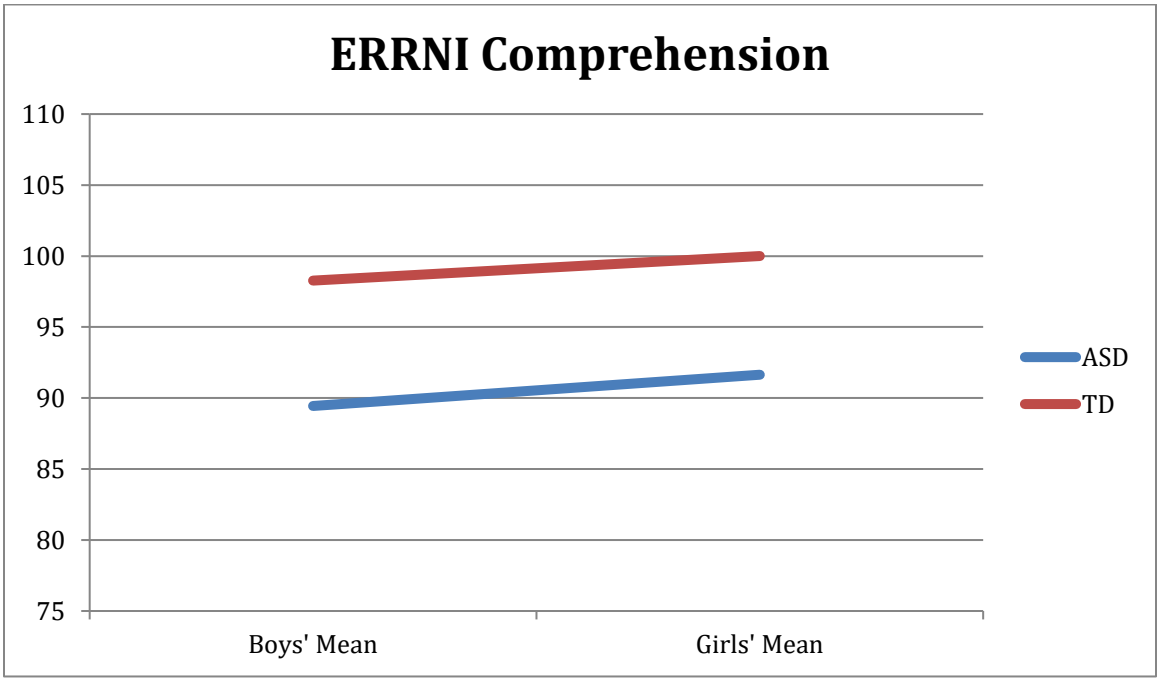
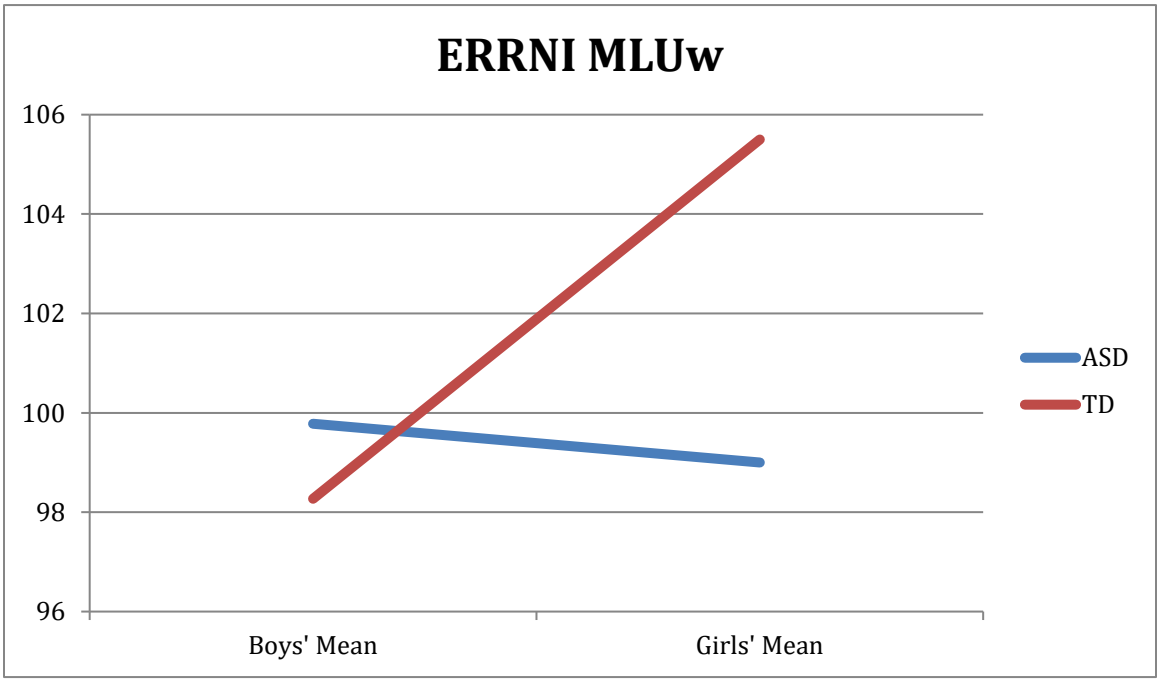


Figure 4.17 ERRNI MLUw standard scores in 10-year-olds, by diagnostic group



4.3.3.2 *Detailed transcript analysis – microstructure.*

When examining microstructure, as shown on Table 4.6, MANOVA results reveal a large statistically significant difference of diagnostic group ($F(4,36) = 12.114$, $p < 0.001$; Wilks' $\Lambda = 0.440$, $\eta_p^2 = 0.56$) and of gender ($F(4,36) = 8.604$, $p < 0.001$; Wilks' $\Lambda = 0.525$, $\eta_p^2 = 0.48$). There was no significant interaction effect. Due to the multiple comparisons of the follow up ANOVAs, a Bonferroni correction was applied and $\alpha \leq 0.0125$ was set as significant. The Pragmatic Index showed a large main effect of both diagnostic group ($F(1) = 17.297$, $p < 0.001$, $\eta_p^2 = 0.297$) and gender ($F(1) = 17.856$, $p < 0.001$, $\eta_p^2 = 0.303$) (Figure 4.18) where typically developing 10-year-olds had significantly fewer pragmatic errors than 10-year-olds with ASD and girls had significantly fewer errors than boys. There was no significant interaction effect. To further examine the presentation of the gender differences, a *t*-test was run comparing the TD boys and girls on the Pragmatic Index. An alpha level of $\alpha \leq 0.025$ was set as significant for the *t*-tests. Results indicated that there was a large statistically significant difference between the TD boys and girls on the Pragmatic Index ($t(22) = 2.753$, $p = 0.012$, $d = 1.12$) where TD girls had significantly fewer pragmatic errors than TD boys. These findings are in line with what was seen in the 10-year-old ASD cohort, where girls with ASD had significantly fewer pragmatic errors than boys with ASD (see Chapter 3).

For the Semantic Enhancement Index, there as a large main effect of both diagnostic group ($F(1) = 24.885$, $p < 0.001$, $\eta_p^2 = 0.378$) and gender ($F(1) = 15.935$, $p < 0.001$, $\eta_p^2 = 0.280$) (Figure 4.19) where typically developing 10-year-olds enhanced their stories significantly more than 10-year-olds with ASD and girls enhanced their stories significantly more than boys. There was no significant interaction effect. Follow up *t*-

tests for the TD group revealed a large statistically significant difference between the boys and the girls *(t(*22) = 2.607, p = 0.016, d = 1.06) where TD girls enhanced their stories significantly more than TD boys. This is consistent for what was seen in the ASD sample, as there was a significant gender difference between the participants with ASD on this index (Chapter 3). For the Syntactic Complexity (Figure 4.20) and Formulation (Figure 4.21) Indices there were no main effects of diagnostic group or gender, and there were no significant interaction effects.

Table 4.6 DTA scores of 10-year-olds by diagnostic group and gender

DTA	TD participants' Mean (*SD*)	ASD participants' Mean (*SD*)	TD Boys' Mean (*SD*)	TD Girls' Mean (*SD*)	ASD Boys' Mean (*SD*)	ASD Girls' Mean (*SD*)	ANOVA and *p* values for diagnostic group	ANOVA and *p* values for gender	*t*-test and *p* values for gender in TD group
Pragmatic Index*	0.24 (0.18)	0.50 (0.30)	0.33 (0.21)+	0.15 (0.09) +	0.68 (0.20) ^	0.33 (0.29) ^	$F(1) = 17.30$, $p < 0.001$	$F(1) = 17.86$, $p < 0.001$	$t(22) = 2.75$, $p = 0.012$
Semantic Index*	0.44 (0.13)	0.30 (0.08)	0.38 (0.13) +	0.50 (0.11) +	0.25 (0.05) ^	0.35 (0.07) ^	$F(1) = 24.89$, $p < 0.001$	$F(1) = 15.94$, $p < 0.001$	$t(22) = 2.61$, $p = 0.016$
Syntactic Complexity Index	0.24 (0.10)	0.25 (0.19)	0.21 (0.13)	0.26 (0.06)	0.19 (0.18)	0.30 (0.19)	$F(1) = 0.04$, $p = 0.839$	$F(1) = 3.42$, $p = 0.072$	N/A
Formulation Index	0.42 (0.14)	0.54 (0.23)	0.48 (0.15)	0.37 (0.11)	0.62 (0.21)	0.47 (0.24)	$F(1) = 5.29$, $p = 0.027$	$F(1) = 5.78$, $p = 0.021$	N/A

Note. * = significant difference of $p \leq 0.0125$

$^{+}$ = significant difference of $p \leq 0.025$

^ = significant ASD gender difference of $p \leq 0.0125$, see Chapter 3.

Figure 4.18 DTA Pragmatic Index scores in 10-year-olds, by diagnostic group

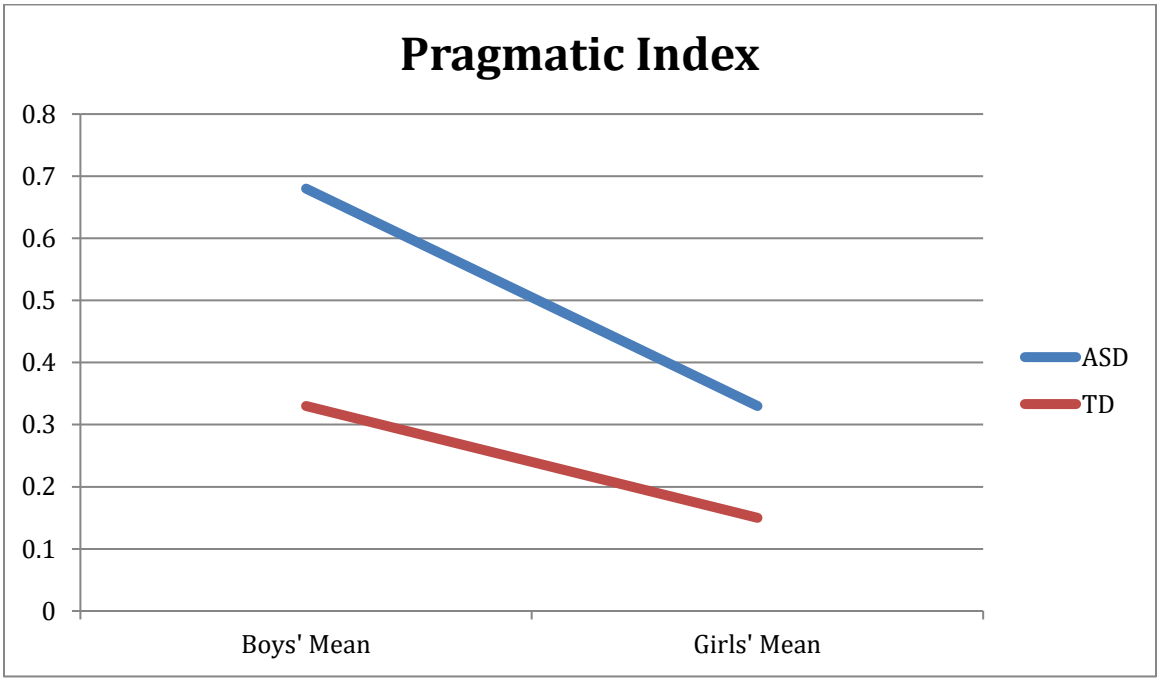


Figure 4.19 DTA Semantic Index scores in 10-year-olds, by diagnostic group

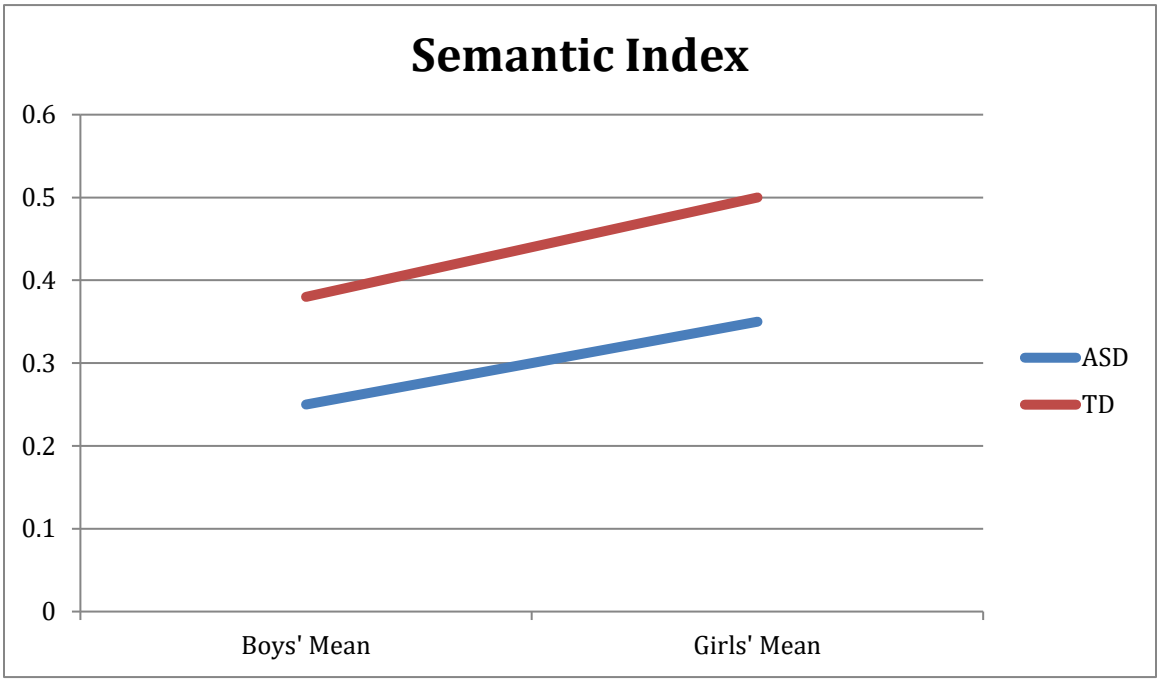


Figure 4.20 DTA Syntactic Complexity Index scores in 10-year-olds, by diagnostic group

