Summer 2019

The Effects of Autism Symptom Severity and Social Anxiety on Pragmatic Language in Young Adult Males with Fragile X Syndrome

Sara McGrath Matherly

THE EFFECTS OF AUTISM SYMPTOM SEVERITY AND SOCIAL ANXIETY ON PRAGMATIC LANGUAGE IN YOUNG ADULT MALES WITH FRAGILE X SYNDROME

by

Sara McGrath Matherly

Bachelor of Science
University of North Carolina Chapel Hill, 2007

Master of Arts
University of South Carolina, 2016

Submitted in Partial Fulfillment of the Requirements

For the Degree of Doctor of Philosophy in

School Psychology

College of Arts and Sciences

University of South Carolina

2019

Accepted by:

Jane Roberts, Major Professor

Jessica Klusek, Major Professor

Kimberly Hills, Committee Member

Amanda Fairchild, Committee Member

Cheryl L. Addy, Vice Provost and Dean of the Graduate School

ACKNOWLEDGEMENTS

This work would not have been possible without the contributions and financial support of the National Institutes of Health (F32DC013934; R01MH090194; R01HD024356; U54HD079125) and the Research Participant Registry Core of the Carolina Institute for Developmental Disabilities (P30HD03110). I am also indebted to the adolescents and families who participated in this study. Without their support and willingness to share their experiences, none of this work would have been possible. I also want to thank the staff at the Neurodevelopmental Disorders Lab at the University of South Carolina for assisting with recruitment, data collection and processing, and coordinating study visits.

I am grateful to each of the members of my Dissertation Committee who provided me with insights, support, and guidance throughout this process. I want to especially thank Drs. Jessica Klusek and my mentor, Jane Roberts, the co-chairs of my committee. You have both emulated an example of what a scientist-practitioner is meant to be through your actions, writing, and collaboration. I hope to continue your perseverance, determination, and legacies as I transition into my own professional career.

I draw no greater inspiration from the members of my family. Most importantly, I wish to thank my husband, Kevin, for his unconditional and unwavering support throughout this journey. And to my children, Owen and Austin, you have shown me the value of helping every person achieve their fullest life possible and may this work begin a devotion to this cause throughout my career.

ABSTRACT

Pragmatic, or social, language skills play a pivotal role in abilities that facilitate interpersonal relationships and independence, particularly in adulthood. Pragmatic language deficits are considered a core trait of males with fragile X syndrome (FXS); however, mechanisms that influence these abilities are not well known. This research is also limited by a lack of valid assessments that adequately capture pragmatic language skills. The present dissertation is the first to examine pragmatic language skills and mechanisms that influence these abilities using a novel, dynamic language assessment, the *Yale in vivo Pragmatic Protocol (YiPP)* in young adult males with FXS. Results revealed that communicative responses were lacking and required significant scaffolding from a conversational partner in the form of specific verbal requests. However, conversational turn taking appeared to be an area of personal strength. Increased severity of autism symptomology, but not social anxiety, was related to greater pragmatic language impairments. These findings have implications for informing measurement of pragmatic language skills and examination of mechanisms that may influence these abilities in more diverse clinical populations with intellectual disability (ID).

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ASD ..... Autism Spectrum Disorder

FMR1 ..... Fragile X Mental Retardation 1

FMRP ..... Fragile X Mental Retardation Protein

FXS ..... Fragile X Syndrome

ID ..... Intellectual Disability

YiPP ..... Yale In Vivo Pragmatic Protocol

CHAPTER 1

INTRODUCTION

Pragmatic, or social, language is a major component of language development that enables reciprocal social interactions and promotes interpersonal relationships (Emerson, 1985). The majority of research on pragmatic language development focuses on early childhood and adolescence. However, pragmatic language skills are critical across the lifespan as the use of pragmatic language skills are required to develop and maintain friendships, intimate relationships, employment, and leisure activities which positively influence quality of life in adulthood (Emerson, 1985; Emerson & Hatton, 1994; Hughes, Hwang, Kim, Eisenman, & Killian, 1995). Pragmatic language builds upon foundational language abilities and is characterized by the integration of three major communicative functions including the appropriate use of language for social goals (e.g. greeting, demanding, and promising), adjusting language to the needs of the listener (e.g. speaking differently to a stranger than family member), and adhering to conversational and storytelling rules (e.g. turn-taking, topic maintenance, and integration of verbal and nonverbal cues) (ASHA, 2017; Bates, 1976; McTear & Conti-Ramsden, 1992; Prutting & Kittchner, 1987). As such, pragmatic language reflects an individual's ability to know "when to speak, when not to, and what to talk about with whom, when, where, and in what manner" (Hymes, 1971, p.227). Pragmatic language skills are of interest for clinical populations with neurodevelopmental disorders and intellectual disabilities as they

present deficits in these areas which impact interpersonal relationships, independence, and quality of life.

1.1 FRAGILE X SYNDROME

Fragile X syndrome (FXS) is a neurodevelopmental disorder with hallmark deficits in pragmatic language (Abbeduto, Brady, & Kover, 2007; Sudhalter, Cohen, Silverman, & Wolf-Schein, 1990). FXS results from an expansion of cytosine, guanine, guanine (CGG) nucleotide repeats on the X chromosome at the *Fragile X Mental Retardation 1 (FMR1)* gene and affects roughly 1 in 2,500 to 5,000 individuals (Bailey et al., 2008; Bostrom et al., 2016; Crawford et al., 2001). The *FMR1* gene naturally contains a series of CGG repeats that represent the 5'-untranslated region. In individuals with FXS, the CGG repeat length has surpassed 200 repeats and is known as the full mutation (Devys, Lutz, Rouyer, Bellocq, & Mandel, 1993; Oberle et al., 1991; Pieretti et al., 1991; Sutcliffe et al., 1992). The full mutation is characterized by altering *FMR1* gene function through hypermethylation and transcriptional silencing resulting in reduced production of the Fragile Mental Retardation Protein (FMRP). FMRP is required for synaptic maturation and plasticity and is thought to be involved in typical cognitive functioning and learning (Darnell et al., 2011; Bostrom et al, 2016). FXS is the leading known monogenetic cause of intellectual disability, with cognitive abilities in the moderately to severely impaired range for males (i.e., IQ 35-50; Hagerman, 1999). Females are generally less affected than males due to the buffering effect of having a second X chromosome and functioning copy of the *FMR1* gene (Devys et al., 1993). The majority of research in FXS focuses on males due to females being less affected and presenting with greater cognitive and behavioral phenotypic heterogeneity.

Heightened rates of ASD and anxiety are also commonly found in males with FXS (Cordeiro, Ballinger, Hagerman, & Hessl, 2011; Kaufmann et al., 2004). Rates of ASD diagnosis in males with FXS range from 60 to 80%, with 90% of males exhibiting behaviors characteristic of the ASD phenotype (Budimirovic & Kaufmann, 2011; Clifford et al., 2007; García-Nonell et al., 2008; Harris et al., 2008; Klusek et al., 2014). Similar rates of anxiety are also present with roughly 86% of individuals with FXS meeting criteria for one or more anxiety disorders with social anxiety being one of most prevalent at 35% (Clifford et al., 2007; Cordeiro, Ballinger, Hagerman, & Hessl, 2011; Kaufmann et al., 2004; Loesch, Huggins, & Hagerman, 2004). Social anxiety has been found to be significantly more common in young adults with FXS than among children (Cordeiro et al., 2011) and often presents with elevated rates of gaze aversion and social escape behaviors (Bailey et al., 2008; Cordeiro et al., 2011; Thurman, McDuffie, Hagerman, & Abbeduto, 2014a). ASD and social anxiety are prevalent features of the clinical phenotype in males with FXS, and these are thought to negatively impact social interactions, including pragmatic language abilities.

1.2 PRAGMATIC LANGUAGE IN FXS

Despite relative strengths in foundational language skills, such as expressive and receptive vocabulary, and an intrinsic social motivation, pragmatic language skills present a particular area of challenge in FXS with impairments affecting the majority of males (Abbeduto, Murphy, Rice, & Warren, 2004; Dykens et al., 1989; Sudhalter & Belser, 2001; Sudhalter et al., 1990). Pragmatic language builds upon foundational language skills and has been described as the most difficult aspect of language ability to assess as this skillset depends on nuanced social-linguistic factors within the speaker's

interactive environment (Adams, Green, Gilchrist, & Cox, 2002; Landa, 2000; Simmons, et al., 2015). Using standardized assessments or comprehensive rating scales, greater pragmatic violations were found in school-age children with FXS than controls with performance similar to non-syndromic ASD populations (Klusek, Martin, & Losh, 2014; Losh, Martin, Klusek, Hogan-Brown, & Sideris, 2012; Martin, Losh, Estigarribia, Sideris, & Roberts, 2013). However, these findings are drawn from socially decontextualized settings, lacking key dynamic factors within the social-interactive environment that may influence this ability. Furthermore, standardized assessments and rating scales extract social knowledge using explicit instructions in structured settings, which differ from everyday communication that follows more implicit rather than explicit rules (Ketelaars & Embrechts, 2017; Martin, Lee, & Losh, 2017). For this reason, semi-naturalistic conversational samples have been considered the gold standard method for measuring pragmatic language skills in these more nuanced settings and have frequently been used in FXS to highlight areas of weakness and relative strengths (Adams, 2002; McTear & Conti-Ramsden, 1992; Prutting & Kittchner, 1987). Klusek and colleagues (2014) applied the Pragmatic Rating Scale - School Age (Landa 2011) to semi-naturalistic, play-based interactions and captured greater pragmatic violations in FXS than controls after controlling for expressive and receptive vocabulary abilities. The use of transcription and hand coding methods have also been used to evaluate pragmatic skills in conversation or narration, with these studies demonstrating that males with FXS present greater rates of perseverative topics, tangential speech, self-repetition, and off-topic language than other ID populations (Belser & Sudhalter, 2001; Roberts et al., 2007; Sudhalter & Belser, 2001; Martin 2012). Other reports have used experimental measures

to evaluate discrete pragmatic skills, such as a narrative task where the examiner feigns confusion and the participant is required to repair the communicative breakdown. Males with FXS demonstrate greater impairments in discourse management and communicative repair on these experimental tasks relative to controls; however, their performance is similar to that of males with ID (Abbeduto et al., 2008, 2006; Martin et al., 2017). Therefore, communicative repair and discourse management strategies may be an area of pragmatic language weakness in ID populations, including FXS. This work illustrates that pragmatic violations are common in FXS with areas of weakness in discourse management; however, the majority of work examined these abilities in school-age children with only one study measuring these skills in adults. Given the importance of pragmatic language in developing social relationships, particularly as individuals age, more research is needed to understand the presentation of pragmatic language impairments in adulthood and factors that may be influencing them.