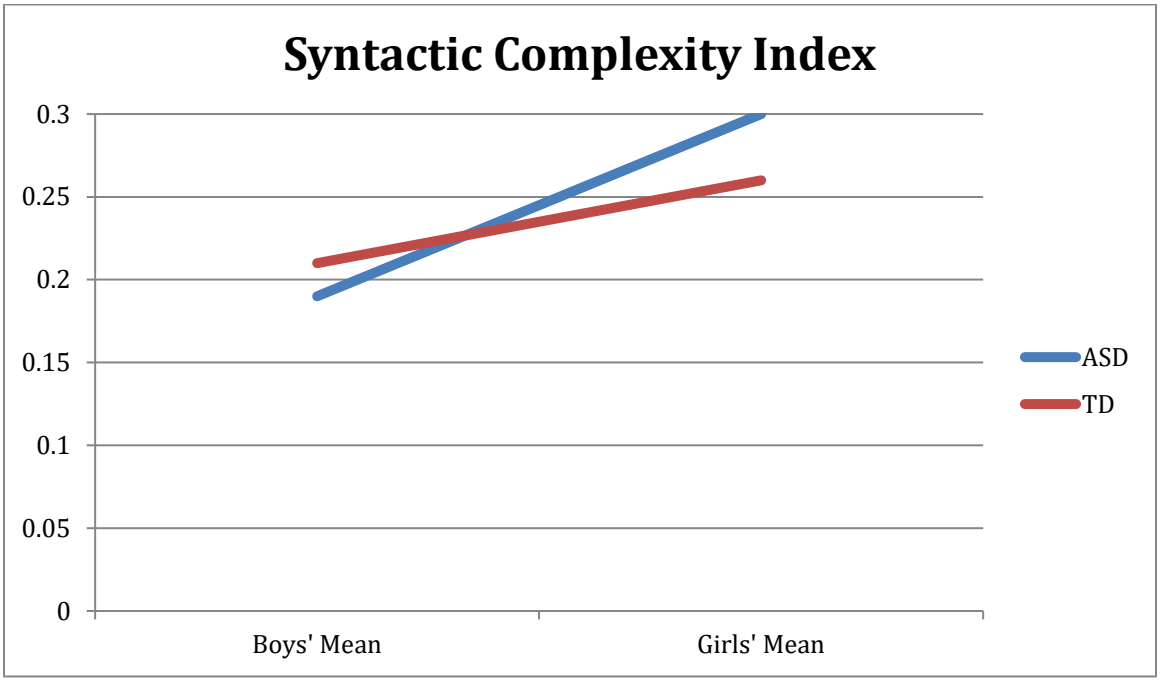
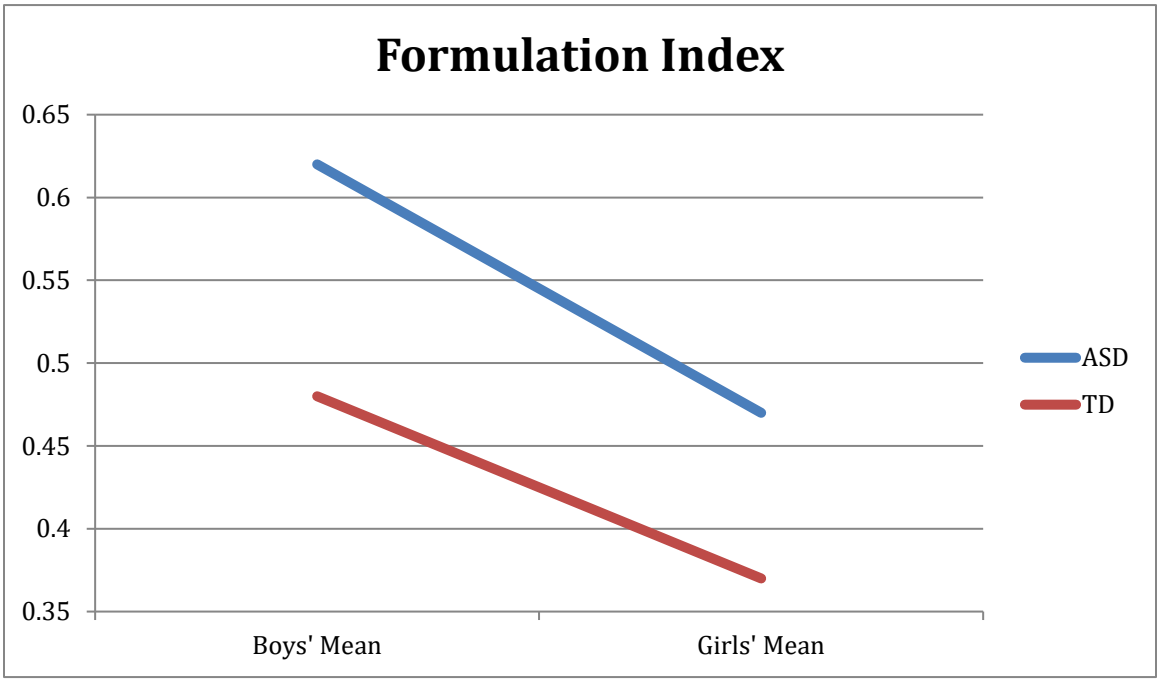


Figure 4.21 DTA Formulation Index scores in 10-year-olds, by diagnostic group



4.3.3.3 *Detailed transcript analysis – macrostructure.*

Main effects for group were found for the following macrostructure categories: Settings, Conflict/Conflict Resolution, and Cohesion. Main effects for gender were found only found on the Referencing category, and there were no main effects of either group or gender on the Conclusion category. There were no significant interaction effects (Table 4.7). The Settings category showed a large main effect of diagnostic group ($F(1) = 39.157$, $p < 0.001$, $\eta_p^2 = 0.489$) but not gender (Figure 4.22) where typically developing 10-year-olds had significantly more setting story elements than 10-year-olds with ASD. For the Referencing category there was a large main effect of gender ($F(1) = 22.691$, $p < 0.001$, $\eta_p^2 = 0.356$) but not of diagnosis (Figure 4.23) where girls had significantly fewer errors than boys. Follow up *t*-tests for the TD group revealed a large statistically significant differences between the boys and the girls on this index *(t(*22) = 2.555, $p = 0.018$, $d = 1.04$) where TD girls made significantly fewer referencing errors than TD boys. This is in keeping with previous findings from the 10-year-old ASD sample, where significant gender differences were seen on this index. For the Conflict/Conflict Resolution category there was a large main effect of diagnostic group ($F(1) = 17.903$, $p < 0.001$, $\eta_p^2 = 0.304$) but not of gender (Figure 4.24) where typically developing 10-year-olds had significantly more conflict/conflict resolution story elements than 10-year-olds with ASD. For the Cohesion category there was a large main effect of diagnostic group ($F(1) = 41.390$, $p < 0.001$, $\eta_p^2 = 0.502$) but not of gender (Figure 4.25) where typically developing 10-year-olds made significantly fewer cohesive errors compared to 10-year-olds with ASD. For the Conclusion category (Figure 4.26) of story macrostructure there was no significant effect of diagnostic group or gender.

Table 4.7 Story Macrostructure scores of 10-year-olds by diagnostic group and gender

Story macrostructure component	TD participants' Mean (*SD*)	ASD participants' Mean (*SD*)	TD Boys' Mean (*SD*)	TD Girls' Mean (*SD*)	ASD Boys' Mean (*SD*)	ASD Girls' Mean (*SD*)	MANOVA and *p* values for diagnostic group	MANOVA and *p* values for gender	*t*-test and *p* values for gender in TD group
Settings (percent correct)	60.96 (7.80)*	39.71 (15.11)*	59.33 (7.14)	62.58 (8.40)	34.60 (12.24)	44.36 (16.49)	$F(1) = 39.16$, $p < 0.001$	$F(1) = 3.59$, $p = 0.065$	N/A
Referencing (number of errors)	1.29 (1.33)	2.10 (1.73)	1.92 (1.44)*+	0.67 (0.89)*+	3.30 (1.25)*^	1.00 (1.34)*^	$F(1) = 5.31$, $p = 0.026$	$F(1) = 22.69$, $p < 0.001$	($t(22) = 2.555$, $p = 0.018$)
Conflict/Conflict Resolution (percent correct)	52.00 (13.51)*	32.81 (18.06)*	48.33 (15.68)	55.67 (10.31)	26.80 (9.95)	38.27 (22.23)	$F(1) = 17.90$, $p < 0.001$	$F(1) = 4.18$, $p = 0.047$	N/A

Cohesion (number of errors)	1.21 (0.88)*	3.14 (1.28)*	1.50 (0.91)	0.92 (0.79)	3.70 (0.82)	2.64 (1.43)	$F(1) = 41.39$, $p < 0.001$	$F(1) = 7.31$, $p = 0.010$	N/A
Conclusion (percent correct)	42.63 (13.26)	32.62 (15.40)	37.67 (11.80)	47.58 (13.22)	32.80 (12.78)	32.45 (18.09)	$F(1) = 5.59$, $p = 0.023$	$F(1) = 1.28$, $p = 0.264$	N/A

Note. * = significant difference of $p \leq 0.01$

$^{+}$ = significant difference of $p \leq 0.05$

^ = significant ASD gender difference of $p \leq 0.01$, see Chapter 3.

Figure 4.22 Story Macrostructure percentage of correct elements in Settings category in 10-year-olds, by diagnostic group

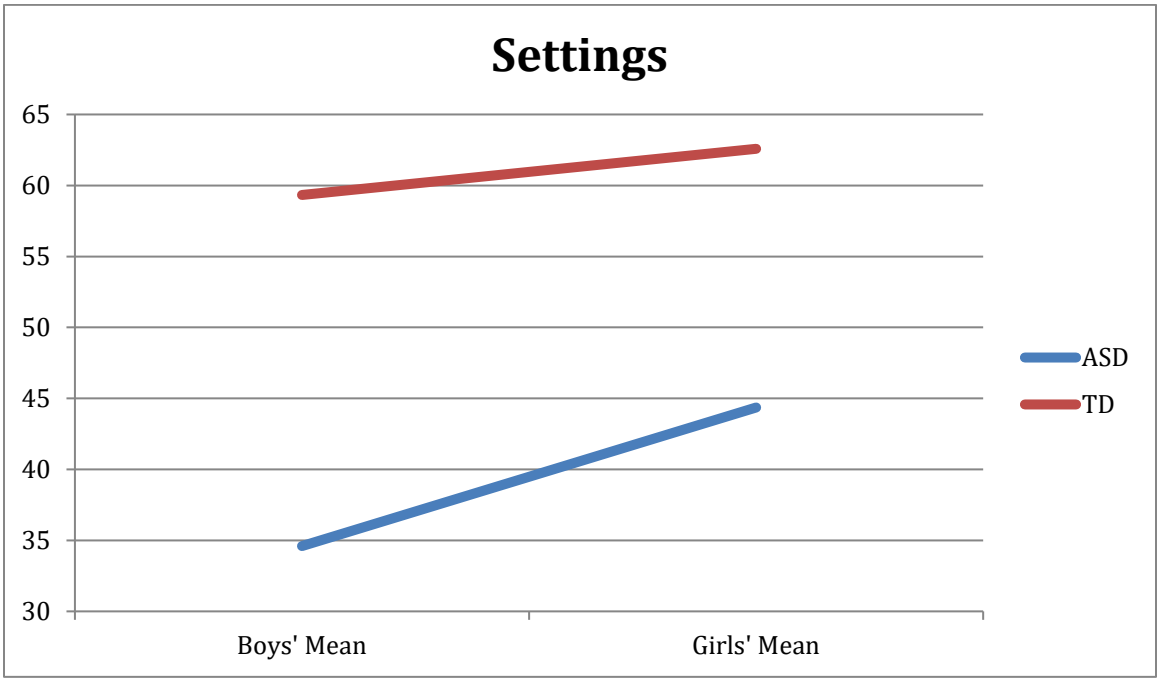


Figure 4.23 Story Macrostructure number of errors in Referencing category in 10-year-olds, by diagnostic group

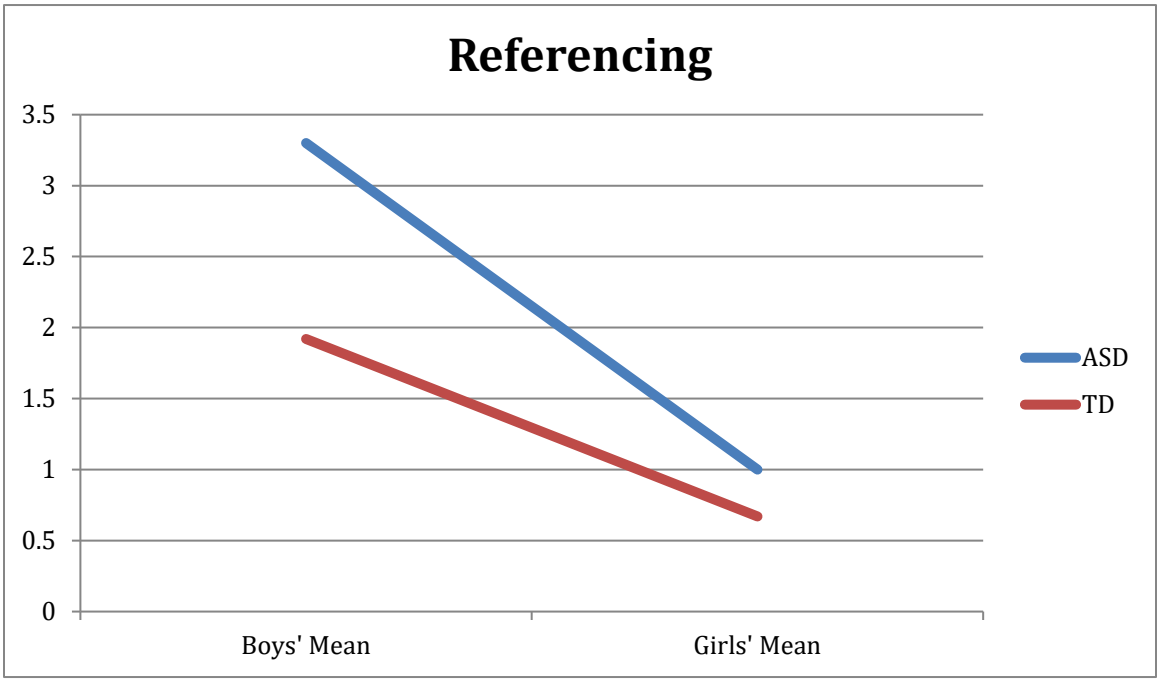


Figure 4.24 Story Macrostructure percentage of correct elements in Conflict/Conflict Resolution category in 10-year-olds, by diagnostic group