Prior investigations of pragmatic language in FXS has highlighted this skill as an area of weakness deserving attention in future research (Abbeduto et al., 2007; Martin, Lee, & Losh, 2017; Wolf-Schein et al., 1987). However, a barrier to the study of pragmatics is the lack of ecologically valid measures that are cost effective and feasible to administer. Existing methods for measuring pragmatic language performance are time consuming, relying on transcription and coding, sometimes by hand, of individual language samples. Additionally, reliance on semi-naturalistic conversational samples introduces the potential for performance variability due to context effects rather than the participant's skills per se (Adams, 2002; Adams, Lloyd, Adams, & Lloyd, 2005; Landa, Klin, Volkmar, & Sparrow, 2000). In contrast, existing experimental assessments

introduce increased standardization, sometimes at the expense of a naturalistic social interactive component, which may interfere with accurately capturing performance in this skillset (Ketelaars & Embrechts, 2017; Kover, et al., 2015). Finally, due to the lack of standardization and scope of semi-naturalistic conversational samples, it can be difficult to capture measurable growth or change over time for monitoring progress following language interventions. In summary, a significant barrier to the study of pragmatic competence in FXS is the lack of sensitive assessment tools that can be administered relatively quickly, follow standardized procedures, evaluate a wide range of pragmatic skills, and allow for the ability to measure growth over time (Adams, 2002; Adams et al., 2005; Landa et al., 2000; Ketelaars & Embrechts, 2017).

This is the first study to utilize a novel, dynamic assessment to capture pragmatic language abilities in young adults with FXS. The *Yale in vivo Pragmatic Protocol (YiPP),* a dynamic assessment, has demonstrated clinical utility by differentiating school age children with ASD and average cognitive abilities from their typically developing peers and by highlighting specific pragmatic language impairments attributed to ASD (Simmons, et al., 2015). Dynamic assessment is one approach that improves the efficiency and ecological validity of assessing pragmatic language. During the *YiPP,* the degree of environmental support is manipulated to measure an individual's optimal level of pragmatic language performance and the amount of conversational scaffolding required to elicit this achievement (Gutierrez-Clellen & Pena, 2001; Simmons, Paul, & Volkmar, 2015; Swanson & Lussier, 2001). Dynamic assessments are also structured in such a way for ease of scoring; greatly increasing the efficiency with which pragmatic language skills are measured. These procedures are ideally suited for the assessment of

pragmatic language skills in FXS, as they are intended to emulate real life social contexts, allowing for measurement of performance within semi- naturalistic conversational settings. Dynamic assessments are also valuable for identifying explicit conversational skills for targeting during therapeutic interventions, such as those requiring the highest level of conversational prompting from a partner (Adams, 2002; Simmons et al., 2015). Finally, elements from the social interactive context play an important role in the judgment and use of appropriate pragmatic functions and are taken into consideration during the dynamic assessment process (Adams, 2002; Young, Diehl, Morris, Hyman, & Bennetto, 2005). This work has important implications as pragmatic impairments may hinder the communicative effectiveness of the individual resulting in communication breakdowns (Emerson & Hatton, 1994). Communication breakdowns for young adults with ID are particularly problematic given these are likely to occur more often (Emerson, 1985). For young adult males with FXS communication breakdowns ultimately have significant negative ramifications by hindering learning opportunities to practice and perfect linguistic and social skills to effectively and independently navigate the world around them.

1.3 MECHANISMS INFLUENCING PRAGMATIC LANGUAGE IN FXS

While research has supported that pragmatic language impairments are a core feature in FXS; less is known about underlying mechanisms that influence these skills. ASD and anxiety are two mechanisms that have been hypothesized to hinder pragmatic language skills in FXS. The application of dynamic systems theory provides a framework for how these mechanisms influence pragmatics. A dynamic systems theoretical model recognizes that multiple systems effect change and interact across time. Pragmatic

language development depends on multiple internal (i.e. language, executive, social cognitive and psychological) and external, environmental (i.e. home, family, school, community and culture) systems that interact with one another to make up an individual's competence and use of language (Fidler, Lunkenheimer, & Hahn, 2011; Snow & Douglas, 2017). While many systems are involved in pragmatic language development, this study will focus on the influence of biological, cognitive, social cognitive, and affective systems on the pragmatic language phenotype in males with FXS (See Figure 1.1). One way to isolate the influence of biological mechanisms is to study pragmatic language in a well-defined genetic sample, such as FXS (Fidler et al., 2011; Karmiloff-Smith et al., 2012; Pieretti et al., 1991).

FXS is associated with broad intellectual impairments along with elevated rates of autism spectrum disorders (ASD); these cognitive and social cognitive mechanisms appear to negatively influence pragmatic abilities (Budimirovic & Kaufmann, 2011; García-Nonell et al., 2008; Hagerman & Harris, 2008; Klusek, Martin, & Losh, 2014). Additionally, elevated symptoms of social anxiety are present in FXS which represents an affective mechanism that is believed to contribute to poor execution of language expression given elevated arousal (Cornish, Sudhalter, & Turk, 2004) and are linked to greater social isolation and reduced opportunities for learning (Bailey et al., 2008; Scherr, Hogan, Hatton, & Roberts, 2017; Thurman, McDuffie, Hagerman, & Abbeduto, 2014b). Thus, pragmatic language deficits in FXS can be better understood under a conceptual framework that accounts for the multifactorial interaction of biological (*FMR1* gene dysfunction), linguistic (expressive vocabulary), social cognitive (ASD; intellectual impairment), and affective (social anxiety) mechanisms over time.

Prior works into the influence of social cognitive mechanisms have focused on the detrimental effect of ASD on pragmatic language abilities in FXS. A diagnosis of ASD is a behaviorally defined disorder based on the presence of social and communication impairments along with restricted and repetitive behaviors (American Psychiatric Association, 2013). Recent evidence suggests that a co-occurring diagnosis of ASD or greater ASD symptomatology is associated with more severe pragmatic language impairments in FXS, specifically on skills involving conversational turns, communicative repair strategies, and knowledge of appropriate language for diverse social situations (Abbeduto et al., 2006; Martin et al., 2017, 2013). During a semi-naturalistic play-based setting, males with FXS and ASD exhibited greater pragmatic language deficits than those with FXS without ASD and a comparison group with ID (Klusek et al., 2014). A comorbid diagnosis of ASD in FXS has resulted in greater rates of perseverative and noncontingent language than those without ASD, a comparison group with ID, and those with typical development (Martin, Roberts, Helm-Estabrooks, Sideris, & Vanderbilt, 2012; Roberts et al., 2007).Yet, the relationship between ASD symptom severity and pragmatic language warrants further investigation in FXS due to the exclusion of participants with co-occurring ASD diagnoses in some studies (Abbeduto et al., 2008, 2006). Early work in pragmatic language skills in FXS often did not specify ASD status (Belser & Sudhalter, 2001; Levy, Gottesman, Borochowitz, Frydman, & Sagi, 2006; Sudhalter et al., 1990; Wolf-Schein et al., 1987). Meanwhile other studies dichotomized males with FXS into those with and without ASD and did not investigate from a continuous perspective, the relationship between ASD symptom severity and pragmatic language deficits (Losh et al., 2012; Martin et al., 2013; Roberts et al., 2007). This makes

understanding and comparing findings on the role of ASD on pragmatic language impairments difficult.

Recent evidence has shown an increased prevalence of ASD symptoms and diagnoses in adolescence and young adulthood in FXS (Lee, Martin, Berry-Kravis, & Losh, 2016; Thurman, McDuffie, Hagerman, Josol, & Abbeduto, 2017). However, no work has examined the relationship of increased ASD symptom severity to pragmatic language in early adulthood. This is important to study given that elevated ASD symptoms are likely to contribute to elevated pragmatic language deficits which could negatively affect social interactions within the environment and continued interpersonal learning. The examination of ASD as a mechanism that influences pragmatic language is particularly important during the transition to adulthood given the increased expectations for independence including employment and personal independence which rely on strong language and social skills.

The role of anxiety as an underlying affective mechanism that hinders pragmatic language abilities in FXS remains elusive. Researchers have credited pragmatic language deficits to increased rates of arousal and anxiety as these traits are thought to contribute to difficulties with comprehension and expression of language (Belser & Sudhalter, 1995; Cornish, Sudhalter, & Turk, 2004; Klusek, Roberts, & Losh, 2015; Murphy & Abbeduto, 2007). Yet, contrary to this hypothesis, more recent work found that generalized anxiety behaviors and arousal dysregulation were not associated with pragmatic language impairments in FXS (Klusek, Martin, & Losh, 2013). To our knowledge, no other study has examined of the association between social anxiety and pragmatic language impairments. This highlights an area that warrants further research as social anxiety, like

ASD, is also known to increase with age in FXS (Cordeiro et al., 2011). Therefore, it is critical to understand the influence of both social cognitive and affective mechanisms that could be contributing to the pragmatic deficits found in early adulthood. This knowledge can better inform factors that influence pragmatic language abilities in FXS for future research studies and to assist clinicians with tailoring assessment and interventions.

1.4 PRESENT STUDY

The aim of the present study was to investigate pragmatic language skills in young adult males with FXS through the use a dynamic, semi-structured conversational assessment; the *Yale in vivo Pragmatic Protocol* (*YiPP;* Simmons et al., 2015). The *YiPP* provides conversational probes to collect communicative responses on a variety of speech acts and captures the level of scaffolding required from a partner to elicit such a response. This work will also assist with characterizing the predictive role of linguistic (i.e. expressive vocabulary), social cognitive (i.e. ASD; intellectual impairment), and affective (i.e. social anxiety) mechanisms on these abilities. This is particularly critical given recent evidence that greater ASD symptom and social anxiety severity are present with increasing age in FXS, and prior work has often not explored these as underlying mechanisms related to pragmatic language impairments. The study's research questions and hypotheses included the following:

1. Research Question: What is the profile of pragmatic language strengths and weaknesses using the *YiPP* in young adult males with FXS?
2. Research Question: Does ASD symptom severity predict poorer overall pragmatic language skills? *Hypothesis: Greater ASD symptom severity will predict worse pragmatic language skills, as indexed by inappropriate language responses and*

the need for greater examiner contextual cueing to elicit a communicative response, during the YiPP.

3. Research Question: Do social anxiety symptoms predict pragmatic language skills in young adult males with FXS above and beyond ASD symptom severity?

   Hypothesis: Greater social anxiety will predict poorer pragmatic language skills, indexed again by inappropriate language responses and the need for greater examiner contextual cueing, above and beyond ASD symptom severity.

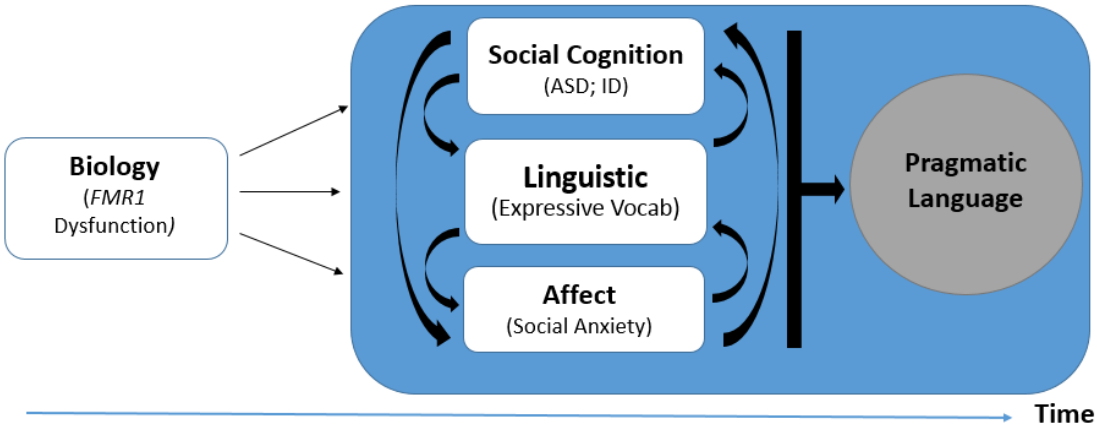

Figure 1.1. Dynamic Systems Theory Framework for Pragmatic Language Development

CHAPTER 2

METHODS

2.1 PARTICIPANTS

The present study included 30 young adult male participants with FXS, from 17 to 25 years of age, who were drawn from a larger, two site longitudinal study on language development (PI: Abbeduto). The original parent study was designed for four annual assessments. The *YiPP* was not part of the original battery but was added to the University of South Carolina (USC) site given interest in pragmatic language at that site. The *YiPP* was added to the longitudinal study protocol during participant's 3rd or 4th annual visit. Males with FXS were recruited out of the Medical Investigation of Neurodevelopmental Disorders (MIND) Institute at the University of California, Davis and University of South Carolina through parent listservs, social media, postings by the National Fragile X Foundation, and with the help of the Research Participant Registry Core of the Carolina Institute for Developmental Disabilities at the University of North Carolina at Chapel Hill and the Intellectual and Developmental Disabilities Research Center of the MIND Institute. Females were not considered for the present study due to greater heterogeneity in cognitive, behavioral and linguistic skills. Inclusion in the parent study required the following eligibility criteria for participants: 1) native English speakers, 2) living at home with their biological mothers who are fluent English speakers, and 3) using speech as their primary means of communication with the presence of

phrases of at least three-word combinations. Institutional Review Boards approved the study at both sites, and informed consent was obtained prior to enrollment.

The full mutation was confirmed in the males with FXS through the provision of extant genetic reports documenting the *FMR1* full mutation (i.e. >200 CGG repeats). Replication of genetic results was confirmed through the parent study. Only participants from USC were included due to the addition of the *YiPP*, the pragmatic language assessment, to the larger parent study protocol at that site during participant's 3rd or 4th annual visit. Demographic information for the males in the present study is presented in Table 2.1.

2.2 PROCEDURES

Testing sessions included two consecutive days of evaluation with standardized intelligence and language measures completed on the first day, and the *YiPP* completed on the second day. Roughly two weeks prior to the scheduled assessment, families were mailed a packet of questionnaires to complete including the Anxiety, Depression and Mood Scale (ADAMS). Mothers rated their son's behaviors within the past two weeks, and completed questionnaires were returned prior to culmination of testing with their son on the second day. Data for this study were drawn from a participant's annual visit within the longitudinal study concurrent with completion of the *YiPP* with the exception of ASD symptom severity. Severity of ASD symptoms was assessed during the participant's initial visit (Time 1) to USC through completion of the Autism Diagnostic Observation Schedule, Second Edition (ADOS-2).

2.3 MEASURES

Pragmatic Language Ability. Each participant completed a modified version of the *Yale in vivo Pragmatic Protocol (YiPP,* Simmons et. al., 2015*)*, a semi-structured conversational assessment between the examiner and the participant, which is designed to appear naturalistic in order to measure pragmatic language in children and adolescents from 6 to 17 years of age. The modified version of the *YiPP* included 16 of the 19 conversational probes (removal of muffled speech, unfamiliar acronym, and an ambiguous statement) due to lack of sensitivity in prior validation work (Simmons et al., 2015). Standard administration procedures were followed using the material list, environmental arrangement, examiner script, and scripted verbal cues outlined in the Simmons and colleagues (2015) and corresponding supplemental materials. The examiner was seated diagonally across from the participant and instructed him that they will be having a brief conversation together. The structured conversational task was intended to appear naturalistic to the participant. In the present study, the examiner followed a series of 16 predetermined probes, resulting in a roughly 20 minute sample, to gather pragmatic language performance on a range of conversational speech acts, including discourse management, communicative function, conversational repair, and presupposition. The design of probes targeting specific conversational domains were aligned with ASHA definitions. Discourse management acts intended to target the participant's ability to converse on shared topics of interest. One example of a conversational probe eliciting this skill requested that the participant tell the examiner about his home town so that the examiner could learn how their hometowns differed. Communicative functions captured the participant's use of language to accomplish social

functions including hypothesizing, commenting, requesting, and protesting. For example, the examiner pretended that she forgot to turn on the audio recorder to record their conversation, then proceeded to act as though it was not working and demonstrated that batteries were missing from it. Conversational repair acts measured the participant's ability to express need for clarification, and the examiner would elicit this speech probe by whispering during statements so that her speech was unintelligible to the participant. Finally, presupposition reflected the participant's recognition of additional conversational needs from the examiner who made an ambiguous statement, such as "Also our tigers are really good" with the participant lacking background knowledge regarding who the tigers are referencing.

The examiner administered a set series of predetermined conversational probes and contextual scaffolding to elicit a communicative response from the participant. First, the examiner provided the lowest level of scaffolding (e.g. general prompt such as "I have some hobbies too.") to the participant. If he did not respond, then more supportive probes were provided in the following sequence until a communicative response was elicited: 1) general prompt, 2) expectant waiting without eye contact, 3) warm facial expression with eye contact, 4) repetition of general prompt or nonspecific verbal cue, and 5) specific verbal cue (e.g. "Do you know about my hobbies?"). All *YiPP* administrations were video recorded to allow for later behavioral coding of pragmatic language skills following each of the 16 conversational probes.

Pragmatic language skills were captured from behavioral coding via video for each participant through error and cue scores, which represented the appropriateness of the participant's language response following the initial conversational probe and level of

contextual scaffolding required by the examiner to elicit a communicative response. Error scores ranged from 0, appropriate pragmatic language response, to 2, completely inappropriate or no language response. Cue scores ranged from 0, an appropriate, spontaneous response with no additional prompt, to 6, no response regardless of level of conversational scaffolding provided by the examiner. Higher error and cue scores indicate greater pragmatic language impairments and need for support from the conversational partner. The first author and a secondary coder established training reliability by coding error and cue scores at or above 80% agreement on three consecutive video administrations. In order to determine inter-rater reliability 20% of scored video administrations were randomly selected, with kappa at .78 for error and .70 for cue scores, which is considered "moderate" agreement (Cohen, 1960). Consensus coding on 6 administrations was completed to resolve disagreement between master and second coder's error and cue scores for those scored for reliability purposes. This inter-rater reliability is similar to that found by the developers of the *YiPP* with kappa scores ranging from .71 to .80 (Simmons et al., 2015). Approximately 5% of total pragmatic probes were discarded due to extraneous factors (e.g. distractions from outside noises) or administration errors. Error and cue scores were averaged across the whole administration of the *YiPP* to address each research question regarding the influence of ASD symptom severity and social anxiety behaviors on pragmatic language skills.

Nonverbal Intelligence (IQ). Nonverbal intelligence was measured using the Brief-IQ composite of the Leiter International Performance Scale- Revised (Leiter-R; Roid & Miller, 1997), which consisted of four subscales including Figure Ground, Form Completion, Sequential Order, and Repeated Patterns. These composite subscales have

shown consistent internal consistency reliability (α=0.65-0.86), and the Leiter-R Brief IQ has demonstrated high correlations with the WISC-III Full Scale IQ (*r*=.85). Standard scores provided a measurement of nonverbal intelligence for the study population (Roid & Miller, 1997) and was explored as a possible covariate for pragmatic language skills.

Expressive Vocabulary. Expressive vocabulary skill was assessed using the Expressive Vocabulary Test, Second Edition (EVT-2; Williams, 2007), which is an individually administered standardized assessment of expressive vocabulary. Participants were instructed to view a color picture on an easel and to provide an appropriate label or synonym for the image. The EVT-2 has demonstrated high levels of internal consistency reliability with a mean α of .96 including normative data consisting of individuals from to 2 years 6 months to greater than 81 years of age. The EVT-2 has also strongly correlated with other measures of word retrieval such as the Comprehensive Assessment of Spoken Language (CASL) Lexical/Semantic Composite (*r*=.84) and Antonyms (*r*=.80). Recent work in non-syndromic ASD populations has demonstrated that structural language abilities, such as expressive vocabulary, play a key role in pragmatic language skills, above that of nonverbal intelligence or mental-age (Mervis & Klein-Tasman 2004; Mervis, Robinson, Levy, & Schaeffer, 2003). Given this recent work and that structural language abilities tend to be an area of relative strength in FXS, growth scale value scores provide a measurement of expressive vocabulary over time on a continuous scale and were used to covary for foundational language skills that contribute to pragmatic language performance (Thurman et al., 2017). Growth scale values were used rather than standard scores as they provide a true interval scale compared to age equivalents and are

less susceptible to flooring effects, which are frequently found in this population (Williams, 2007).