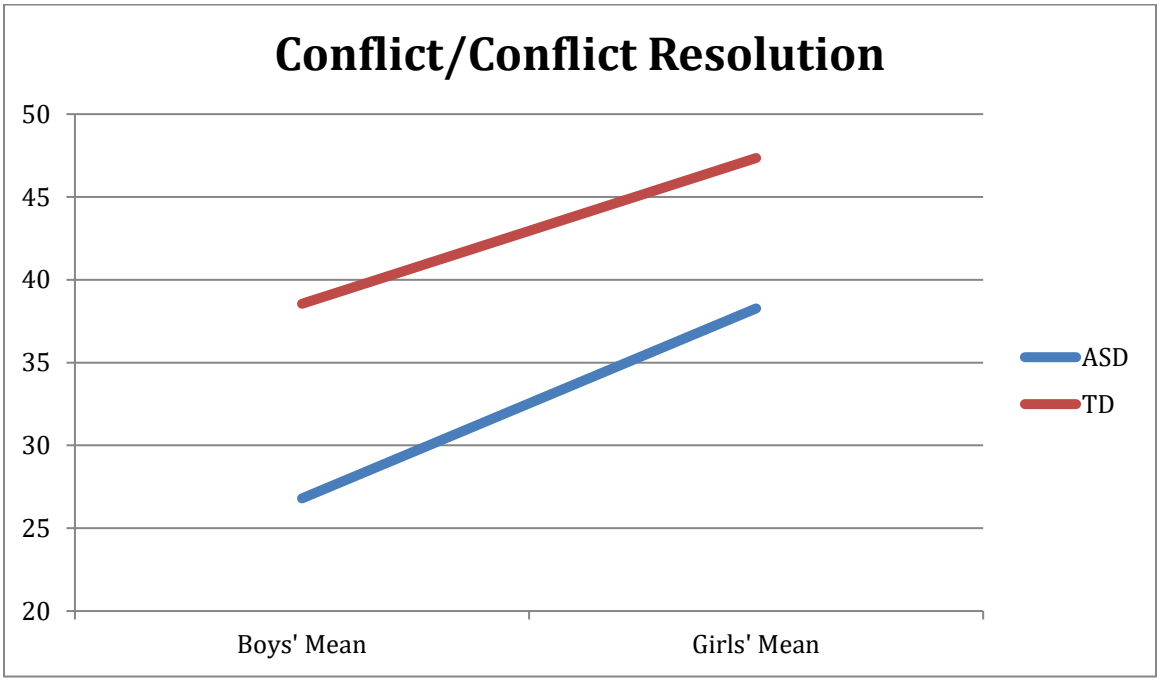


Figure 4.25 Story Macrostructure number of errors in Cohesion category in 10-year-olds, by diagnostic group

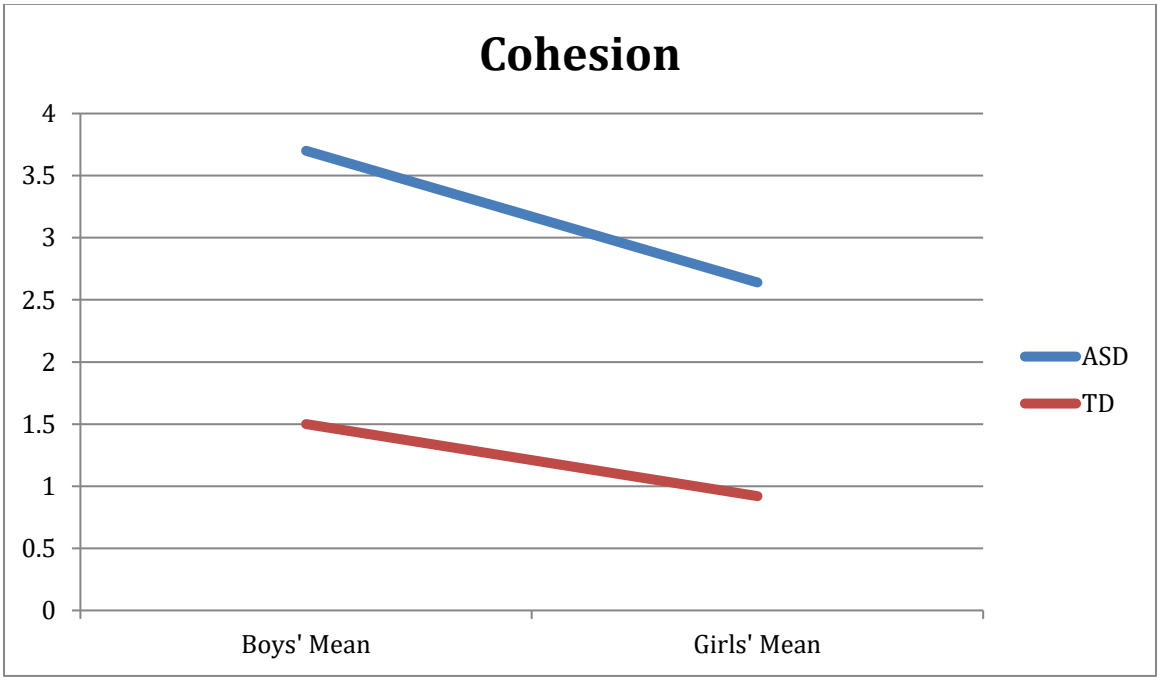
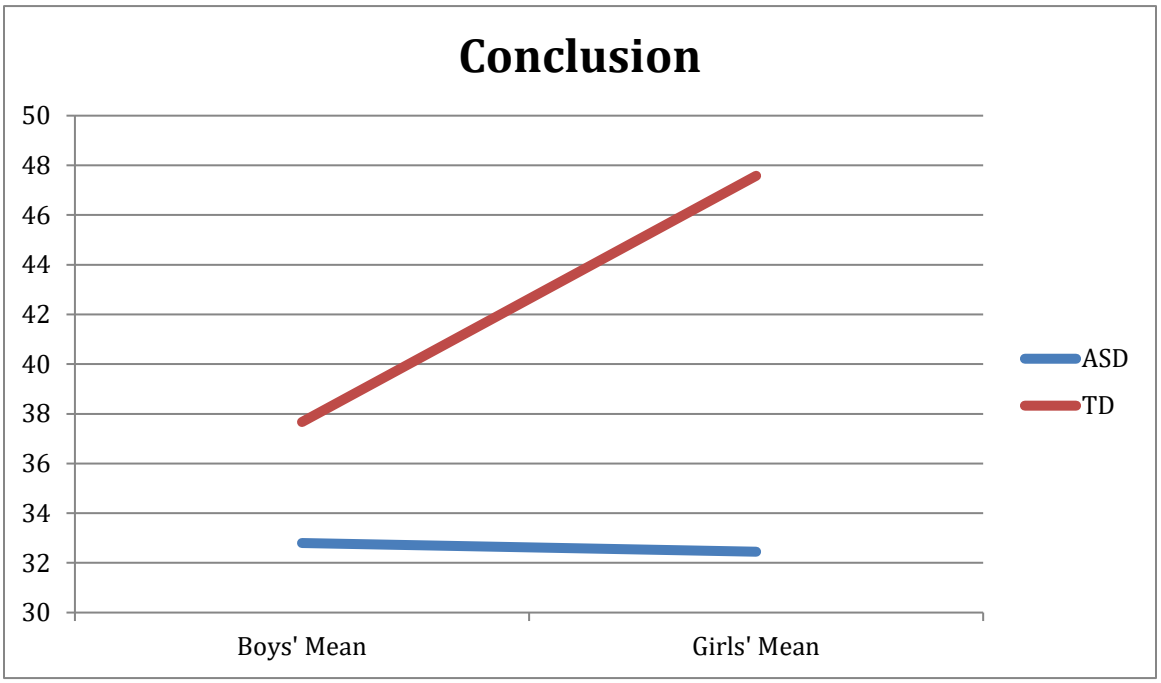


Figure 4.26 Story Macrostructure percentage of correct elements in the Conclusion category in 10-year-olds, by diagnostic group



4.3.3.4 *CASL*.

As shown in Table 4.8, analysis of the CASL revealed a large statistically significant difference in diagnostic group ($F(3,30) = 4.09$, $p = 0.015$; Wilks' $\Lambda = 0.710$, $\eta_p^2 = 0.29$) but not gender. There was no significant interaction effect. Due to the multiple comparisons of the follow-up ANOVAs, a Bonferroni correction was applied and $\alpha \leq 0.0167$ was set as significant. For the Non-literal language SS, there was a large main effect of diagnostic group ($F(1) = 7.178$, $p = 0.012$, $\eta_p^2 = 0.183$) (Figure 4.27) where typically developing 10-year-olds had significantly higher scores than 10-year-olds with ASD. For the CASL Inference SS, there was a large main effect of diagnostic group ($F(1) = 11.671$, $p = 0.002$, $\eta_p^2 = 0.267$) (Figure 4.28) where typically developing 10-year-olds had significantly higher standard scores than 10-year-olds with ASD. For the CASL Pragmatic Judgment SS (Figure 4.29) there was no significant effect of diagnostic group.

Table 4.8 CASL scores by diagnostic group and gender

CASL Standard Score	TD participants' Mean (*SD*)	ASD participants' Mean (*SD*)	TD Boys' Mean (*SD*)	TD Girls' Mean (*SD*)	ASD Boys' Mean (*SD*)	ASD Girls' Mean (*SD*)	ANOVA and *p* values for diagnostic group
Non-literal language	107.46 (9.14)*	97.92 (11.07)*	103.83 (8.57)	111.08 (8.51)	95.00 (10.52)	102.00 (11.62)	$F(1) = 7.18$, $p = 0.012$
Inference	100.96 (9.04)*	89.50 (10.05)*	99.67 (10.60)	102.25 (7.41)	90.57 (10.69)	88.00 (10.08)	$F(1) = 11.67$, $p = 0.002$
Pragmatic Judgment	93.17 (8.07)	86.92 (10.13)	90.25 (8.11)	96.08 (7.19)	87.43 (8.89)	86.20 (12.76)	$F(1) = 4.19$, $p = 0.049$

Note. * = significant difference of $p \leq 0.0167$

Figure 4.27 CASL Non-literal language standard score, by diagnostic group

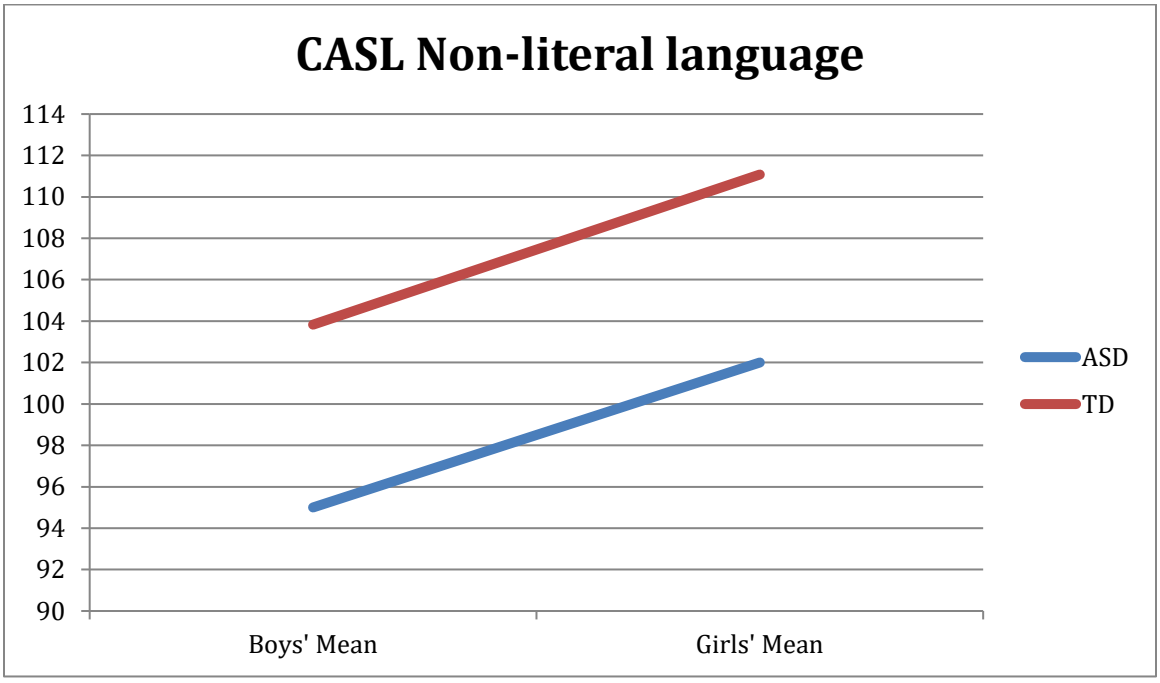


Figure 4.28 CASL Inference standard score, by diagnostic group

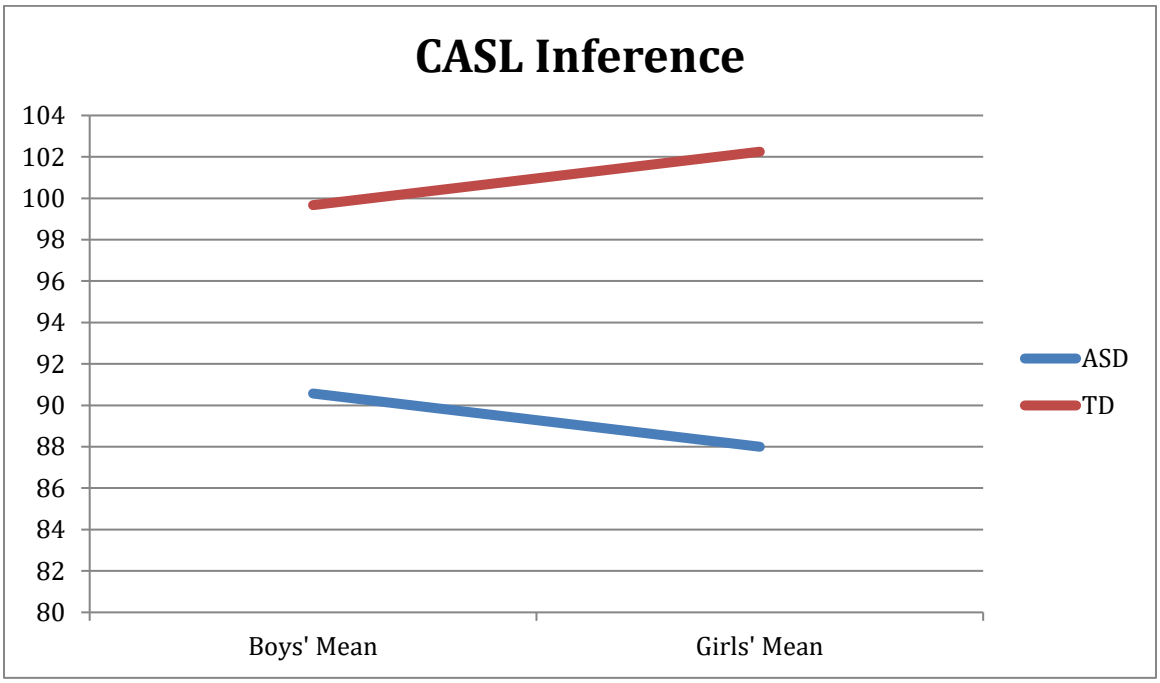
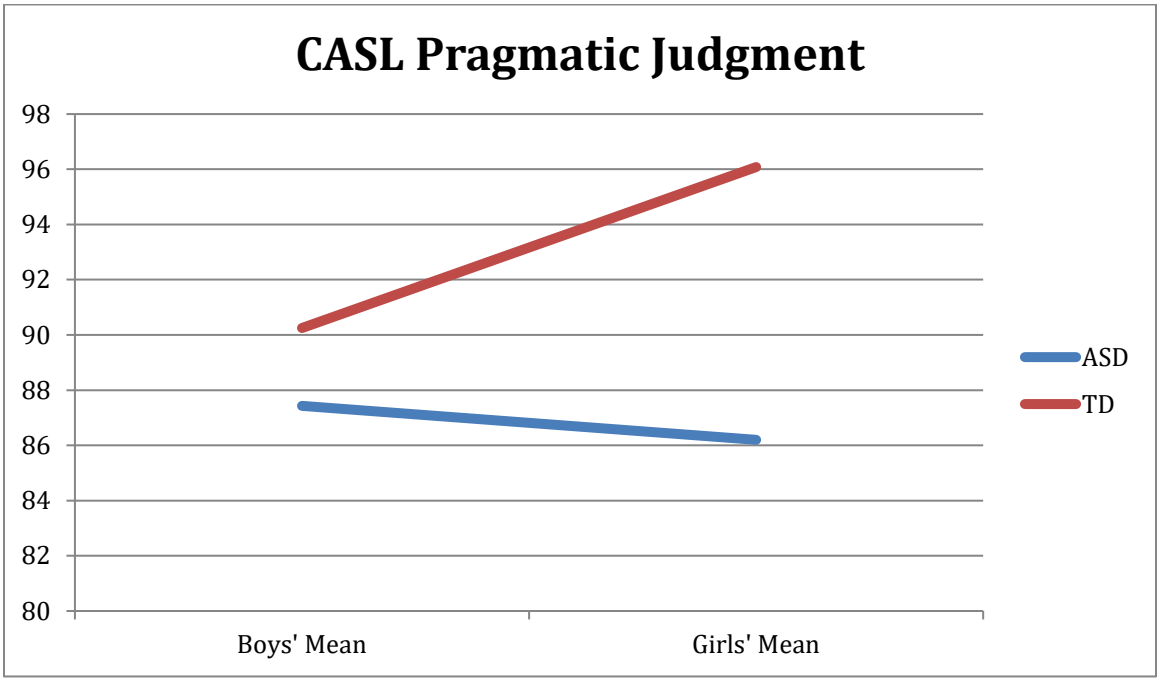


Figure 4.29 CASL Pragmatic Judgment standard score, by diagnostic group



4.4 Discussion

I set out to examine if the gender differences found in my previous work with participants with ASD (Conlon et al., 2018, Conlon, Chapter 3) would also be found in the typically developing population. I wanted to know if strengths that were discovered in the narrative skills of girls with ASD would also be found in TD girls, or if this finding would be something unique to girls diagnosed with ASD. Overall, I discovered that many areas of strengths for girls with ASD were also areas of strength for TD girls. The discussion of the results will be broken down by assessment/analysis to provide clarity around the comparisons of the groups and genders.

4.4.1 Expression, Reception and Recall of Narrative Instrument (ERRNI).

Findings from the ERRNI revealed some interesting features of gender and ASD. On Ideas-Initial and Ideas-Recall SS, both 8- and 10-year-old TD participants included

significantly more salient story elements than participants with ASD. This finding is not surprising since previous studies have documented the challenges with narrative tasks that children with ASD face in comparison to TD children, particularly in the area of narrative coherence, irrelevant details, and causal connections (Diehl et al., 2006; Kelley, Paul, Fein, & Naigles, 2006; Losh & Capps, 2003; Norbury, 2005, Sturrock et al., 2019). There were no significant group differences in either age group on the Comprehension or MLUw SS of the ERRNI. Other researchers have also found similar findings when comparing the narratives TD and ASD participants, as many have found similarities in narrative length and grammatical complexity between the groups (Diehl et al., 2006; Losh & Capps, 2003).

Interestingly, there were no significant gender differences on the ERRNI for either the TD 8-or 10-year-olds. This is in contrast to my findings in the ASD cohort (Conlon et al., 2018; Conlon, Chapter 3) where significant gender differences were seen on the ERRNI Ideas-Initial SS, where girls with ASD included significantly more salient story elements than boys with ASD. In the current study comparing participants with ASD to matched TD participants, the results for the Ideas-Initial SS showed the same trend in gender in both age groups, where the participants fell on a continuum of boys (both TD and ASD) having lower mean SS than girls, although girls with ASD still had substantially lower scores than TD boys (See Tables 4.2 and 4.5). The gender differences reached statistical significance for the ASD group but not for the TD groups.

4.4.2 Detailed Transcript Analysis (DTA).

There were significant differences on both group and gender for the DTA. In both the 8-year-olds and the 10-year-olds, there were significant group differences on the

Pragmatic and Semantic indices, with TD participants exhibiting significantly fewer pragmatic errors and more semantically enriched narratives than participants with ASD. Such diagnostic group differences were expected as deficits in social communication are a hallmark of an ASD diagnosis (American Psychiatric Association, 2013), and several studies have documented similar specific pragmatic and semantic differences (Diehl et al., 2006; Kelley et al., 2006, Paul et al., 2009; Siller et al., 2014).

The findings that are more novel are the significant gender differences on the Pragmatic and Semantic Enhancement Indices. In the 8-year-old ASD cohort, initially significant differences on the Pragmatic Index did not survive corrections for multiple comparisons (Conlon et al., 2018). In 10-year-olds with ASD, the differences were large enough to survive and girls made fewer pragmatic errors than boys (Conlon, Chapter 3). In both groups TD participants, however, girls made significantly fewer pragmatic errors than boys. To my knowledge, this particular aspect of narratives has not been studied previously in the TD population, but reports that TD girls have conversations that are more collaborative (Leaper, 1991) and use more polite terms (Ladegaard & Bleses, 2003) compared to TD boys appear to support girls as having superior pragmatic skills. Mulac et al (2006) suggest that this may be accounted for by girls being exposed to a social environment that provides them with a different language learning experience than boys (i.e. within same-gendered peer groups).

The Semantic Enhancement Index showed variation between the TD groups, such that 10-year-old girls enriched their stories more than the 10-year-old boys, but the same differences were not seen between the 8-year-old boys and girls. In the ASD group, gender differences were significant on this index, both when the participants were 8-

years-old and again when they were 10 (Conlon et al., 2018; Conlon, Chapter 4). Using two different groups of TD participants, each matched to the participants with ASD at a different time point, likely introduces more variability in results in the TD groups and may account for the lack of gender differences at 8 years. Whether or not gender differences in semantic enhancement skills in the TD population exist or grow over time will have to wait for a study using larger samples or employing a longitudinal design.

There were no significant group or gender differences on the Syntactic Complexity or Formulation Index for both the 8-year-olds and 10-year-olds. Again, this was anticipated, as previous studies have shown that length and complexity of narratives are similar between participants with ASD and TD controls (Diehl et al., 2006; Losh & Capps, 2003) and studies examining language in TDs only have shown no gender differences on grammar complexity (Adani & Cepanec, 2019).

4.4.3 Story Macrostructure.

Results also showed that there were significant group and gender differences for story macrostructure elements in the 8-year-olds and 10-year-olds. For the 8-year-olds, all aspects of story macrostructure showed significant group differences, where TD 8-year-olds had more story elements (Settings, Conflict/Conflict Resolution, Conclusion) and fewer errors in referencing and cohesion than 8-year-olds with ASD. The 10-year-olds had slightly different findings, where group differences were seen only on the Settings, Conflict/Conflict Resolution, and Cohesion elements of story macrostructure. The 10-year-old TD participants had significantly more plot points in the Settings and Conflict/Conflict resolution categories, and made significantly fewer cohesive errors than 10-year-old participants with ASD. These group differences are not surprising as

previous works indicate that narratives of participants with ASD are generally weaker in comparison to TD participants, especially in macrostructure areas such as overall cohesion and referencing (Diehl et al., 2006; Norbury, 2005; Siller et al., 2014).

Significant gender differences were only found on the Referencing element of story macrostructure, where girls had significantly fewer referencing errors than boys. This trend was seen in my previous work (Conlon et al., 2018; Conlon, Chapter 3), where girls with ASD had fewer referencing errors than the matched boys. When looking at the TD group only, significant differences were seen between the TD 10-year-olds but not the TD 8-year-olds; 10-year-old TD girls had significantly fewer referencing errors than 10-year-old TD boys. The differences in findings likely are due to the variation introduced by having two groups of TD participants rather than one group over two time points.

For the CASL, significant group differences were seen on the Non-literal language and Inference subtests, where TD 10-year-olds had significantly higher SS than 10-year-olds with ASD. This is in keeping with previous findings by Sturrock and colleagues who also examined pragmatics through measures other than a narrative task. In their study, the figurative language task (an experimental measure that looked at meaning and intention of a set of 21 utterances with an accompanying picture) showed significant group differences as well, with TD participants identifying the correct (but not literal) meaning of the utterance significantly more than the participants with ASD (Sturrock et al., 2019). Taken together, these two studies demonstrate that differences between children with ASD and TD children were found on non-narrative measures of pragmatic skill as well as on narrative measures of pragmatics.

This is the first study that longitudinally compares participants with ASD on a standardized narrative measure, and including comparison groups of matched TD participants. Furthermore, this is the first study examining gender differences in TD and ASD participants using a detailed transcript analysis of narratives in order to capture differences that might not be apparent on less sensitive instruments. On detailed analysis girls, whether they are developing typically or diagnosed with ASD, display some significant differences from boys in their communication profile. The results revealed that the 8 and 10-year-old girls had significantly fewer pragmatic errors in their narratives and 10-year-old girls enhanced their narratives significantly more than boys.

It is not clear what factors influence these differences in communication. Traditionally, it was thought that parents and caregivers raised girls and boys differently. For example, some studies have found that mothers discuss emotions more with their daughters than with their sons (Adams, Kuebli, Boyle, & Fivush, 1995; Dunn, Bretherton, & Munn, 1987; Zahn-Waxler, Cole, & Barrett, 1991) and in particular Fivush, Brotman, Buckner, and Goodman (2000) found that mothers and fathers talked more about sad events with daughters than with sons. A meta-analysis conducted by Leaper, Anderson, and Sanders (1998) found that boys are encouraged more to control their emotions and assert themselves whereas girls were encouraged to engage socially. These authors also concluded from their meta-analysis that mothers provide different language learning experiences based on the gender of their child (Leaper, Anderson, & Sanders, 1998). Moving past language and communication, another meta-analysis examining socialization found that parents encouraged their sons and daughters to partake in gender-stereotyped play and household chores (Lytton & Romney, 1991).

Even outside of the home environment, kindergarten girls have been found to communicate and connect more easily with teachers, and receive more positive praise compared to kindergarten boys (Dumais, 2002). Therefore, there is some evidence to suggest that at least in the past, boys and girls may have experienced their social worlds differently as social aspects may have been presented to them differently depending on their gender.

Although society has seen a shift in gender roles since the mid-20th century (Goldscheider, Bernhardt, & Lappegard, 2015) there is still a question as to whether this shift in gender roles has also led to a shift in gender stereotypes that may initially begin in the home through raising a son and daughter differently. A meta-analysis that examined gender stereotypes from 1983 to 2014 found that gender stereotypes were stable over this period despite societal changes such as more women entering the workforce (Haines, Deaux, & Lofaro, 2016). Another current meta-analysis that examined stereotypes from 1946 to 2018 also found stability in gender stereotypes in all areas except competence, where society now viewed women as equally competent as men (Eagly, Nater, Miller, Kaufmann, & Sczesny, 2019). Therefore, although within society gender roles have shifted, it seems as though our stereotypes about gender roles have not yet caught up to that shift. These gender stereotypes and individual social and societal experience may influence how boys and girls learn and use language for social purposes, and may partially provide reason for the different communication patterns noted in this study.

Although this study provides novel information about gender differences in communication of 8 and 10-year-old children, it has some limitations that need to be acknowledged. First of all, the TD participants were two separate groups rather than one

group followed over time like the ASD sample. This inevitably introduced more variance into the TD cohort and may limit the ability to find significant differences. Also, although the sample size was acceptable according to sample size calculations, the small sample may limit this study to detect large differences only and potentially this study may be underpowered to detect small differences within and between groups. Furthermore, unfortunately IQ and language level scores were not available when the participants with ASD were 10-years-old, and although this group demonstrated stability on other measures over the two year period, the lack of data on these measures limits their comparability to the TD groups. Future studies should longitudinally examine all participants (ASD and TD) over at least three time points in order to truly capture differences and a developmental trajectory.

CHAPTER 5: Discussion

5.1 Objectives of Thesis

My primary aim for this thesis was to examine the social communication ability of school aged boys and girls with ASD to determine if there were differences between genders. I set out to collect and analyze data on girls with ASD, as girls with ASD are an understudied and underrepresented population in ASD literature (Wijngaarden-Cremers et al., 2014). I wanted to know how girls with ASD presented on tasks that specifically tapped into social communication ability, such as narratives, in order to add to the small but growing literature around the female phenotype of ASD. Furthermore, I wanted to conduct a fine-grained analysis of narratives in order to speak to exact areas of differences of the narratives of boys and girls with ASD. To address this primary objective, I used the data of participants from a larger longitudinal study (The *Pathways in ASD* study) in order to match and examine the narrative ability of 26 (13M, 13F) 8-year-olds with ASD. The fine-grained analysis was conducted as part of this thesis (not part of the Pathways in ASD study). After examining the results from the 8-year-olds, I wanted to discern if there was stability in the findings. Therefore, using the same group of participants I examined narrative ability and conducted fine-grained analysis when the participants were 10-years-old (N = 21, 10M, 11F).