ASD Symptom Severity. The Autism Diagnostic Observations Schedule, Second Edition (ADOS-2; Lord et al., 2012) is a semi-structured play-based assessment that creates specific interactive contexts to elicit and observe the participant's reciprocal social communication skills and restricted and repetitive behaviors. In the present study, one of three modules (1, 2, or 3) was administered to all participants during their first annual visit as part of the parent study. The ADOS-2 was scored live by graduate students or Ph.D.-level professionals, all of whom completed standard research reliability training (i.e., training with the instrument developers). A module was selected based on the participant's expressive language ability and chronological age to provide a continuous metric of ASD symptom severity through the use of the total calibrated severity score which ranges from 1 to 10 (Hus, Gotham, & Lord, 2014). Strong psychometric properties have been found with the ADOS-2, including inter-rater reliability of 92% as measured by mean exact agreement across modules 1, 2 and 3 (Lord et al., 2012). Inter-rater reliability on each item of the ADOS-2 demonstrated kappa values that ranged from .55 to 1.00 for module 1, .38 to .93 for module 2, and .46 to 1.00 for module 3 (Lord et al., 2012). Ten percent of the administrations were randomly selected and cross-site reliability across all examiners at both sites was assessed via videotaped administration. Consensus codes for each reliability administration were achieved through group discussion and mean percent agreement of each individual examiner relative to the consensus was calculated. Agreement of examiners with the consensus codes averaged 80% across all items and on the diagnostic algorithm. Seventy-three percent of the FXS

males were found to meet a classification for ASD. Calibrated severity scores provided a dimensional measurement of autism behaviors investigated in the first research question of this study. Subdomain severity scores provided measurement of social communicative deficits and restricted and repetitive behaviors for subsequent exploratory analyses.

Social Anxiety Behaviors. The Anxiety Depression and Mood Scale (ADAMS; Esbensen, Rojahn, Aman, & Ruedrich, 2003) is a 28-item questionnaire used to assess symptoms of anxiety, depression, and mania among individuals with intellectual disabilities. Behaviors are rated on a 4-point Likert scale of 0 (not a problem) to 3 (severe problem) and then tallied for each subscale. The ADAMS is comprised of 5 subscales including General Anxiety, Social Avoidance, Depression, Manic/Hyperactive, and Obsessive/Compulsive Behavior. The ADAMS was psychometrically normed and validated with psychiatric patients with ID (Esbensen et al., 2003). Internal consistency was calculated using Cronbach's α and found to be .83 for the Social Avoidance subscale, with a mean of .80 for all domains. Interrater reliability, as calculated using interrater correlation (ICC) with a one-way random effect model, was found to be "fair" at .48 for the total score (Cicchetti, 1994). The Social Avoidance subscale had a mean subscale ICC of.61. For the present study, the Social Avoidance subscale, from the participant's concurrent visit with administration of the *YiPP*, provided dimensional symptomatology of social anxiety behaviors and were analyzed as a potential predictor of pragmatic language skills.

Table 2.1

Participant Demographic and Descriptive Statistics

Measure	**Descriptive Statistics**
Chronological Age (years)	
Mean (*SD*)	19.8 (*2.2*)
Range	17.0 - 25.8
Maternal Education Level	(%)
High school or lower	56.7
Bachelor's degree	20.0
Master's degree	20.0
Unknown	3.3
Household Income	(%)
<20k	3.3
21-40k	23.3
41-60k	3.3
61-80k	20.0
81-100k	6.7
>100k	43.3
Race	(%)
Caucasian	83.3
African American	10.0
Other	6.7

Note. N=30.

CHAPTER 3

DATA ANALYSIS PLAN

Data were first analyzed for violations of assumptions including outliers, linearity, normality, little or no multicollinearity, and homoscedascity. Data did not violate assumptions for linear regression analyses. Shapiro-Wilks tests confirmed normality of error ($W = 0.95$, $p = 0.188$) and cue ($W = 0.975$, $p = 0.668$) scores. Additionally, residuals from the linear composite were evenly distributed across predicted values, illustrating homoscedascity. Next, descriptive statistics were calculated for each variable in this study (e.g. nonverbal intelligence, expressive language level, and ASD symptom severity) including error and cue scores; see Tables 3.1 and 3.2. The primary analyses included four linear regressions to examine the research objectives of this study.

Statistical a priori power estimates using a generalized linear model indicate reasonable effect sizes for the study's sample using the pwr package in R. A sample size of 30 was sufficient to detect a medium to large effect size of .22 to .41 at a power of .80. Prior studies have found that ASD symptom severity accounted for roughly 34% of variance in pragmatic language performance in FXS; therefore, medium to large effects were expected (i.e.R^2 from .33 to .35; Klusek et al., 2014). Analyses were conducted in two phases with the first phase investigating possible covariates by examining the relationship of chronological age, expressive vocabulary level, and nonverbal intelligence to overall error and cue scores through the use of Pearson correlations (Table 3.3). Expressive vocabulary level and nonverbal intelligence have both been found to

influence pragmatic language abilities in FXS (Capps et al., 1998; Ozonoff et al., 1990; Tager-Flusberg, 2004; Volden, 2017). Preliminary correlations informed model selection of expressive vocabulary level as a covariate in the following multiple regression analyses as both expressive vocabulary and nonverbal intelligence were highly correlated with one another; yet, only expressive vocabulary level, but not nonverbal intelligence, was significantly correlated with error and cue scores (see Table 3.3). Independent variables (e.g. covariates, ASD symptom severity, and social anxiety behaviors) were transformed to standardized z scores and centered so the expected value of error and cue scores were set to the means of the independent variables prior to running multiple regression analyses. This was undertaken to assist with ease of interpretation of results, particularly as each of the predictors were measured on different measurement scales. Next, two linear regression models were run hierarchically to analyze each research question and the relationship of ASD symptom severity (1st research question), and then social anxiety behaviors (2nd research question) on pragmatic language skills (i.e. error score and cue score) after controlling for expressive vocabulary level. Expressive vocabulary level was first entered into the model, followed by ASD symptom severity, and finally socially anxious behaviors. Change in R squared following the incorporation of each independent variable provided a measure of effect size with 0.01 (small effect), 0.09 (medium effect), and 0.25 (large effect; Cohen 1988).

Table 3.1

Descriptive Statistics of Performance on Measures

Measure	**M (*SD*)**	**Range**
Leiter-R		
Nonverbal IQ, Standard Score[1]	39.5 (*5.4*)	36.0 - 54.0
Nonverbal IQ, Growth Scale Value Score[1,2]	465.4 (*9.6*)	447.0 - 486.0
EVT-2		
Standard Score	57.5 (*17.8*)	20.0 – 86.0
Growth Scale Value Score[3]	150.1 (*19.3*)	93.0 - 178.0
ADOS-2		
Overall ASD Symptom Severity[4]	5.7 (*2.4*)	1.0 - 10.0
Social Communication Symptom Severity[4]	5.5 (*2.2*)	1.0 - 10.0
Restricted and Repetitive Behavior Symptom Severity[4]	6.0 (*3.2*)	1.0 - 10.0
ADAMS		
Social Avoidance subtest, Raw Score	4.7 (*3.4*)	0.0 - 12.0

Note. N=30. Leiter-R = Leiter International Performance Scale-Revised. EVT-2 = Expressive Vocabulary Test-Second Edition. ADOS-2 = Autism Diagnostic Observation Schedule- Second Edition. ASD = autism spectrum disorder. ADAMS = Anxiety, Depression and Mood Scale.

[1]Measured by the Brief IQ Scale of the Leiter-R.

[2]Possible Leiter-R Growth Scale Value scores range from 372-548; a Growth Scale Value of 460 corresponds with the nonverbal intelligence of approximately a 4.5 year old.

[3]Possible EVT-2 Growth Scale Value scores range from 42-245, a Growth Scale Value of 150 corresponds with the expressive vocabulary abilities of a 6.5 year old.

[4] Indexed by Comparison Scores of the ADOS-2 with Overall Scores $\geq$4 consistent with a diagnosis of ASD (Low level of ASD-related symptoms range from 3-4, Moderate level from 5-7, and a High level from 8-10 for Overall and Subdomain Scores).

Table 3.2

Summary of Pragmatic Language Performance by Individual Probes

	Error Scores		Cue Scores	
Item	**M (*SD*)**	**Mode**	**M (*SD*)**	**Mode**
Initiation	1.17 (*.83*)	2	2.47 (*2.34*)	1
Requesting Information	1.30 (*.95*)	2	3.13 (*2.47*)	5
Hypothesizing	1.47 (*.86*)	2	3.31 (*2.35*)	5
Background Information	0.77 (*.86*)	0	1.67 (*2.34*)	0
Comment Contingently	1.03 (*.85*)	2	2.27 (*2.46*)	0
Decreased Volume	1.66 (*.72*)	2	4.07 (*2.05*)	5
Incorrect Article	1.37 (*.85*)	2	3.27 (*2.41*)	5
Request Additional Information	1.43 (*.77*)	2	3.33 (*2.32*)	5
Ambiguous Pronoun	1.77 (*.63*)	2	4.33 (*1.71*)	5
Termination	0.48 (*.81*)	0	0.85 (*1.84*)	0
Response to Change Speakers	0.46 (*.78*)	0	0.96 (*1.92*)	0
Topic Maintenance	1.33 (*.88*)	2	3.20 (*2.44*)	5
Comment	1.30 (*.92*)	2	3.27 (*2.55*)	5
Request Object	1.25 (*.97*)	2	3.10 (*2.57*)	0
Express Denial	1.52 (*.87*)	2	3.90 (*2.27*)	5
Insufficient Information	1.86 (*.45*)	2	4.64 (*1.59*)	5
Overall Mean Score	1.29 (*.49*)	--	3.00 (*1.51)*	--

Note. Error raw scores ranged from 0 to 2 and cue raw scores from 0 to 6; spanning the complete range.

Table 3.3

Correlation Matrix among Study Variables

Measure	1	2	3	4	5	6	7
1 Nonverbal Cognitive Ability[1]	1.00						
2 Chronological Age	0.38*	1.00					
3 Expressive Language Level[2]	0.72**	0.34	1.00				
4 ASD Severity[3]	-0.26	-0.18	-0.34	1.00			
5 Social Anxiety[4]	-0.12	0.06	-0.21	0.30	1.00		
6 Error Scores[5]	-0.31	-0.09	-0.51**	0.54**	0.43*	1.00	
7 Cue Scores[5]	-0.35	-0.12	-0.55**	0.52**	0.34	0.97**	1.00

Note. [1]Measured with the Leiter-R Brief IQ Growth Score. [2]Measured by EVT-2 Growth Score. [3]Indexed by the ADOS-2 overall severity score. [4]Indexed by the ADAMS Social Avoidance subscale. [5]Yale in vivo Pragmatic Protocol determined pragmatic language impairments from error scores and environmental scaffolding from cue scores.
*$p < .05$; ** $p < .01$

CHAPTER 4

RESULTS

4.1 DESCRIPTIVE STATISTICS

Descriptive statistics presenting means, standard deviations and ranges of demographic variables and covariates are presented in Tables 2.1 and 3.1, and *YiPP* error and cue raw scores by individual probes and overall means reflected in Table 3.2. Correlations between demographic variables, covariates, and error and cue scores are reflected in Table 3.3.