While examining the data from the ASD participants, my secondary objective developed. Although I had found differences between the boys and girls with ASD, I was unclear if these differences seen were also found within the typically developing (TD) population. Therefore, my secondary aim was to examine the social communication ability of TD school aged boys and girls to determine if gender differences existed. To do

this I recruited and collected data (narrative and matching measures) from TD 8-year-olds (N = 27, 14M, 13F) and 10-year-olds (N = 24, 12M, 12F). I then conducted the same fine-grained analysis as was used with the participants with ASD and made between (ASD vs TD) and within (TD boys vs TD girls) group comparisons. From the three above studies, I was able to draw conclusions about the social communication ability of these boys and girls with ASD as well as make conclusions about the social communication abilities of the TD boys and girls. The following sections will discuss the findings, implications, and limitations from my research, and will offer suggestions on future directions.

5.2 Findings and Implications

The results of the first study (Conlon et al., 2018) revealed that the 8-year-old girls with ASD told stories that were more complete than those of the 8-year-old boys with ASD, by including more salient elements in their stories. The fine-grained analysis revealed that girls' stories were also richer, describing characters' intentions more than boys; and girls were able to avoid errors in reference (i.e. ambiguous references) significantly more than boys. Although gender differences were revealed on the broad, standardized, narrative test (Expression Reception and Recall of Narrative Instrument; ERRNI; Bishop, 2004) specific pragmatic differences were only revealed as a result of the fine-grained language analysis. Along with the key findings of the differences in narrative ability of boys and girls with ASD, my findings from this study also emphasized the importance of looking beyond traditional sentence-level tests of language competence in order to understand pragmatic or overall social communication in children with ASD.

Results from this study suggest that subtle yet significant differences in social communication may exist between intellectually able boys and girls with ASD. Furthermore, it is important to note that instruments specifically designed to tap into social communication skills captured these differences, and that the nature of these differences may be further revealed by fine-grained language sample analysis.

The implications from this study are two-fold; first this study lends support to the previous notion of a female-specific phenotype of ASD (Kreiser & White, 2014; Lai et al., 2014) as the girls with ASD had a unique social communication profile compared to the boys with ASD. As deficits in social communication are a defining feature of ASD (American Psychiatric Association, 2013), this unique ability found in the girls that participated in this study is important, as it may help to shape our future understanding of the social communication ability of girls with ASD. The second implication of this study was that there is a need for efficient and effective tools to measure sophisticated social-communication skills, as these tools may be the only avenue of capturing social communication differences in people with ASD.

When examining the stability of the findings from the first study, results from my second study (Conlon Chapter 3) revealed that the gender differences that were demonstrated at age 8 were still present at age 10. On the ERRNI, 10-year-old girls with ASD had narratives with significantly more salient story elements than 10-year-old boys with ASD. In terms of fine-grained analysis, the girls enhanced the story significantly more than the boys by adding details such as describing the thoughts of the character or describing character intentions, and continued to produce narratives with significantly fewer errors in reference. A unique finding was revealed on the Pragmatic Index of the

fine-grained analysis of the 10-year-olds' narratives. This index showed that girls had narratives with significantly fewer pragmatic errors than boys. Although this finding approached significance at age 8, it did not survive correction for multiple comparisons at that time. By age 10, the significantly better performance of the girls did survive correction for multiple comparisons. Finally, over time, both boys and girls improved on most indices of narrative performance.

The findings from this study also suggest that gender differences exist in social communication ability of cognitively capable participants with ASD. Furthermore, the results from the Pragmatic Index may indicate that girls' better social communication skills are becoming more evident over time. These findings add support to the notions that girls with ASD have a unique social communication profile (Conlon et al., 2018; Kauschke et al., 2016; Sturrock et al., 2019) and that they may present with a novel phenotype (Kreiser & White, 2014; Lai et al., 2014). Furthermore, as seen in previous work (Conlon et al., 2018), although standardized test scores revealed significant differences, without the fine-grained analysis, the exact nature of how boys' and girls' narratives differ would not be clear.

By including a typically developing comparison group, as I did in my third study (Conlon, Chapter 4), I was able to draw broader conclusions as I could speak to the social communication skills both between groups (TD population compared to the ASD population) and within group (narrative skills of TD boys compared to TD girls). In general, I found that many areas of strengths for girls with ASD were also strengths for TD girls.

Briefly, there were no significant gender differences in the TD cohorts (both 8 and 10-year-olds) for the standardized narrative measure (ERRNI). This is in contrast to what is seen in the ASD cohort, as gender differences were seen between both the 8-year-olds and 10-year-olds on this measure. On fine-grained analysis, significant gender differences in the TD cohorts (both 8 and 10-year-olds) were seen on the Pragmatic Index where TD girls made significantly fewer pragmatic errors than TD boys. This trend was also seen in the ASD population, where the 8-year-old girls approached significance on this index, and the 10-year-old girls had significantly fewer errors on this index. This is a novel finding within the TD population, and one that may be important both in understanding typical development and when considering intervention for children with language disorders. If differences exist in social communication between the genders in typically developing children, then standards for achieving age-appropriate competence will need to be developed and intervention efforts targeted accordingly. The Semantic Enhancement Index also showed significant gender differences in the TD population, although this was only seen in the 10-year-olds, where 10-year-old TD girls enhanced their narratives significantly more than 10-year-old TD boys. Semantic enhancement was also a strength for girls in the ASD cohort (both when the participants were 8-years-old and 10-years-old) and may speak to another area of social communication strength for girls. Because the gender difference was not apparent in 8-year-old TD girls more research needs to be conducted in this area to determine if the results found in the 10-year-olds can be replicated in other age groups. A similar trend was seen when examining errors in reference in the TD population, as gender differences were seen only in the 10-year-olds, with 10-year-old TD girls having significantly fewer referencing errors than

10-year-old TD boys. Again this result would need to be confirmed and replicated in other studies before conclusions could be proposed about referencing ability in the TD population.

Overall, results revealed that regardless of diagnostic status, the 8 and 10-year-old girls had significantly fewer pragmatic errors in their narratives and 10-year-old girls enhanced their narratives significantly more than boys. There are certain considerations that need to be addressed in light of these findings. First, it is important to acknowledge that typical gender differences in language and social communication development at this age are not well defined. It is unclear if the gender differences seen in the 8 and 10-year-olds are typical differences that balance out over time, or if the discrepancies found are life-long discrepancies in narrative/social communication ability of boys and girls. To determine this, a longitudinal detailed analysis of narratives in a cohort of matched TD participants would be able to provide stronger evidence as to whether this difference is consistently found, or one that equalizes over time.

Secondly, an important consideration overall is whether the differences in social communication are due to "nature" or "nurture". The answer to this question is beyond the scope of this thesis and it is likely that these differences are due to a combination of biological and environmental factors. However, it is important to recognize that society has a large impact on shaping gendered social communication development (Bussey & Bandura, 1999). One of the first places to look when examining environmental factors influencing gendered social communication development is in the home. Research has shown that mothers talk differently with their daughters than with their sons (Lanvers, 2004). For example, mothers used more mental state terms when talking with their

daughters compared to their sons (Fivush et al., 2000). Researchers also found that the quantity of talk was different with daughters than with sons, where mothers talked more with their daughters (Cherry & Lewis, 1976). Fivush (1989) also reported a difference in the types of emotional language used with daughters. She found that mothers talked more about positive emotions with daughters, whereas with sons mothers talked equally about positive and negative emotions. When looking at both fathers' and mothers' interactions with their children, Roger, Rinaldi and Howe found that both mothers and fathers used language that described internal states more with their sons than with their daughters (Roger, Rinaldi, & Howe, 2012). These gender differences in socialization may at the very least contribute to some of the gender differences seen in communication, especially if viewed through a social cognitive framework. A social cognitive framework suggests that competence in social and emotional skills is developed through interactions with others in close relationships (Roger et al., 2012). Therefore, when considering this framework, the social skills that children develop are correlated to their interactions with family members (close relationships) and if these interactions are different depending on gender (which research has shown) then it could be expected that social skills may differ depending on gender.

Regardless of the cause of the gender differences seen in the social communication ability of boys and girls, implications of this thesis overall speak to the differing social communication profiles of these matched cognitively capable boys and girls, and in particular the boys and girls with ASD. Consistent large significant differences were seen in the ASD population, where these girls seemed to present with not only a unique social communication profile, but also significant areas of strength

compared to the boys with ASD. This finding is important as it has implications for the general understanding of the female presentation of ASD. It seems that these girls have a social communication advantage compared to their male counterparts. This finding, along with findings from other researchers examining the female phenotype of ASD may lend to a deeper understanding of how girls and women on the autism spectrum present. With a greater understanding of the female profile of ASD, clinicians, doctors, and those involved in diagnostic and assessment teams may be better able to identify girls and women on the spectrum and may be able to help them access resources and interventions specifically tailored to their unique symptom profile.

5.3 Limitations

Although best efforts were made to minimize limitations, there are limitations that need to be addressed. The major limitation of my work is the small sample size. Unfortunately, only 13 girls with ASD were able to complete the narrative task out of the larger longitudinal study (the Pathways in ASD study) from which my ASD sample was collected. This limited the ASD cohort to 26 participants (13 matched boys with ASD to the 13 girls), which therefore dictated the size of my typically developing control groups. As a result, my studies may have been underpowered to detect some true differences in narrative ability between genders.

Another limitation is that my sample was only of intellectually able, verbally fluent participants. Although to complete a narrative, one usually is fluent verbally, results from this study may not be generalizable to children with cognitive impairments or who are less verbally fluent.

Finally, the data for TD participants were captured in a cross-sectional manner while the ASD sample data were collected longitudinally. By having two different groups of TD participants, more variance was introduced, which may limit the ability to find significant differences. Furthermore, unfortunately IQ and language level scores were not available when the participants with ASD were 10-years-old, although this group demonstrated stability on other measures over the 2-year period, the lack of data on these measures limits their comparability to the TD groups.

5.4 Future directions

Future studies should focus on three main areas. First, it would be beneficial to examine social communication ability longitudinally in TD participants, in order to determine if the gender differences found in Conlon Chapter 4 were replicable in other TD cohorts. As longitudinally examining gender differences in narrative performance of TD participants and conducting fine-grained analysis has currently not been investigated, this may be an area of interest in order to have a deeper understanding of gender differences in social communication in TD participants. Secondly, more research in the area of gender differences in social communication ability of participants with ASD is warranted in order to better understand how girls with ASD present. Specifically, longitudinally examining gender differences in social communication ability over at least three time points would allow a true developmental trajectory to be proposed. Finally, examining if the gender differences found in ASD are also present in other childhood developmental disorders (such as Developmental Language Disorder - DLD) would be beneficial. If the gender differences seen in ASD are shared with DLD, there may be an impact on assessment and diagnosis, as it may speak to the need to need to adjust

evaluation and diagnostic processes for both conditions. Additionally, by examining the role of gender in social communication a person many need to reconsider the impact of social communication as a functional domain in all childhood developmental disorders.

REFERENCES

Adams, C. (2002). Practitioner review: The assessment of language pragmatics. *J.Child Psychol.Psychiatry Allied Discipl.(Print), 43*(8), 973-987.

Adams, C. (2005). Social communication intervention for school-age children: Rationale and description. *Seminars in Speech & Language, 26*(3), 181-188.

Adams, C. (2016). Assessment and intervention for children with pragmatic language impairment, in *Social Communication Development and Disorders,* Deborah Hwa-Froelich*,* Ed., Psychology Press Ltd, New York, p. 141-170.

Adams, S., Kuebli, J., Boyle, P. A., & Fivush, R. (1995). Gender differences in parent-child conversations about past emotions: A longitudinal investigation. *Sex Roles, 33*(5), 309-323. doi:10.1007/BF01954572

Adani, S., & Cepanec, M. (2019). Sex differences in early communication development: Behavioral and neurobiological indicators of more vulnerable communication system development in boys. *Croatian Medical Journal, 60*(2), 141-149. doi:10.3325/cmj.2019.60.141

American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of Mental Disorders* (Fifth Edition ed.). Arlington, VA: American Psychiatric Association.

American Speech-Language-Hearing Association. (2016). Components of social communication.

Andersson, G. W., Gillberg, C., & Miniscalco, C. (2013). Pre-school children with suspected autism spectrum disorders: Do girls and boys have the same

profiles? *Research in Developmental Disabilities: A Multidisciplinary Journal, 34*(1), 413-422.

APA. (2017). *Publication Manual of the American Psychological Association* (Sixth edition ed.). Washington, DC: American Psychological Assoc.

Attwood, T., & Grandin, T. (2006). *Asperger's and girls: World-renowned experts join those with Asperger's syndrome to resolve issues that girls and women face every day! / featuring Tony Attwood and Temple Grandin, plus 7 more experts* Arlington, Tex. : Future Horizons, Inc., c2006.

Auyeung, B., Wheelwright, S., Allison, C., Atkinson, M., Samarawickrema, N., & Baron-Cohen, S. (2009). The children's empathy quotient and systemizing quotient: Sex differences in typical development and in autism spectrum conditions. *Journal of Autism & Developmental Disorders, 39*(11), 1509-1521. doi:10.1007/s10803-009-0772-x

Baio, J., Wiggins, L., Christensen, D. L., Maenner, M. J., Daniels, J., Warren, Z., . . . Dowling, N. F. (2018). Prevalence of autism spectrum disorder among children aged 8 years — autism and developmental disabilities monitoring network, 11 sites, united states, 2014. *Morbidity and Mortality Weekly Report. Surveillance Summaries (Washington, D.C.: 2002), 67*(6), 1-23. doi:10.15585/mmwr.ss6706a1

Baird, G., & Norbury, C. F. (2016). Social (pragmatic) communication disorders and autism spectrum disorder. *Archives of Disease in Childhood, 101*(8), 745-751. doi:10.1136/archdischild-2014-306944

Banney, R. M., Harper-Hill, K., & Arnott, W. L. (2015). The autism diagnostic observation schedule and narrative assessment: Evidence for specific narrative impairments in autism spectrum disorders. *International Journal of Speech-Language Pathology, 17*(2), 159-171. doi:10.3109/17549507.2014.977348

Barbu, S., Nardy, A., Chevrot, J., Guellaï, B., Glas, L., Juhel, J., & Lemasson, A. (2015). Sex differences in language across early childhood: Family socioeconomic status does not impact boys and girls equally. *Frontiers in Psychology, 6*, 1874. doi:10.3389/fpsyg.2015.01874

Bates, E., & MacWhinney, B. (1989). Functionalism and the competition model. In E. Bates, & B. MacWhinney (Eds.), *The crosslinguistic study of sentence processing* (pp. 3-73). Cambridge, UK: Cambridge University Press.

Bishop, D. V. (2004). *Expression, Reception and Recall of Narrative Instrument*. London, UK: Harcourt assessment.

Bleses, D., Vach, W., Slott, M., Wehberg, S., Thomsen, P., Madsen, T., & Basboll, H. (2008). The Danish Communicative Developmental Inventories: Validity and Main Developmental Trends. *Journal of Child Language, 35*(3), 651-669. doi:10.1017/S0305000907008574

Bloom, L., & Lahey, M. (1978). *Language Development and Language Disorders* John Wiley & Sons.

Botting, N. (2002). Narrative as a tool for the assessment of linguistic and pragmatic impairments. *Child Language Teaching & Therapy, 18*(1), 1-21.

Bouchard, C., Trudeau, N., Sutton, A., Boudreault, M., & Deneault, J. (2009). Gender differences in language development in French Canadian children between 8 and 30 months of age. *Applied Psycholinguistics, 30*(4), 685-707. doi:10.1017/S0142716409990075

Buckner, J. P., & Fivush, R. (1998). Gender and self in children's autobiographical narratives. *Applied Cognitive Psychology, 12*(4), 407-429. doi:AID-ACP575>3.0.CO;2-7

Bussey, K., & Bandura, A. (1999). Social cognitive theory of gender development and differentiation. *Psychological Review, 106*(4), 676-713. https://doi.org/10.1037/0033-295X.106.4.676

Camarata, S. (1991). Assessment of oral language. In J. Salvia, & J. Ysseldyke (Eds.), *Assessment in special and remedial education* (pp. 263-301). Boston, MA: Houghton-Mifflin.

Capps, L., Losh, M., & Thurber, C. (2000). `The frog ate the bug and made his mouth sad': Narrative competence in children with autism. *Journal of Abnormal Child Psychology, 28*(2), 193.

Carrow-Woolfolk, E. (1999). *Comprehensive assessment of spoken language* Western Psychological Services.

Carter, A. S., Black, D. O., Tewani, S., Connolly, C. E., Kadlec, M. B., & Tager-Flusberg, H. (2007). Sex differences in toddlers with autism spectrum disorders. *Journal of Autism & Developmental Disorders, 37*(1), 86-97.

Cherry, L., & Lewis, M. (1976). Mothers and two-year-olds: A study of sex-differentiated aspects of verbal interaction. *Developmental Psychology, 12*(4), 278–282. https://doi.org/10.1037/0012-1649.12.4.278

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Oxford, UK: Routledge.

Conlon, O., Volden, J., Smith, I. M., Duku, E., Zwaigenbaum, L., Waddell, C., . . . Pathways in ASD Study Team. (2018). Gender differences in pragmatic communication in school-aged children with autism spectrum disorder (ASD). *Journal of Autism and Developmental Disorders, 49*(5), 1937-1948. doi:10.1007/s10803-018-03873-2 [doi]

Cowley, J., & Glasgow, C. (1994). *The Renfrew Bus Story* (American Ed). Centreville, DE: The Centreville School.

Crystal, D. (1987). Towards a 'bucket' theory of language disability: Taking account of interaction between linguistic levels. *Clinical Linguistics & Phonetics, 1*(1), 7-22. doi:10.1080/02699208708985001

De Villiers, J. (2005). Discourse analysis in autism spectrum disorder. *Linguistics & the Human Sciences, 1*(2), 245-260.

Dean, M., Kasari, C., Shih, W., Frankel, F., Whitney, R., Landa, R., . . . Harwood, R. (2014). The peer relationships of girls with ASD at school: Comparison to boys and girls with and without ASD. *Journal of Child Psychology and Psychiatry, 55*(11), 1218-1225. doi:10.1111/jcpp.12242

Diehl, J., Bennetto, L., & Young, E. (2006). Story recall and narrative coherence of high-functioning children with autism spectrum disorders. *Journal of Abnormal Child Psychology, 34*(1), 87-102.

Dumais, S. A. (2002). Cultural capital, gender, and school success: The role of habitus. *Sociology of Education, 75*(1), 44-68. doi:10.2307/3090253

Dunn, J., Bretherton, I., & Munn, P. (1987). Conversations about feeling states between mothers and their young children. *Developmental Psychology, 23*(1), 132-139. doi:10.1037/0012-1649.23.1.132

Eagly, A. H., Nater, C., Miller, D. I., Kaufmann, M., & Sczesny, S. (2019). Gender stereotypes have changed: A cross-temporal meta-analysis of U.S. public opinion polls from 1946 to 2018. *American Psychologist.* doi:10.1037/amp0000494

Ehlers, S., & Gillberg, C. (1993). The epidemiology of Asperger syndrome. A total population study. *Journal of Child Psychology & Psychiatry & Allied Disciplines, 34*(8), 1327-1350. doi:10.1111/1469-7610.ep11358370

Eriksson, M., Marschik, P. B., Tulviste, T., Almgren, M., Pérez Pereira, M., Wehberg, S., . . . Gallego, C. (2012). Differences between girls and boys in emerging language skills: Evidence from 10 language communities. *British Journal of Developmental Psychology, 30*(2), 326-343. doi:10.1111/j.2044-835X.2011.02042.x

Fenson, L., Dale, P. S., Reznick, J. S., Bates, E., Thal, D. J., Pethick, S. J., . . . Stiles, J. (1994). Variability in early communicative development. *Monographs of the Society for Research in Child Development, 59*(5), i-185. doi:10.2307/1166093

Fernández, C., & Melzi, G. (2008). Evaluation in Spanish-speaking Mother–Child narratives: The social and sense-making function of internal-state references. In A. McCabe, A. L. Bailey & G. Melzi (Eds.), *Spanish-language narration and literacy: Culture, cognition, and emotion* (pp. 92-118). Cambridge: Cambridge University Press. doi:10.1017/CBO9780511815669.007

Fivush, R. (1989). Exploring sex differences in the emotional content of mother-child conversations about the past. *Sex Roles, 20*(11), 675-691. doi:10.1007/BF00288079

Fivush, R., Brotman, M. A., Buckner, J. P., & Goodman, S. H. (2000). Gender differences in Parent–Child emotion narratives. *Sex Roles, 42*(3), 233-253. doi:10.1023/A:1007091207068

Fombonne, E. (2009). Epidemiology of pervasive developmental disorders. *Pediatric Research, 65*(6), 591.

Gillam, R. B., & Pearson, N. A. (2004). *Test of Narrative Language;*. Austin, TX: PRO-ED.

Gillberg, C., & Steffenburg, S. (1987). Outcome and prognostic factors in infantile autism and similar conditions: A population-based study of 46 cases followed through puberty. *J.Autism Dev.Disord. 17*(2), 273-287.

Goldberg, W. (2010). *Current Directions in Gender Psychology*. Boston: Allyn & Bacon.

Goldscheider, F., Bernhardt, E., & Lappegård, T. (2015). The gender revolution: A framework for understanding changing family and demographic

behavior. *Population and Development Review, 41*(2), 207-239. doi:10.1111/j.1728-4457.2015.00045.x

Gould, J., & Ashton-Smith, J. (2011). Missed diagnosis or misdiagnosis? girls and women on the autism spectrum. *Good Autism Practice, 12*(1), 34-41.

Gray, J. (2002). *Men are from Mars, Women are from Venus*. London: Thorsons.

Haas, A. (1979). Male and female spoken language differences: Stereotypes and evidence. *Psychological Bulletin, 86*(3), 616-626. doi:10.1037/0033-2909.86.3.616

Haines, E. L., Deaux, K., & Lofaro, N. (2016). The times they are a-changing … or are they not? A comparison of gender stereotypes, 1983–2014. *Psychology of Women Quarterly, 40*(3), 353-363. doi:10.1177/0361684316634081

Harris, P. L. (1993). Pretending and planning. *Understanding Other Minds: Perspectives from Autism*, 228-246.

Harrop, C., Shire, S., Gulsrud, A., Chang, Y., Ishijima, E., Lawton, K., & Kasari, C. (2015). Does gender influence core deficits in ASD? an investigation into social-communication and play of girls and boys with ASD. *Journal of Autism & Developmental Disorders, 45*(3), 766-777. doi:10.1007/s10803-014-2234-3

Hartley, S. L., & Sikora, D. M. (2009). Sex differences in autism spectrum disorder: An examination of developmental functioning, autistic symptoms, and coexisting behavior problems in toddlers. *Journal of Autism & Developmental Disorders, 39*(12), 1715-1722. doi:10.1007/s10803-009-0810-8

Hebert-Myers, H., Guttentag, C. L., Swank, P. R., Smith, K. E., & Landry, S. H. (2006). The importance of language, social, and behavioral skills across early and later childhood as predictors of social competence with peers. *Applied Developmental Science, 10*(4), 174-187. doi:10.1207/s1532480xads1004_2

Hiller, R. M., Young, R. L., & Weber, N. (2014). Sex differences in autism spectrum disorder based on DSM-5 criteria: Evidence from clinician and teacher reporting. *Journal of Abnormal Child Psychology, 42*(8), 1381-1393. doi:10.1007/s10802-014-9881-x

Holtmann, M., Bölte, S., & Poustka, F. (2007). Autism spectrum disorders: Sex differences in autistic behaviour domains and coexisting psychopathology. *Developmental Medicine & Child Neurology, 49*(5), 361-366.

Hyde, J. S., Bigler, R. S., Joel, D., Tate, C. C., & van Anders, S. M. (2019). The future of sex and gender in psychology: Five challenges to the gender binary. *The American Psychologist, 74*(2), 171-193. doi:10.1037/amp0000307

Johnston, J. R. (2008). Narratives: Twenty-five years later. *Topics in Language Disorders, 28*(2), 93-98. doi:10.1097/01.TLD.0000318931.08807.01

Kauschke, C., van der Beek, B., & Kamp-Becker, I. (2016). Narratives of girls and boys with autism spectrum disorders: Gender differences in narrative competence and internal state language. *Journal of Autism & Developmental Disorders, 46*(3), 840-852. doi://dx.doi.org/10.1007/s10803-015-2620-5

Kelley, E., Naigles, L., & Fein, D. (2010). An in-depth examination of optimal outcome children with a history of autism spectrum disorders. *Research in Autism Spectrum Disorders, 4*(3), 526-538. doi:10.1016/j.rasd.2009.12.001

Kelley, E., Paul, J. J., Fein, D., & Naigles, L. R. (2006). Residual language deficits in optimal outcome children with a history of autism. *Journal of Autism and Developmental Disorders, 36*(6), 807. doi:10.1007/s10803-006-0111-4

Kim, S. H., Paul, R., Tager-Flusberg, H., & Lord, C. (2014). Language and communication in autism. In F. Volkmar, S. Roger, R. Paul & K. A. Pelphry (Eds.), *Handbook of autism and pervasive developmental disorders, volume I: Diagnosis, development and brain mechanisms* (pp. 230-262). Hoboken, NJ: Wiley.

King, D., Dockrell, J. E., & Stuart, M. (2013). Event narratives in 11–14-year-olds with autistic spectrum disorder. *International Journal of Language & Communication Disorders, 48*(5), 522-533. doi:10.1111/1460-6984.12025

King, D., Dockrell, J., & Stuart, M. (2014). Constructing fictional stories: A study of story narratives by children with autistic spectrum disorder. *Research in Developmental Disabilities, 35*(10), 2438-2449. doi:10.1016/j.ridd.2014.06.015

Kopp, S., & Gillberg, C. (2011). The autism spectrum screening questionnaire (ASSQ)-revised extended version (ASSQ-REV): An instrument for better capturing the autism phenotype in girls? A preliminary study involving 191 clinical cases and community controls. *Research in Developmental Disabilities, 32*, 2875-2888. doi:10.1016/j.ridd.2011.05.017

Kreiser, N., & White, S. (2014). ASD in females: Are we overstating the gender difference in diagnosis? *Clinical Child & Family Psychology Review, 17*(1), 67-84. doi:10.1007/s10567-013-0148-9

Kuo, M. H., Orsmond, G. I., Cohn, E. S., & Coster, W. J. (2013). Friendship characteristics and activity patterns of adolescents with an autism spectrum disorder. *Autism: The International Journal of Research & Practice, 17*(4), 481-500. doi:10.1177/1362361311416380

Ladegaard, H. J., & Bleses, D. (2003). Gender differences in young children's speech: The acquisition of sociolinguistic competence. *International Journal of Applied Linguistics, 13*(2), 222-233. doi:10.1111/1473-4192.00045

Lai, M., Lombardo, M. V., & Baron-Cohen, S. (2014). Autism. *Lancet, 383 North American Edition* (9920), 896-910. doi:10.1016/S0140-6736(13)61539-1

Lai, M., Lombardo, M. V., Pasco, G., Ruigrok, A. N. V., Wheelwright, S. J., Sadek, S. A., . . . Baron-Cohen, S. (2011). A behavioral comparison of male and female adults with high functioning autism spectrum conditions. *PLoS ONE, 6*(6), 1-10. doi:10.1371/journal.pone.0020835

Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: A practical primer for t-tests and ANOVAs. *Frontiers in Psychology, 4*, 863. doi:10.3389/fpsyg.2013.00863

Landa, R. J., & Goldberg, M. C. (2005). Language, social, and executive functions in high functioning autism: A continuum of performance. *Journal of Autism and Developmental Disorders, 35*(5), 557. doi:10.1007/s10803-005-0001-1

Lanvers, U. (2004). Gender in discourse behaviour in parent-child dyads: A literature review. *Child: Care, Health and Development, 30*, 481-93. doi:10.1111/j.1365-2214.2004.00443.x

Lawson, L. P., Joshi, R., Barbaro, J., & Dissanayake, C. (2018). Gender differences during toddlerhood in autism spectrum disorder: A prospective community-based longitudinal follow-up study. *Journal of Autism and Developmental Disorders, 48*(8), 2619-2628. doi:10.1007/s10803-018-3516-y

Leaper, C. (1991). Influence and involvement in children's discourse: Age, gender, and partner effects. *Child Development, 62*(4), 797.