4.2 PROFILE OF PRAGMATIC LANGUAGE STRENGTHS AND WEAKNESSES

Males with FXS achieved a mean error score of 1.29 (*SD* = 0.49) and mean cue score of 3.00 (*SD* = 1.51) with variability existing in pragmatic language performance upon further inspection of individual probes. Mean error scores represent mildly to completely inappropriate communicative responses (i.e. no response), and mean cue scores indicate the need for more explicit conversational scaffolding such as repetition of the conversational probe or a specific verbal cue in Table 3.2. Discourse management skills, including providing background information, termination of speech, and halting speech for a change in speaker, presented the lowest error (*M* = 0.46-0.77) and cue (*M* = 0.85-1.67) scores; indicating the best performance and a relative strength in this area. Error (*M* = 1.77-1.86) and cue (*M* = 4.33-4.64) scores achieved during conversational bids that referenced an ambiguous person and that did not provide sufficient information for completing a task, represented the worst performance. These conversational bids

represent presupposition skills which capture awareness and expression of language that fits social rules as a possible area of weakness.

4.3 RELATIONSHIP BETWEEN ASD SYMPTOM SEVERITY AND PRAGMATIC LANGUAGE SKILLS

The first research question focused on the effect of ASD symptom severity on pragmatic language performance, as represented by error and cue scores, after controlling for expressive language abilities. Expressive vocabulary level was first incorporated into regression analyses as a covariate and found to account for 27% of the variance in error scores ($F(1,28) = 10.41$, $p = 0.003$) and 29% of the variance in cue scores ($F(1,28) = 11.54$, $p = 0.002$); see Table 4.1. As expressive vocabulary skills increased, both pragmatic errors and level of cueing were found to decrease, indicating less communicative impairment and support from a conversational partner. The combined effect of expressive vocabulary level and ASD symptom severity significantly predicted both error, ($F(2,27) = 10.64$, $p < 0.001$, 44% explained variance), and cue scores, ($F(2,27) = 10.93$, $p < 0.001$, 45% explained variance). Increasing ASD symptom severity resulted in greater pragmatic language errors and levels of cueing, indicating increased conversational support. The effect size of ASD symptom severity was calculated using change in R squared and indicated a medium to large effect on error ($\Delta R^2 = 0.17$) and cue scores ($\Delta R^2 = 0.16$). Regression coefficients are depicted in Table 4.1 for mean error and cue score models.

4.4 RELATIONSHIP BETWEEN SOCIAL ANXIETY AND PRAGMATIC LANGAUGE SKILLS

After accounting for level of expressive vocabulary and ASD symptom severity, social anxiety was not a significant predictor for both error (β = 0.12, p = 0.103) or cue scores (β = 0.28, p = 0.225). While not a significant predictor, social anxiety did result in a small to medium effect on both errors (ΔR^2 = 0.06) and level of cueing (ΔR^2 = 0.03; Cohen 1988). Greater social anxiety was related to higher rates of pragmatic language errors and levels of cueing but did not reach significance. Regression coefficients for both models are illustrated in Table 4.2. Figures 4.1 and 4.2 represent the individual contributions of ASD symptom severity and social anxiety on error and cue scores, demonstrating similar, but stronger relationships with ASD symptom severity.

4.5 ASD SEVERITY SUBDOMAINS PREDICTING PRAGMATIC LANGUAGE SKILLS

Exploratory regression analyses were utilized to decipher the predictive effects of ASD symptom subdomains on pragmatic language impairments. These analyses assist with determining if error and cue scores were directly impacted by the social communication or restricted and repetitive behavior subdomains of ASD, specifically. Greater social communication deficits significantly predicted higher rates of both error (β = 0.18, p = 0.023) and cue scores (β= 0.52, p = 0.044). Increased social communication deficits resulted in greater communicative errors and conversational scaffolding. Interestingly, restricted and repetitive behaviors only predicted cue (β= 0.49, p = 0.037), but not error scores (β = 0.12, p = 0.101). Higher rates of restricted and repetitive behaviors were predictive of increased levels of cueing from a conversational partner.

Table 4.3 depicts ASD symptom severity subdomain regression coefficients for error and cue score models.

Table 4.1

Regression Coefficients for ASD Symptom Severity as a Predictor of Pragmatic Language Skills

	Error Scores					Cue Scores				
Effect	*β*	*SE*	*t*	*p*	R^2	*β*	*SE*	*t*	*p*	R^2
Step 1: Covariate					0.27					0.29
Intercept	1.29	0.08	16.66	<0.001**		3.00	0.24	12.71	<0.001**	
Expressive vocab	-0.25	0.08	-3.23	0.003**		-0.82	0.24	-3.40	0.002**	
Step 2:					0.44					0.45
Intercept	1.29	0.07	18.68	<0.001**		3.00	0.21	14.13	<0.001**	
Expressive vocab	-0.18	0.07	-2.44	0.021*		-0.60	0.23	-2.63	0.014*	
ASD symptom severity	0.21	0.07	2.86	0.008**		0.63	0.23	0.76	0.010*	

Note. [1]Measured by EVT-2. [2]Indexed by ADOS-2 overall severity score.
*p <. 05; ** p <.01.

Table 4.2

Regression Coefficients for Social Anxiety as a Predictor of Pragmatic Language Skills

	Error Scores					Cue Scores				
Effect	*β*	*SE*	*t*	*p*	R^2	*β*	*SE*	*t*	*p*	R^2
Step 3:					0.50					0.48
Intercept	1.29	0.07	19.31	<0.001*		3.00	0.21	14.28	<0.001*	
Expressive vocab[1]	-0.16	0.07	-2.31	0.029*		-0.57	0.23	-2.49	0.020*	
ASD symptom severity[2]	0.18	0.07	2.45	0.021*		0.56	0.23	2.39	0.024*	
Social anxiety[3]	0.12	0.07	1.69	0.103		0.28	0.23	1.24	0.225	

Note. [1]Measured by EVT-2. [2]Indexed by ADOS-2 overall severity score. [3]Indexed by the ADAMS Social Avoidance subscale.
$^{+}$ $p <. 10$; *$p <. 05$; ** $p <.01$.

Table 4.3

ASD Symptom Severity Subdomains Predicting Pragmatic Language Performance

	Error Scores					Cue Scores				
Effect	*β*	*SE*	*t*	*p*	R^2	*β*	*SE*	*t*	*p*	R^2
ASD Severity Subdomains					0.46					0.49
Intercept	1.29	0.07	18.05	<0.001**		3.00	0.21	14.39	<0.001**	
Expressive vocab	-0.18	0.08	-2.39	0.025*		-0.62	0.23	-2.70	0.012*	
Social Comm Def	0.18	0.08	2.41	0.023*		0.52	0.23	2.12	0.044*	
Restricted and Rep Beh	0.12	0.07	1.70	0.101		0.49	0.21	2.20	0.037*	

Note. Indexed by ADOS-2 Social Communicative and Restricted and Repetitive Behavior severity subdomain comparison scores.
$^{+}$ $p <. 10$; *$p <. 05$; ** $p <.01$.

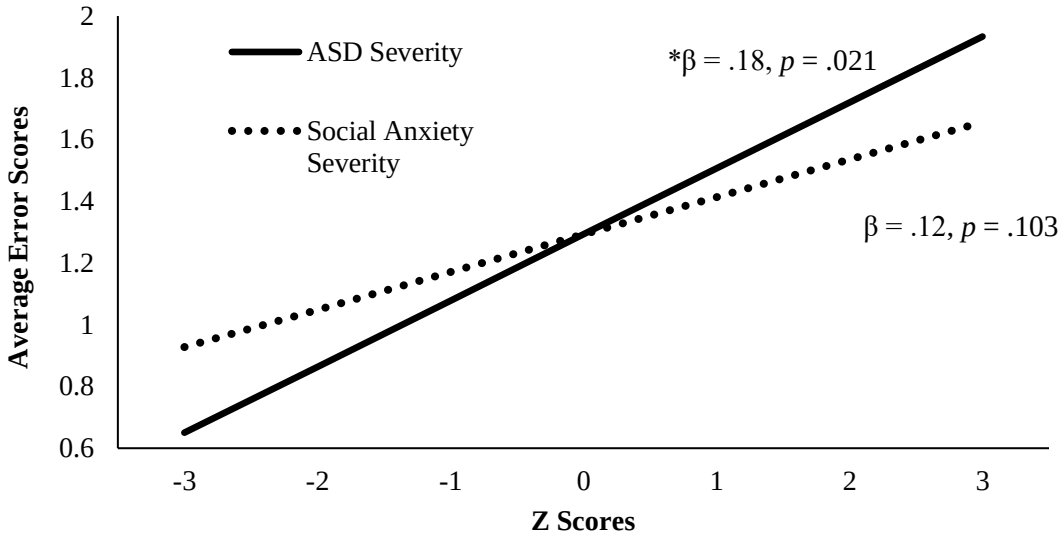

Figure 4.1. ASD Symptom Severity versus Social Anxiety Predicting Pragmatic Language Errors

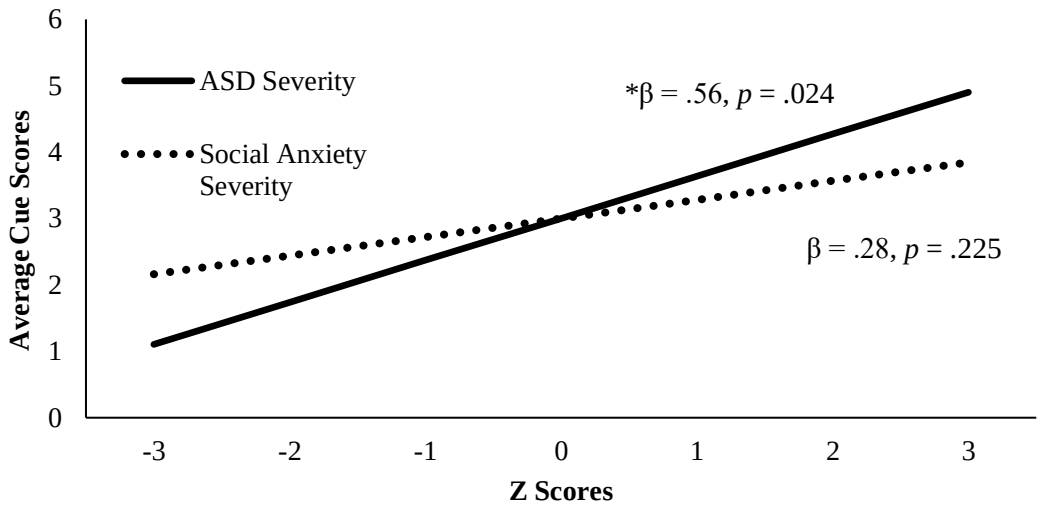

Figure 4.2. ASD Symptom Severity versus Social Anxiety Predicting Pragmatic Language Cue Scores

CHAPTER 5

DISCUSSION

While pragmatic language deficits are framed as central to males with FXS, investigation into underlying mechanisms that impact these abilities is warranted especially in early adulthood. The purpose of the present study was to investigate the role of ASD and social anxiety symptom severity as factors that negatively impact pragmatic language skills in young adults. This is critical given the possible rise in ASD and social anxiety symptomatology and diagnoses during adolescence and adulthood in males with FXS, and the possible negative effect these may have on pragmatic language skills (Hernandez et al., 2009; Lee et al., 2016). This work takes a novel approach as it is the first to utilize a dynamic, semi-structured assessment to measure the pragmatic language phenotype in FXS.