Leaper, C., Anderson, K. J., & Sanders, P. (1998). Moderators of gender effects on parents' talk to their children: A meta-analysis. *Developmental Psychology, 34*(1), 3-27. doi:10.1037/0012-1649.34.1.3

Leyfer, O. T., Folstein, S. E., Bacalman, S., Davis, N. O., Dinh, E., Morgan, J., . . . Lainhart, J. E. (2006). Comorbid psychiatric disorders in children with autism: Interview development and rates of disorders. *Journal of Autism and Developmental Disorders, 36*(7), 849-861. doi:10.1007/s10803-006-0123-0

Longobardi, E., Lonigro, A., Laghi, F., & O'Neill, D. K. (2017). Pragmatic language development in 18- to 47-month-old italian children: A study with the language use inventory. *First Language, 37*(3), 252-266. doi:10.1177/0142723716689273

Lorber, J., & Moore, L. (2007). *Gendered bodies: Feminist perspectives*. Los Angeles: Roxbury.

Lord, C., Risi, S., Lambrecht, L., Cook Jr., E. H., Leventhal, B. L., DiLavore, P. C., . . . Rutter, M. (2000). The autism diagnostic observation schedule generic: A standard measure of social and communication deficits associated with the spectrum of autism. *Journal of Autism & Developmental Disorders, 30*(3), 205-223.

Losh, M., & Capps, L. (2003). Narrative ability in high-functioning children with autism or Asperger's syndrome. *Journal of Autism & Developmental Disorders, 33*(3), 239-251.

Losh, M., & Capps, L. (2006). Understanding of emotional experience in autism: insights from the personal accounts of high-functioning children with autism. *Developmental Psychology, 42*(5), 809-818. doi:10.1037/0012-1649.42.5.809

Loveland, K. A., McEvoy, R. E., Tunali, B., & Kelley, M. L. (1990). Narrative story telling in autism and down's syndrome. *British Journal of Developmental Psychology, 8*(1), 9-23. doi:10.1111/j.2044-835X.1990.tb00818.x

Lytton, H., & Romney, D. M. (1991). Parents' differential socialization of boys and girls. *Psychological Bulletin, 109*(2), 267-296. doi:10.1037/0033-2909.109.2.267

Maccoby, E. E. (2002). Gender and group process: A developmental perspective. *Curr Dir Psychol Sci, 11*(2), 54-58. doi:10.1111/1467-8721.00167

Makinen, L., Loukusa, S., Leinonen, E., Moilanen, I., Ebeling, H., & Kunnari, S. (2014). Characteristics of narrative language in autism spectrum disorder: Evidence from the Finnish. *Research in Autism Spectrum Disorders, 8*(8), 987-996.

Mandy, W., Chilvers, R., Chowdhury, U., Salter, G., Seigal, A., & Skuse, D. (2012). Sex differences in autism spectrum disorder: Evidence from a large sample of children and adolescents. *Journal of Autism & Developmental Disorders, 42*(7), 1304-1313. doi:10.1007/s10803-011-1356-0

Matlin, M. (2008). *The Psychology of Women* (6. ed). Fort Worth: Hartcourt Brace.

May, T., Cornish, K., & Rinehart, N. (2014). Does gender matter? A one-year follow-up of autistic, attention and anxiety symptoms in high-functioning children with autism spectrum disorder. *Journal of Autism and Developmental Disorders,* (5), 1077.

Mayer, M. (2003). *A Boy, a Dog, and a Frog* Dial Books.

McLennan, J. D., Lord, C., & Schopler, E. (1993). Sex differences in higher functioning people with autism. *Journal of Autism and Developmental Disorders, 23*(2), 217-227. doi:10.1007/BF01046216

Meier, C. R., DiPerna, J. C., & Oster, M. M. (2006). *Importance of Social Skills in the Elementary Grades.* West Virginia University Press.

Mulac, A., Bradac, J. J., & Gibbons, P. (2006). Empirical support for the gender-as-culture hypothesis: An intercultural analysis of male/female language differences. *Human Communication Research, 27*(1), 121-152. doi:10.1111/j.1468-2958.2001.tb00778.x

Newman, M. L., Groom, C. J., Handelman, L. D., & Pennebaker, J. W. (2008). Gender differences in language use: An analysis of 14,000 text samples. *Discourse Processes, 45*(3), 211-236. doi:10.1080/01638530802073712

Norbury, C. F., & Bishop, D. (2003). Narrative skills of children with communication impairments. *International Journal of Language & Communication Disorders, 38*(3), 287-313.

Norbury, C. F. (2005). Barking up the wrong tree? lexical ambiguity resolution in children with language impairments and autistic spectrum disorders. *Journal of Experimental Child Psychology, 90*(2), 142-171. doi://doi.org/10.1016/j.jecp.2004.11.003

Norbury, C. F., Gemmell, T., & Paul, R. (2014). Pragmatics abilities in narrative production: A cross-disorder comparison. *Journal of Child Language, 41*(3), 485-510. doi:10.1017/S030500091300007X

Novogrodsky, R. (2013). Subject pronoun use by children with autism spectrum disorders (ASD). *Clinical Linguistics & Phonetics, 27*(2), 85-93. doi:10.3109/02699206.2012.742567

O'Neill, D. K. (2007). The language use inventory for young children: A parent-report measure of pragmatic language development for 18- to 47-month-old children. *Journal of Speech, Language, and Hearing Research, 50*(1), 214-228. doi:10.1044/1092-4388(2007/017)

Owens, R. E. (2014). *Language Disorders A Functional Approach to Assessment and Intervention*. Upper Saddle River, NJ: Pearson Education Inc.

Parish-Morris, J., Liberman, M., Cieri, C., Herrington, J., Yerys, B., Bateman, L., . . . Schultz, R. (2017). Linguistic camouflage in girls with autism spectrum disorder. *Molecular Autism, 8*(1), 48.

Paul, R., Orlovski, S. M., Marcinko, H. C., & Volkmar, F. (2009). Conversational behaviors in youth with high-functioning ASD and Asperger syndrome. *Journal of Autism and Developmental Disorders, 39*(1), 115-125. doi:10.1007/s10803-008-0607-1

Pilowsky, T., Yirmiya, N., Shulman, C., & Dover, R. (1998). The autism diagnostic interview-revised and the childhood autism rating scale: Differences between diagnostic systems and comparison between genders. *Journal of Autism & Developmental Disorders, 28*(2), 143-151.

Rider, E. (2005). *Our Voices: Psychology of women* (2nd ed.). Hoboken: John Wiley & Sons.

Rivet, T., & Matson, J. (2011). Gender differences in core symptomatology in autism spectrum disorders across the lifespan. *Journal of Developmental & Physical Disabilities, 23*(5), 399-420. doi:10.1007/s10882-011-9235-3

Roger, K.M., Rinaldi, C.M. & Howe, N. (2012), Mothers' and Fathers' Internal State Language with Their Young Children: An Examination of Gender Differences During an Emotions Task. *Inf. Child Dev*., 21: 646-666. doi:10.1002/icd.1762

Rollins, P. (2014). Personal narratives in individuals with high-functioning ASD: A lens into social skills. *Perspectives on Language Learning and Education, 21*(1), 13-20. doi:10.1044/lle21.1.13

Roux, A. M., Shattuck, P. T., Cooper, B. P., Anderson, K. A., Wagner, M., & Narendorf, S. C. (2013). Postsecondary employment experiences among young adults with an autism spectrum disorder. *Journal of the American Academy of Child & Adolescent Psychiatry, 52*(9), 931-939. doi://doi.org/10.1016/j.jaac.2013.05.019

Rumpf, A., Kamp-Becker, I., Becker, K., & Kauschke, C. (2012). *Narrative competence and internal state language of children with Asperger syndrome and ADHD* doi://doi.org/10.1016/j.ridd.2012.03.007

Russell, R. L. (2007). Social communication impairments: Pragmatics. *The Pediatric Clinics of North America, 54*(3), 483-506. doi:10.1016/j.pcl.2007.02.016

Rutter, M., LeCouteur, A., & Lord, C. (2003). *ADI-R: The Autism Diagnostic Interview-Revised*. Los Angeles, CA: Western Psychological Services.

Semel, E., Wiig, E., & Secord, W. (2003). *Clinical Evaluation of Language Fundamentals* (4th ed.). San Antonio, TX: Pearson.

Siller, M., Swanson, M. R., Serlin, G., & George, A. (2014). Internal state language in the storybook narratives of children with and without autism spectrum disorder: Investigating relations to theory of mind abilities. *Research in Autism Spectrum Disorders, 8*(5), 589-596.

Smith, B. (2007). *The Psychology of Sex and Gender*. Boston: Pearson/Allyn & Bacon.

Solomon, M., Miller, M., Taylor, S., Hinshaw, S., & Carter, C. (2012). Autism symptoms and internalizing psychopathology in girls and boys with autism spectrum disorders. *Journal of Autism & Developmental Disorders, 42*(1), 48-59. doi:10.1007/s10803-011-1215-z

Sparrow, S. S., Cicchetti, D. V., & Balla, D. A. (2005). *Vineland II: A Revision of the Vineland Adaptive Behavior Scales: I. Survey/Caregiver form*. Circle Pines, MN: American Guidance Service.

St Clair, M. C., Pickles, A., Durkin, K., & Conti-Ramsden, G. (2011). A longitudinal study of behavioral, emotional and social difficulties in individuals with a history of specific language impairment (SLI). *Journal of Communication Disorders, 44*(2), 186-199. doi://doi.org/10.1016/j.jcomdis.2010.09.004

Sturrock, A., Yau, N., Freed, J., & Adams, C. (2019). Speaking the same language? A preliminary investigation, comparing the language and communication skills of females and males with high-functioning autism. *Journal of Autism and Developmental Disorders,* doi:10.1007/s10803-019-03920-6

Swineford, L. B., Thurm, A., Baird, G., Wetherby, A. M., & Swedo, S. (2014). Social (pragmatic) communication disorder: A research review of this new DSM-5 diagnostic category. *Journal of Neurodevelopmental Disorders, 6*(1), 41. doi:10.1186/1866-1955-6-41

Szatmari, P., Georgiades, S., Duku, E., Bennett, T., Bryson, S., Fombonne, E., . . . Thompson, A. (2015). Developmental trajectories of symptom severity and adaptive

functioning in an inception cohort of preschool children with autism spectrum disorder. *JAMA Psychiatry,* (3), 276. doi:10.1001/jamapsychiatry.2014.2463

Taylor, J. L., Henninger, N. A., & Mailick, M. R. (2015). Longitudinal patterns of employment and postsecondary education for adults with autism and average-range IQ. *Autism, 19*(7), 785-793. doi:10.1177/1362361315585643

Tillmann, J., Ashwood, K., Absoud, M., Bölte, S., Bonnet-Brilhault, F., Buitelaar, J. K., . . . Charman, T. (2018). Evaluating sex and age differences in ADI-R and ADOS scores in a large European multi-site sample of individuals with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 48*(7), 2490-2505. doi:10.1007/s10803-018-3510-4

Unger, R. (1979). Toward a redefinition of sex and gender. *American Psychologist, 34*, 1085-1094.

Volden, J. (2004). Conversational repair in speakers with autism spectrum disorder. *International Journal of Language & Communication Disorders, 39*(2), 171-189. doi:10.1080/13682820410001663252

Volden, J., Dodd, E., Engel, K., Smith, I. M., Szatmari, P., Fombonne, E., . . . Duku, E. (2017). Beyond sentences: Using the expression, reception, and recall of narratives instrument to assess communication in school-aged children with autism spectrum disorder. *Journal of Speech, Language & Hearing Research, 60*(8), 2228-2240. doi:10.1044/2017_JSLHR-L-16-0168

Wechsler, D. (2003). *Wechsler Intelligence Scale for Children.* (4th ed.). Toronto, CA: Pearson Education Inc.

Wijngaarden-Cremers, P., van Eeten, E., Groen, W. B., Van Deurzen, P. A., Oosterling, I. J., & Van, d. G. (2014). Gender and age differences in the core triad of impairments in autism spectrum disorders: A systematic review and meta-analysis. *Journal of Autism and Developmental Disorders, 44*(3), 627-635.

Wood, J. (1999). *Gendered lives: Communication, gender, and culture* (3rd ed.). Belmont: Wadsworth.

Zahn-Waxler, C., Cole, P., & Barrett, K. (1991). Guilt and empathy: Sex differences and implications for the development of depression. In J. Garber & K. Dodge (Eds.), *The Development of Emotion Regulation and Dysregulation* (Cambridge Studies in Social and Emotional Development, pp. 243-272). Cambridge: Cambridge University Press. doi:10.1017/CBO9780511663963.012

APPENDICES

Appendix A – Detailed Transcript Analysis Coding Manual (modeled on Norbury, Gemmell & Paul, 2014)

Step 1: Enter transcription of narrative into a Systematic Analysis of Language Transcripts (SALT) file following these general procedures:

1. Type child's story into SALT. Begin each line with a "c" to identify the child as the speaker. If the adult also talks, use an "e" to note the speaker's turn. End each line with punctuation.
2. Each line should represent a t-unit, which includes a full main clause and all subordinate clauses that belong to it. Each clause should have a subject and be able to stand on its own.
3. Abandoned utterances should end with a">".
4. False starts are hesitations or reformulations, called mazes in the SALT program, and should be surrounded by ( ).
5. Unintelligible utterances: If you really can't hear what a child has to say, mark XXX in the transcript.
6. Missing obligatory elements are indicated by an asterisk – for example he *is going to the pet store.

GENERAL GUIDELINES FOR CODING:

1. All codes must be enclosed in square brackets [ ].

2. Utterance level (U) codes must include a space between the utterance and the code.

3. Word level (W) codes are placed next to the coded word, with NO SPACE between the word and the bracket.

A. Pragmatic Index

Pedantic language [PL]:

'Formal language' that does not enhance the meaning of the utterance. These can include stereotyped phrases that the child uses repetitively, e.g., 'actually' 'in order to'. NB: Distinguish these from perseverations, which are direct repetitions within a sequence of utterances of an idea—not necessarily verbatim.

Misattributions [MA]:

Misattribution errors occur when an incorrect inference is drawn leading to a misunderstanding of the point of the utterance, action or story. This can include mental state misattributions (ie, stating that the boy was upset when the girls returned the fish), and special interest topics being included in the narrative (ie, talking about Minecraft during the narrative task).

Irrelevant Detail [ID]:

Irrelevant details include correct but nonessential mentions (e.g., mentioning the motorcycle that appears in a story picture), tangential remarks, including remarks unrelated to story, and literal description of pictures not essential to plot.

Non-Narrator Speech [NN]:

Narrator comes out of narrator role to comment on aspect of story (ie; asking examiner if they have a fish). Code only complete utterances, not single words (such as "sorry") or phrases embedded in utterances.