5.1 PROFILE OF PRAGMATIC LANGUAGE STRENGTHS AND WEAKNESSES

Males with FXS produced high rates of errors during language responses (i.e. mean error score 1.29; *SD = 0.49*) to conversational probes, and high levels of contextual cueing, or scaffolding (i.e. mean cue score of 3.00; *SD = 1.51*), from a conversational partner were required to elicit communicative responses. A performance score of "0" is expected in typically developing populations as this indicates mastery of a pragmatic language skill. The rates of errors demonstrated by males with FXS are higher than that observed in both school age children who are typically developing and those with high functioning ASD which is consistent with previous work that utilized standardized

instruments and semi-naturalistic conversational samples (Klusek et al., 2014; Losh et al., 2012). Language responses and level of conversational scaffolding spanned the complete range for each conversational probe on the *YiPP,* from appropriate with no scaffolding to completely lacking communicative responses despite very specific verbal requests. However, the majority of communicative responses were often completely lacking or impaired (i.e. scripting to self) during the initial probe and subsequent forms of explicit contextual scaffolding were required to evoke a response from the speaker.

A relative strength in pragmatic language performance appeared to exist during probes involving conversational turn-taking, such as when the participant needed to provide the examiner with an opportunity to speak. During these times, males with FXS often complied by allowing a conversational turn. Additionally, the initial probe provided sufficient conversational scaffolding for the males with FXS to terminate their speech. This finding is similar to that of Sudhalter and colleagues (1990) who found that males with FXS engaged in more appropriate forms of conversational turn-taking than non-syndromic males with ASD. However, these findings differ from work that illustrated greater impairments in conversational turn-taking for school age males with FXS who also met criteria for ASD (Klusek et al., 2014; Martin et al., 2012; Roberts et al., 2007). Anecdotally, participants in the present study tended to be more reserved during social interactions and engaged in more limited presentations of tangential, or perseverative speech, allowing for appropriate termination of speech. Discourse management skills combine the ability to appropriately terminate speech as well as maintain topics of conversation that allow for reciprocity during conversational turn-taking. The reserved conversational disposition of the participants is again reflected in poor topic maintenance

performance which fell in the mildly to completely inappropriate range, requiring more contextual scaffolding from the examiner. Dominating pragmatic language profiles have been found in previous FXS populations; however, findings from the present study suggest that this was not a trait in these young adult males (Sudhalter & Belser, 2001). While males with FXS tended to terminate their speech, they failed to initiate or continue appropriate topics of conversation with their partner ultimately hindering reciprocity.

Males with FXS seemed to struggle most during subtle or ambiguous conversational probes or when advocating for themselves by expressing their desires or need for assistance. During these instances, significant levels of conversational scaffolding from the examiner were required to elicit a communicative response, in the form of a specific verbal request, such as "Did I give you the wrong magazine," or "Do I need to say that more clearly?". Ultimately, these communicative qualities have the potential to reduce reciprocity during social interactions with peers and other conversational partner, likely hindering learning opportunities and socialization.

The majority of work on pragmatic language skills in FXS results from semi-naturalistic conversational samples. Analyzing pragmatic language performance from conversational samples provide considerable qualitative information; however, are extremely time intensive and cumbersome. The *YiPP* provided vital information regarding the pragmatic phenotype in FXS through an efficient assessment that captured two unique skillsets, not only the expression of pragmatic language errors, but also the level of contextual scaffolding required to elicit communicative responses. The *YiPP* was less time-intensive than prior pragmatic language assessments from semi-naturalistic conversational samples with administrations and coding averaging around 40 minutes for

the *YiPP* contrasted to at least 2 hours for semi-naturalistic conversational samples. Coding was fairly straightforward, yielding moderate reliability, and requiring less professional training than transcribing and coding conversational samples. The *YiPP* is also structured in such a manner that communicative responses could be scored live, making it useful in clinical settings given the lack of ecologically valid and efficient pragmatic language assessments. Finally, the *YiPP* allowed for measurement of two pragmatic language indices; communicative responses and contextual cueing from a conversational partner. Each of these indices appear to provide unique utility regarding pragmatic language abilities. Clinicians may be able to focus targeted interventions on conversational areas that required the greatest contextual cueing levels to measure growth during therapeutic services.

5.2 ASD SYMPTOM SEVERITY ON PRAGMATIC LANGUAGE SKILLS

Results indicated that increased ASD symptom severity was associated with greater pragmatic language impairments in FXS. The present study used a continuous approach to ASD in FXS, and these findings align with and expands upon previous work which demonstrated the negative relationship of ASD symptom severity to pragmatic language in FXS. A comorbid diagnosis of ASD has been associated with lower ability across a variety of pragmatic skills, such as alerting a conversational partner about a lack of comprehension, discourse management, and knowledge about social contexts and norms (Martin et al., 2017, 2013; Roberts et al., 2007). A handful of studies took a continuous approach to ASD and found a similar relationship between ASD symptom severity and pragmatic language impairments in school age boys (Klusek et al., 2014; Martin et al., 2017, 2013; Roberts et al., 2007). The current results add to the literature

illustrating that the deleterious effects of ASD symptom severity on pragmatic language skills exist in adulthood.

Recent evidence suggests that social communication deficits and restricted and repetitive behaviors, subdomains of ASD, may have differing genetic underpinnings (Brukner-Wertman, Laor, & Golan, 2016). In this study, symptoms within the subdomains of social communication and restricted and repetitive behaviors appeared to be related to different aspects of pragmatic language performance. Social communicative deficits were associated with both an individual's communicative response and his ability to be attuned to the needs of a conversational partner. However, restricted and repetitive behaviors were only related to the need for greater conversational scaffolding, not appropriateness of communicative responses. One possibility for this finding is that rumination of restricted interests, stereotypic language, or engagement in complex motor movements hindered an individual's ability to meet the needs of a conversational partner. This work suggests that social communicative deficits and restricted, repetitive behaviors negatively influence pragmatic language performance in slightly different ways.

5.3 INFLUENCE OF SOCIAL ANXIETY ON PRAGMATIC LANGUAGE SKILLS

Severity of social anxiety was not significantly related to pragmatic language performance (i.e. error and cue scores) during the *YiPP*, although effect sizes were small to medium. A lack of power due to a small sample size is likely influencing the ability to detect a significant relationship between social anxiety and pragmatic language deficits. Future studies would benefit from larger study samples to determine if social anxiety is an underlying mechanism that hinders pragmatic abilities in FXS.

The impact of anxiety on pragmatic language skills has been mixed. Previous work by Klusek and colleagues (2013) found generalized anxiety behaviors were not

related to pragmatic language impairments in school age boys with FXS; however, work by Halls and colleagues (2014) found that social anxiety behaviors were related to greater social communicative deficits in typically developing youth. When comparing these findings to the current study, it is possible that differentiating ASD from social anxiety behaviors may be more difficult in young adult males with FXS than TD peers. For example, peer avoidance may be related to a lack of skill, an indifference to social contact (i.e. ASD) and/or significant distress and fear during social interactions (i.e. social anxiety). Additional complexities emerge as young adult males with FXS, unlike TD peers, may not have the communicative abilities to accurately describe emotions and feelings pertaining to social interaction. They may also live in more restrictive environments which limit social interactive experiences, leading parents to make assumptions based on limited opportunities to perceive these behaviors. For example, parents may perceive peer avoidance as a manifestation of anxiety and hyperarousal in social settings; however, the child may actually be experiencing feelings of indifference and a lack of motivation to interact with others. This may be coupled with limited opportunities to demonstrate these behaviors as the child may live at home with their parents and not have access to a variety of social settings. Future research would likely benefit from examining the restrictiveness of social interactive environments as well as examining social anxiety through exploratory and comprehensive diagnostic measures as differentiating social anxiety from ASD symptoms can be difficult particularly in populations with intellectual disabilities.

5.4 STUDY LIMITATIONS AND FUTURE DIRECTIONS

This study has some limitations that pose as opportunities for future research. First, the sample size of individuals with FXS is limited, likely contributing to the

inability to find significant associations between underlying mechanisms to pragmatic language abilities. It is noteworthy that medium to large effects of ASD symptom severity were found on these pragmatic language skills despite modest sample sizes. Larger sample sizes may also allow for exploration of pragmatic language performance based on conversational domain. Prior literature on pragmatic skills in males with FXS is suggestive of strengths in foundational linguistic skills, as in the area of expressive and receptive vocabulary, and weaknesses in conversational abilities including topic maintenance and providing comprehensible messages, which the *YiPP* could directly explore using a more efficient assessment. An additional limitation of the present study is the inclusion of only males. It is unclear if the findings in the present study would generalize to females with FXS due to the buffering effect from an unaffected X chromosome. Investigations into the pragmatic language performance of females with FXS are warranted as relationships may differ from those seen in males.

A second limitation of the present study is the lack of a comparison group. Exploration of how performance in males with FXS compares with other clinical populations such as males with ID and non-syndromic ASD with similar cognitive abilities will greatly assist with interpretation of findings and better defining pragmatic areas of strength and weakness. This is especially true as the majority of research has examined pragmatics in individuals with average cognitive abilities, and positive relationships have been found between intelligence and pragmatic language skills (Abbeduto et al., 2006; Martin et al., 2013; Murphy & Abbeduto, 2003; Sudhalter et al., 1990). This work would better differentiate traits attributed to ID than ASD symptomatology. The differentiation of ASD symptomatology into social communicative

deficits and restricted and repetitive behaviors may also provide insight into mechanisms influencing pragmatic language performance across these genetic etiologies.

A third limitation of the present study is that it is cross-sectional in nature and only provides a snapshot of pragmatic language performance in time. Longitudinal studies are needed to investigate the trajectories of pragmatic language skills in FXS from childhood to adulthood. Increased ASD symptom severity and social anxiety appear to be present in adulthood (APA, 2013; Lee et al., 2016; Thurman et al., 2017), and this work suggests these are likely to negatively influence pragmatics. Lastly, the *YiPP* was designed to be sensitive to change over time, which could be particularly useful for capturing growth from childhood to adolescence and during language interventions that target higher order social communicative abilities in FXS. The use of this measure during treatment studies could be particularly beneficial for identifying conversational abilities for interventions, creating individualized treatment plans, and measuring growth throughout the therapeutic services.

5.5 CONCLUSION

Pragmatic language skills play an integral part in developing and maintaining relationships, establishing independence, and advocating for oneself, particularly in adulthood. Pragmatic language deficits are frequently reported in FXS; however, the factors influencing these deficits and valid assessments for measuring these impairments are lacking. The current study is the first to use the *YiPP*, a dynamic assessment, which captured pragmatic language skills in young adult males with FXS. Findings indicate that communicative responses to conversational probes were often lacking or inappropriate to the context and significant conversational scaffolding in the form of specific verbal

requests were required. However, one area of strength in pragmatic performance arose when males with FXS tended to engage in conversational turns without significant conversational scaffolding. Furthermore, pragmatic language abilities appear to be negatively impacted by severity of ASD but not social anxiety; however, these behaviors may be difficult to tease apart in FXS. Finally, the *YiPP* provided a method for efficiently measuring pragmatic language skills in FXS, which may have utility in clinical settings and with more diverse populations of ID.

REFERENCES

Abbeduto, L., Brady, N., & Kover, S. T. (2007). Language Development: Profiles in FXS, *46*, 36–46. https://doi.org/10.1002/mrdd

Abbeduto, L., Murphy, M. M., Kover, S. T., Giles, N. D., Karadottir, S., Amman, A., … Nollin, K. A. (2008). Signaling Noncomprehension of Language: A Comparison of Fragile X Syndrome and Down Syndrome. *American Association on Intellectual and Developmental Disabilities*, *113*(3), 214–230. https://doi.org/10.1352/0895-8017.

Abbeduto, L., Murphy, M. M., Rice, M. L., & Warren, S. F. (2004). Language, social cognition, maladaptive behavior, and communication in Down syndrome and fragile X syndrome. *Developmental Language Disorders: From Phenotypes to Etiologies*, 77–97.

Abbeduto, L., Murphy, M. M., Richmond, E. K., Amman, A., Beth, P., Weissman, M. D., … Karadottir, S. (2006). Collaboration in referential communication: comparison of youth with down syndrome or fragile X syndrome. *American Journal of Mental Retardation*, *111*(3), 170–183. https://doi.org/10.1352/0895-8017

Adams, C. (2002). Practitioner review: The assessment of language pragmatics. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, *43*(8), 973–987. https://doi.org/10.1111/1469-7610.00226

Adams, C., Lloyd, J., Adams, C., & Lloyd, J. (2005). Elicited and spontaneous communicative functions and stability of conversational measures with children who have pragmatic language impairments. https://doi.org/10.1080/13682820400027768

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (DSM 5th ed)*. Arlington: American Psychiatric Publishing.

American Speech Language Hearing Association. (2017). *Social language use (pragmatics).* Retrieved from https://www.asha.org/public/speech/development/social-communication/

Bailey, D. B., Raspa, M., Olmsted, M., & Holiday, D. B. (2008). Co-occurring conditions associated with FMR1 gene variations: Findings from a national parent survey. *American Journal of Medical Genetics Part A*, *146*(16), 2060–2069.

Bates, E. (1976). Pragmatics as a social competence. *Journal of Speech and Hearing Disorders*, *47*, 123–134.

Belser, R. C., & Sudhalter, V. (2001). Conversational characteristics of children with fragile X syndrome: repetitive speech. *American Journal of Mental Retardation*, *106*(1), 28–38. https://doi.org/10.1352/0895-8017(2001)106<0028:CCOCWF>2.0.CO;2

Belser, Rc., & Sudhalter, V. (1995). Arousal Difficulties in Males with Fragile X Syndrome. *Developmental Brain Dysfunction*, *8*(4), 270–279.

Bostrom, C., Yau, S. yu, Majaess, N., Vetrici, M., Gil-Mohapel, J., & Christie, B. R. (2016). Hippocampal dysfunction and cognitive impairment in Fragile-X Syndrome. *Neuroscience and Biobehavioral Reviews*, *68*, 563–574. https://doi.org/10.1016/j.neubiorev.2016.06.033

Brukner-Wertman, Y., Laor, N., & Golan, O. (2016). Social (Pragmatic) Communication Disorder and Its Relation to the Autism Spectrum: Dilemmas Arising From the DSM-5 Classification. *Journal of Autism and Developmental Disorders*, *46*(8), 2821–2829. https://doi.org/10.1007/s10803-016-2814-5

Budimirovic, D. B., & Kaufmann, W. E. (2011). What can we learn about autism from studying fragile X syndrome? *Developmental Neuroscience*, *33*(5), 379–394. https://doi.org/10.1159/000330213

Capps, L., Kehres, J., & Sigman, M. (1998). Conversational abilities among children with autism and children with developmental delays. *Autism*, *2*(4), 325–344.

Cicchetti, D. V. (1994). Guidelines, criteria, and rules of thumb for evaluating normed and standardized assessment instruments in psychology. *Psychological assessment*, 6(4), 284.

Clifford, S., Dissanayake, C., Bui, Q. M., Huggins, R., Taylor, A. K., & Loesch, D. Z. (2007). Autism spectrum phenotype in males and females with fragile X full mutation and premutation. *Journal of Autism and Developmental Disorders*, *37*, 738–747. https://doi.org/10.1007/s10803-006-0205-z

Cohen, J. (1960). A coefficient of agreement for nominal scales. *Educational and psychological Measurement*, 20(1), 37-46.

Cohen J. (1988) *Statistical Power Analysis for the Behavioral Sciences.* Lawrence Erlbaum, Hillsdale, NJ.

Cordeiro, L., Ballinger, E., Hagerman, R., & Hessl, D. (2011). Clinical assessment of DSM-IV anxiety disorders in fragile X syndrome: prevalence and characterization. *Journal of Neurodevelopmental Disorders*, *3*, 57–67. https://doi.org/10.1007/s11689-010-9067-y

Cornish, K., Sudhalter, V., & Turk, J. (2004). Attention and Language in Fragile X. *Mental Retardation and Developmental Disabilities Research Reviews*, *10*(1), 11–16. https://doi.org/10.1002/mrdd.20003

Crawford, D. C., Acuña, J. M., & Sherman, S. L. (2001). FMR1 and the fragile X syndrome: human genome epidemiology review. *Genetics in Medicine*, *3*(5), 359–371.

Darnell, J. C., Van Driesche, S. J., Zhang, C., Hung, K. Y. S., Mele, A., Fraser, C. E., … Darnell, R. B. (2011). FMRP stalls ribosomal translocation on mRNAs linked to synaptic function and autism. *Cell*, *146*(2), 247–261. https://doi.org/10.1016/j.cell.2011.06.013

Devys, D., Lutz, Y., Rouyer, N., Bellocq, J.-P., & Mandel, J.-L. (1993). The FMR–1 protein is cytoplasmic, most abundant in neurons and appears normal in carriers of a fragile X premutation. *Nature Genetics*, *4*(4), 335–340.

Dykens, E. M., Hodapp, R. M., Ort, S., Finucane, B., Shapiro, L. R., & Leckman, J. F. (1989). The trajectory of cognitive development in males with fragile X syndrome. *Journal of the American Academy of Child & Adolescent Psychiatry*, *28*(3), 422–426.

Emerson, E. B. (1985). Evaluating the impact of deinstitutionalization on the lives of mentally retarded people. *American Journal of Mental Deficiency*.

Emerson, E., & Hatton, C. (1994). *Moving out: The impact of relocation from hospital to community on the quality of life of people with learning disabilities*. HM Stationery Office.

Esbensen, A. J., Rojahn, J., Aman, M. G., & Ruedrich, S. (2003). Reliability and validity of an assessment instrument for anxiety, depression, and mood among individuals with mental retardation. *J Autism Dev Disord.*, *33*(6), 617–629. Retrieved from c:%5Cpdf%5Cb%5Cxc27476.pdf

Fidler, D. J., Lunkenheimer, E., & Hahn, L. (2011). Emerging behavioral phenotypes and dynamic systems theory. *International Review of Research on Developmental Disabilities*, *40*, 17–42.

García-Nonell, C., Ratera, E. R., Harris, S., Hessl, D., Ono, M. Y., Tartaglia, N., … Hagerman, R. J. (2008). Secondary medical diagnosis in fragile X syndrome with and without autism spectrum disorder. *American Journal of Medical Genetics Part A*, *146*(15), 1911–1916.

Gutierrez-Clellen, V. F., & Pena, E. (2001). Dynamic assessment of diverse children: A tutorial. *Language, Speech, and Hearing Services in Schools*, *32*(4), 212.

Hagerman, Randi J., Harris, S. W. (2008). Autism Profiles of Males with Fragile X Syndrome. *American Journal of Mental Retardation : AJMR*, *113*(6), 427–438.

Hagerman, R. J. (1999). *Neurodevelopmental disorders: Diagnosis and treatment*. Oxford University Press.

Halls, G., Cooper, P. J., & Creswell, C. (2015). Social communication deficits: specific associations with Social Anxiety Disorder. *Journal of Affective Disorders*, 172, 38-42.

Hall, S. S., Lightbody, A. a, & Reiss, A. L. (2008). Compulsive, self-injurious, and autistic behavior in children and adolescents with fragile X syndrome. *American Journal of Mental Retardation : AJMR*, *113*(1), 44–53. https://doi.org/10.1352/0895-8017(2008)113[44:CSAABI]2.0.CO;2

Harris, S. W., Hessl, D., Goodlin-Jones, B., Ferranti, J., Bacalman, S., Barbato, I., … Hagerman, R. J. (2008). Autism profiles of males with fragile X syndrome. *American Journal on Mental Retardation*, *113*(6), 427–438.

Hernandez, R. N., Feinberg, R. L., Vaurio, R., Passanante, N. M., Thompson, R. E., & Kaufmann, W. E. (2009). Autism Spectrum Disorder in Fragile X Syndrome: A Longitudinal Evaluation. *American Journal of Medical Genetics*, (6), 1125–1137. https://doi.org/10.1002/ajmg.a.32848.Autism

Hughes, C., Hwang, B., Kim, J.-H., Eisenman, L. T., & Killian, D. J. (1995). Quality of life in applied research: A review and analysis of empirical measures. *American Journal on Mental Retardation*.