Inconstant reference [IR]:

Inconstant references include unclear references to characters, or changing of character names in narrative. For example if the child starts off giving the character a proper name, then reverts to 'the boy', code [IR]. Code only the first instance of reversion after using proper name. Reference to an incorrect character is an error. However, if child refers to the wrong character, then corrects, do not code initial mistake as an error. If an unclear reference is made, code [ir] until obvious to listener to whom the child is referring.

Perseveration [P]:

Perseverative use of words or phrases – may be repetitive use of the same words or the restatement of the same idea. Code each repetitious line of part of the story after the second repetition then continue to code all subsequent repetitions.

Vague [V]:

Need a shared knowledge of the story to understand content independent of pronouns/character reference. Give a vague code when there is a lack of clarity in the narrative. For example if the child indicates that the boy in the story was buying a fish and then indicates that the boy was eating ice cream code this as "vague" as the child did not explain that the boy left the pet shop and met friends on his was home and decided to get ice cream.

Total Pragmatic score = ([PL] + [MA] + [ID] + [IR] + [P] + [V] + [NN]) / total number of utterances.

B. Semantic Index

Emotion word [EMO]:

Any word that conveys a feeling (e.g. depressed), or behavior that implies an affective element (e.g. rejoiced, scolded). Code attributions of emotions to others e.g. "You're a pain"[EMO].

Mental state word [MS]:

These words typically involve thinking something and include mental state terms that express knowledge, desire, beliefs, thoughts, imagination, or plans. Code words that apply to the story teller or the characters in the story. For example, "I think [MS] the girl is suspicious [MS]".

Intentional utterance [INT]:

These are utterances that imply planning or forethought by one of the characters (e.g. to go get, plan, let). Also imply awareness by one character of another's mental state and a means to have an impact on another character's mental state or behavior (e.g. hiding, teasing, making fun of, tricking, paying attention).

Note: "to chase" denotes intention; "to catch" does not.

Adverb [ADV]:

Only code adverbs ending in –ly. Do not count words that should be –ly adverbs but to which child does not add –ly.

Character speech [CS]:

Anything that a character actually said that could be put in quotation marks.

Semantic Error [SERR]:

The use of a semantically related, but incorrect, word. Example: "suitcase" for "bag". Code only the first example of the error.

Semantic Enhancement Index = ([EMO] + [MS] + [INT] + [ADV] + [CS] - [SERR]) / total number of utterances

C. Syntactic Complexity

Complex Sentence [C]:

Placed at beginning of the utterance with a space intervening and includes sentences with subordinate clauses, including:

- Infinitive clauses: headed by "to" and a verb.
- Relative clauses: function as adjectives; specify nouns; may or may not be marked with "which" or "that".
- Adverbial clauses: joined with conjunctions such as "if", "because", "when".
- Gerund clauses: containing an –ing form of a verb, functioning as noun. Example: "Swimming is fun".
- wh- clauses: marked by wh- words such as "what", "who", "where", "when", "why" and "how".
- Propositional clauses: Marked by "cognitive" verbs, such as "think", "guess", "wish", "know", "hope", "wonder"; may or may not contain the conjunction "that".
- Coordinate clauses conjoined by anything except "and", "or" and "then".

The following should NOT be counted as complex sentences, if no other clause appears within them:

- Participial phrases with –ed, en.
- Sentences with catenatives (gonna, wanna, gotta, hafta, sposedto, let's, or lemme) if no other subordination is present.
- Sentences in which the only form of subordination is character speech, with no other complex clause included.

Noun Phrase Elaboration [NP]:

More than two modifiers preceding the noun. Place without a space following the noun that is elaborated. For example The boy asked for the big shiny fish[NP].

Do not code prepositional phrases.

Syntactic Complexity = ([C] + [NP]) / total number of utterances.

D. Formulation Index

Error Word [EW]:

Words omitted in obligatory context (e.g., He *is[EW] going.), missing subjects (E.g., *He[EW] finds the fish.), or words used inappropriately (e.g., use of "there's" for "there are"). Code article omissions except where the word without an article could be used as a proper name.

Error Utterance [EU]:

Error utterances are utterances with any type of grammatical error that cannot be attributed to a single word. This includes incomplete or nonsensical utterances in which the meaning is unclear because of multiple misuses and referential errors (e.g., "he would want him so in order to get his friends back and in order for the happen everything would be ok then").

Abandoned Utterance [>]:

SALT program will count any utterance ending with > as abandoned.

Unintelligible Utterance [XXX]:

SALT program will count completely and partially unintelligible utterances separately.

Maze [()]:

Refers to utterances with any mazes, regardless of number.

Formulation Index = ([EW] + [EU] + [>] + [XXX] + [()]) / total number of utterances

E. Story Macrostructure: Settings, Conflict/Conflict Resolution, Conclusion, Cohesion and Referencing

E.1 Settings, Conflict/Conflict Resolution, Conclusion

Assign a score of 0, 1 or 2 to each utterance according to the story context. A score of 2 should be awarded when all of the salient elements of story point are present. A score of 1 should be awarded if only one of the elements is missing, and a 0 should be awarded if none of the salient elements are included in the utterance. Add the number of points for each category (Settings, Conflict/Conflict Resolution, Conclusion) and divided by the total number of points available for that section (total points for Settings, Conflict/Conflict Resolution and Conclusion is 32, 8, and 8 respectively) to produce a percentage. Use this percentage to assign a rating of immature (<33%), emerging (33-75%), or proficient (>75%) in each of the areas.

E.2 Cohesion and Referencing

Cohesion and Referencing are derived from examining the overall narrative. Cohesion refers to how well the story flowed, whether the major events were emphasized, and if the story made sense. Referencing is a rating of how well the child refers to the correct characters or events to help reduce confusion. Each narrative could receive a rating of either “immature”, “emerging” or “proficient”. Assign a rating of “immature” if there are more than 3 mistakes or unclear points in the narrative. Assign a rating of “Emerging” if there are 2 or 3 mistakes or unclear points in the narrative. Assign a rating of “Proficient” if there are 0 or 1 mistakes or unclear points in the narrative.

Appendix B – Narrative Score Sheet

Carry decimals in scores to two places.

Transcript Summary

Total number of utterances	
Total number of words	
Total number of different words	
Type-token ratio	
Mean Length of Utterance (words)	

Pragmatic Index Score

Misattributions [ma]	
Irrelevant attributions/detail [id]	
Inconstant reference [ir]	
Pedantic language [pl]	
Perserveration [p]	
Vague [v]	
Non-narrator speech [nn]	
Pragmatic Score (ma + id + ir + pl + p +v +nn) / total number of utterances	

Semantic Enhancement Index Score

NDW emotion words [emo]	
NDW mental words [ms]	
Intention utterances [int]	
Adverbs [adv]	
character speech [cs]	
Semantic error [serr]	
Semantic score (emo + ms + int + adv + cs - serr) / total number of utterances	

Syntactic Complexity

noun phrase elaborations [np]	
complex sentences [c]	
Syntactic complexity score (np + c) / total number of utterances	

Formulation

error words [ew]	
error utterances [eu]	

mazes – refers to utterances with any mazes, regardless of number.	
Unintelligible utterances (uu)	
Abandoned utterances	
Syntactic deviance score (EW + EU + mazes + uu + abandon) / total number of utterances	

Rubric Score:

	Proficient (3-4)	Emerging (1-2)	Immature (0-1)
Setting (S)			
Referencing (R)			
Conflict resolution (CR)			
Cohesion (COH)			
Conclusion (CON)			

Appendix C – Story Macrostructure Content for Expression Reception and Recall of Narrative Instrument Fish Story

S = setting

CR = conflict resolution

Con = conclusion

1. Boy feeds fish **(S)**
    a. Must introduce the boy and the fish (1)
    b. Must mention something about food/feeding fish (1)
2. Mother gives boy money **(S)**
    a. Must introduce the mother (1)
    b. Must mention the boy receiving money from the mother (1)
3. To buy another fish **(S)**
    a. Must mention new/more/another (1) fish (1)
4. Boy leaves and walks down the street/heads to the shops **(S)**
    a. Must mention that the boy has left (1)
    b. Must mention the boy is heading somewhere (1)
5. He arrives at the pet shop **(S)**
    a. Must mention boy arriving (1)
    b. Must mention the pet shop (1)
6. Show the shopkeeper the fish he wants **(S)**
    a. Must mention the shop attendant (1)
    b. Must mention pointing to or showing the fish (1)

7. Shopkeeper puts the fish in his (the boy's) bag **(S)**
    a. Must mention the shop attendant (1)
    b. Must mention placing the fish in the boy/his bag (1)
8. Boy buys the fish **(S)**
    a. Must mention an exchange of money (ie buys) (1)
    b. Must mention the fish (1)
9. Boy leaves pet shop/sets off home **(S)**
    a. Must mention the boy leaving (1)
    b. Must mention the boy heading home (1)
10. He meets two friends **(S)**
    a. Must mention 2 people (1)
    b. Must mention they are friends (1)
11. Boy and girl go buy an ice cream **(S)**
    a. Must mention boy and girl (1)
    b. Must mention they are going to get food (1)
12. The little girl takes the fish out of the bag **(S)**
    a. Must mention the other girl (1)
    b. Must mention the fish (1)
13. They sit on the bench **(S)**
    a. Must mention the bench (1)
    b. Must mention more than one person (they, the friends, they boy and girl) (1)
14. And eat their ice cream **(S)**

a. Must mention them eating (1)

b. Must mention ice cream (1)

15. The boy waves goodbye and goes home **(S)**

a. Must mention the boy saying goodbye somehow (waves, says bye) (1)

b. Must mention boy going home (1)

16. The boy finds he has a doll in his bag **(S)**

a. Must mention the doll (1)

b. Must mention him finding it or having some sort of element of surprise (1)

17. He tells his mother **(CR)**

a. Must mention mother (1)

b. Must mention telling (1)

18. Mother phones his friends **(CR)**

a. Must mention mother phoning (1)

b. Must mention friends (1)

19. Friends come over with the fish **(CR)**

a. Must mention the friends arriving or coming over (1)

b. Must mention fish (1)

20. They exchange the contents of the bag **(CR)**

a. Must mention an exchange (1)

b. Must mention the contents (ie doll and fish) (1)

21. The boy gets his fish back **(Con)**

a. Must mention the boy (1)

b. Must mention a return of the fish (1)

22. The boy puts the new fish in the tank **(Con)**

    a. Must mention the fact that it is another or new or multiple (ie second or new or other) fish (1)

    b. Must mention the tank (1)

23. The boy shows his friends the fish **(Con)**

    a. Must mention the boy showing (1)

    b. Must mention the friends (1)

24. The little girl is happy to have her doll **(Con)**

    a. Must mention the girl feeling an emotion such as happy, relief, glad (1)

    b. Must mention doll (1)

Appendix D – Ethics Approval for Conlon, Chapter 4

Approval Form

Date:	May 19, 2017
Study ID:	Pro00071927
Principal Investigator:	Joanne Volden
Study Title:	Gender Differences in Communication
Approval Expiry Date:	Friday, May 18, 2018

Approved Consent Form:	Approval Date 5/19/2017 5/19/2017	Approved Document Information letter Consent form

Sponsor/Funding Agency:	Glenrose Rehabilitation Hospital	GRH

	Project ID	Project Title	Speed Code	Other Information
RSO-Managed Funding:	View 00071927	Gender Differences in Social Communication in Autism Spectrum Disorder		

Thank you for submitting the above study to the Health Research Ethics Board - Health Panel. Your application, including the following, has been reviewed and approved on behalf of the committee;

- Recruitment Poster (5/16/2017)
- Assent Form (5/16/2017)
- Parent Questionnaires (5/3/2017)
- Study Protocol (5/2/2017)

The Health Research Ethics Board assessed all matters required by section 50(1)(a) of the Health Information Act. Subject consent for access to identifiable health information is required for the research described in the ethics application, and appropriate procedures for such consent have been approved by the HREB Health Panel. In order to comply with the Health Information Act, a copy of the approval form is being sent to the Office of the Information and Privacy Commissioner.

A renewal report must be submitted next year prior to the expiry of this approval if your study still requires ethics approval. If you do not renew on or before the renewal expiry date (Friday, May 18, 2018), you will have to re-submit an ethics application.

Approval by the Health Research Ethics Board does not encompass authorization to access the patients, staff or resources of Alberta Health Services or other local health care institutions for the

purposes of the research. Enquiries regarding Alberta Health approval should be directed to (780) 407-6041. Enquiries regarding Covenant Health approvals should be directed to (780) 735-2274.

Sincerely,

Carol Boliek, PhD.
Associate Chair, Health Research Ethics Board - Health Panel

Note: This correspondence includes an electronic signature (validation and approval via an online system).

Appendix E – Recruitment Flyer for Conlon, Chapter 4

Attention 8 and 10 year olds

Research Study Opportunity

What is the study about?

- Social communication skills of all children
- We want to know if boys and girls have similar or different social communication skills
- Results may help us understand why boys are more likely to have developmental impairments

What is involved in the study?

- Two 2 hour visits with a researcher, where tests that examine language and problem solving skills will be completed
- Visits can take place in your home or at the University of Alberta
- Participants are given a **$20 gift card** as a token of appreciation

Who can participate?

- Any child who is 8 or 10 years old who does not have a diagnosis of Autism Spectrum Disorder

For more information and to sign up please contact:

Olivia Conlon
780-492-9050
social.communication.study@gmail.com

Pro00071927

Appendix F - Edmonton Catholic School Board Approval for Conlon, Chapter 4

EDMONTON CATHOLIC SCHOOLS
Growing in the SPIRIT

Catholic Education Services • 9807-106 Street • Edmonton AB T5K 1C2 • T: 780 441-6000 • F: 780 425.8759 • www.ecsd.net

Date: November 03, 2017

To: Dr. Denise Larsen/ Carrie Lynch

Email: edasg@ualberta.ca

From: Cecilia Fenrich
Research Approval: Edmonton Catholic Schools
780-441-6115
Cecilia.Fenrich@ecsd.net

Research Applicant: Joanne Volden (Olivia Conlon)

Title of Research: Gender Differences in Communication

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Joanne Volden (Olivia Conlon) has permission to conduct the above named research project in the Edmonton Catholic School District:

1. Distribution of the recruitment materials is voluntary and decided by the principal of each school
2. No in-person recruitment can take place at any school
3. No assessment or other research practices can take place at the schools during or after school hours.

Educational Planning
Edmonton Catholic Schools
9807 – 113 Street
Edmonton Alberta
T5K 1C2

EDMONTON CATHOLIC SCHOOLS