Hus, V., Gotham, K., & Lord, C. (2014). Standardizing ADOS domain scores: Separating severity of social affect and restricted and repetitive behaviors. *Journal of Autism and Developmental Disorders*, *44*(10), 2400–2412. https://doi.org/10.1007/s10803-012-1719-1

Hymes, D. (1971). *On communicative competence*. Philadelphia, PA: University of Pennsylvania Press.

Karmiloff-Smith, A., D'Souza, D., Dekker, T. M., Van Herwegen, J., Xu, F., Rodic, M., & Ansari, D. (2012). Genetic and environmental vulnerabilities in children with neurodevelopmental disorders. *Proceedings of the National Academy of Sciences, 109*(Supplement 2), 17261–17265. https://doi.org/10.1073/pnas.1121087109

Kaufmann, W. E., Cortell, R., Kau, A. S. M., Bukelis, I., Tierney, E., Gray, R. M., … Stanard, P. (2004). Autism spectrum disorder in fragile X syndrome: communication, social interaction, and specific behaviors. *American Journal of Medical Genetics Part A, 129*(3), 225–234.

Ketelaars, M. P. & Embrechts, M. T. (2017). Pragmatic Language Impairment. In L. Cummings (Vol. 11), *Research in Clinical Pragmatics* (pp. 29-57). Cham, Switzerland: Springer International Publishing. https://doi.org/10.1007/978-3-319-47489-2_2

Klusek, J., Martin, G. E., & Losh, M. (2013). Physiological arousal in autism and fragile X syndrome: group comparisons and links with pragmatic language. *American Journal on Intellectual and Developmental Disabilities, 118*(6), 475–495. https://doi.org/10.1352/1944.7558-118.6.475

Klusek, J., Martin, G. E., & Losh, M. (2014). A Comparison of Pragmatic Language in Boys with Autism and Fragile X Syndrome. *Journal of Speech, Language, and Hearing Research, 57*(October 2014), 1692–1707. https://doi.org/10.1044/2014_JSHLR-L-13-0064

Klusek, J., Martin, G. E., & Losh, M. (2014). Consistency between research and clinical diagnoses of autism among boys and girls with fragile X syndrome. *Journal of Intellectual Disability Research : JIDR*, 1–13. https://doi.org/10.1111/jir.12121

Klusek, J., Roberts, J. E., & Losh, M. (2015). Cardiac Autonomic Regulation in Autism and Fragile X Syndrome : A Review, *141*(1), 141–175.

Kover, S. T., Davidson, M. M., Sindberg, H. A., & Weismer, S. E. (2014). Use of the ADOS for assessing spontaneous expressive language in young children with ASD: *A comparison of sampling contexts. Journal of Speech, Language, and Hearing Research,* 57(6), 2221-2233.

Landa, R. (2011). Pragmatic Rating Scale for School-Age Children (PRS-SA). *Unpublished manual.*

Landa, R., Klin, A., Volkmar, F., & Sparrow, S. (2000). Social language use in Asperger syndrome and high-functioning autism. *Asperger Syndrome*, 125–155.

Lee, M., Martin, G. E., Berry-Kravis, E., & Losh, M. (2016). A developmental, longitudinal investigation of autism phenotypic profiles in fragile X syndrome. *Journal of Neurodevelopmental Disorders, 8*(1), 47. https://doi.org/10.1186/s11689-016-9179-0

Levy, Y., Gottesman, R., Borochowitz, Z., Frydman, M., & Sagi, M. (2006). Language in boys with fragile X syndrome. *Journal of Child Language*, *33*(1), 125–144.

Loesch, D. Z., Huggins, R. M., & Hagerman, R. J. (2004). Phenotypic Variation and FMRP Levels in FX. *Mental Retardation and Developmental Disabilities Research Reviews*, *10*, 31–41. https://doi.org/10.1002/mrdd.10084

Lord, C., Rutter, M., DiLavore, P. C., Risi, S., Gotham, K., & Bishop, S. L. (2012). *Autism diagnostic observation schedule: ADOS-2*. Western Psychological Services Los Angeles, CA.

Losh, M., Martin, G. E., Klusek, J., Hogan-Brown, A. L., & Sideris, J. (2012). Social Communication and Theory of Mind in Boys with Autism and Fragile X Syndrome. *Frontiers in Psychology*, *3*(August), 1–12. https://doi.org/10.3389/fpsyg.2012.00266

Martin, G. E., Barstein, J., Hornickel, J., Matherly, S., Durante, G., & Losh, M. (2017). Signaling of noncomprehension in communication breakdowns in fragile X syndrome, Down syndrome, and autism spectrum disorder. *Journal of Communication Disorders*, *65*, 22–34. https://doi.org/10.1016/j.jcomdis.2017.01.003

Martin, G.E., Lee, M., & Losh, M. (2017). Intellectual Disability. In L. Cummings (Vol. 11), *Research in Clinical Pragmatics* (pp. 109-129). Cham, Switzerland: Springer International Publishing. https://doi.org/10.1007/978-3-319-47489-2_5

Martin, G. E., Losh, M., Estigarribia, B., Sideris, J., & Roberts, J. (2013). Longitudinal profiles of expressive vocabulary, syntax and pragmatic language in boys with fragile X syndrome or Down syndrome. *International Journal of Language and Communication Disorders*, *48*(4). https://doi.org/10.1111/1460-6984.12019

Martin, G. E., Roberts, J. E., Helm-estabrooks, N., Sideris, J., & Vanderbilt, J. (2012). Perseveration in the Connected Speech of Boys with Fragile X Syndrome with and Without Autism Spectrum Disorder, *117*(5), 384–399. https://doi.org/10.1352/1944-7558-117.5.384

McTear, M., & Conti-Ramsden, G. (1992). *Pragmatic disability in children*. Whurr Pub Limited.

Mervis, C. B., & Klein-Tasman, B. P. (2004). Methodological issues in group-matching designs: α levels for control variable comparisons and measurement characteristics of control and target variables. *Journal of Autism and Developmental Disorders*, 34(1), 7-17.

Mervis, C. B., Robinson, B. F., Levy, Y., & Schaeffer, J. (2003). Methodological issues in cross-group comparisons of language and cognitive development. Language competence across populations: *Toward a definition of specific language impairment*, 233-258.

Murphy, M. M., & Abbeduto, L. (2003). Language and communication in fragile X syndrome. *International Review of Research in Mental Retardation*, *27*, 83–119.

Murphy, M. M., & Abbeduto, L. (2007). Gender differences in repetitive language in fragile X syndrome. *Journal of Intellectual Disability Research*, *51*(5), 387–400. https://doi.org/10.1111/j.1365-2788.2006.00888.x

Oberle, I., Rousseau, F., Heitz, D., Kretz, C., Devys, D., Hanauer, A., … Mandel, J. L. (1991). Instability of a 550-base pair DNA segment and abnormal methylation in fragile X syndrome. *Science*, *252*(5009), 1097–1102.

Ozonoff, S., Pennington, B. F., & Rogers, S. J. (1990). Are there emotion perception deficits in young autistic children? *Journal of Child Psychology and Psychiatry*, *31*(3), 343–361.

Pieretti, M., Zhang, F., Fu, Y.-H., Warren, S. T., Oostra, B. A., Caskey, C. T., & Nelson, D. L. (1991). Absence of expression of the FMR-1 gene in fragile X syndrome. *Cell*, *66*(4), 817–822.

Prutting, C. A., & Kittchner, D. M. (1987). A clinical appraisal of the pragmatic aspects of language. *Journal of Speech and Hearing Disorders*, *52*(2), 105–119.

Reiss, A. L., & Dant, C. C. (2003). The behavioral neurogenetics of fragile X syndrome: analyzing gene–brain–behavior relationships in child developmental psychopathologies. *Development and Psychopathology*, *15*(04), 927–968.

Roberts, J., Martin, G. E. ., Moskowitz, L., Harris, A. A., Foreman, J., & Nelson, L. (2007). Discourse skills of boys with fragile X syndrome in comparison to boys with Down syndrome [corrected] [published erratum appears in JSLHR J SPEECH LANG HEAR RES 2007 Aug;50(4):818]. *Journal of Speech, Language & Hearing Research*, *50*(2), 475–492.

Roid, G., & Miller, L. (1997). Leiter-Revised. *Wood Dale, IL: Steolting*.

Scherr, J. F., Hogan, A. L., Hatton, D., & Roberts, J. E. (2017). Stranger Fear and Early Risk for Social Anxiety in Preschoolers with Fragile X Syndrome Contrasted to Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders*, *47*(12), 3741–3755. https://doi.org/10.1007/s10803-017-3059-7

Simmons, E., Paul, R., & Volkmar, F. (2015). Assessing Pragmatic Language in Autism Spectrum Disorder: The Yale in vivo Pragmatic Protocol. *JSLHR*, *57*(December 2014), 2162–2173. https://doi.org/10.1044/2014

Snow, P., & Douglas, J. (2017). *Research in Clinical Pragmatics* (Vol. 11). https://doi.org/10.1007/978-3-319-47489-2

Sudhalter, V., & Belser, R. C. (2001). Conversational characteristics of children with fragile X syndrome: Tangential language. *American Journal on Mental Retardation*, *106*(5), 389–400.

Sudhalter, V., Cohen, I. L., Silverman, W., & Wolf-Schein, E. G. (1990). Conversational analyses of males with fragile X, Down syndrome, and autism: comparison of the emergence of deviant language. *American Journal on Mental Retardation*.

Sutcliffe, J. S., Nelson, D. L., Zhang, F., Pieretti, M., Caskey, C. T., Saxe, D., & Warren, S. T. (1992). DNA methylation represses FMR-1 transcription in fragile X syndrome. *Human Molecular Genetics*, *1*(6), 397–400.

Swanson, H. L., & Lussier, C. M. (2001). A selective synthesis of the experimental literature on dynamic assessment. *Review of Educational Research*, *71*(2), 321–363.

Tager-Flusberg, H. (2004). Strategies for conducting research on language in autism. [Review] [43 refs]. *Journal of Autism*, *34*(1), 75–80.

Thurman, A. J., McDuffie, A., Hagerman, R., & Abbeduto, L. (2014). Psychiatric symptoms in boys with fragile X syndrome: A comparison with nonsyndromic autism spectrum disorder. *Research in Developmental Disabilities*, *35*(5). https://doi.org/10.1016/j.ridd.2014.01.032

Thurman, A. J., McDuffie, A., Hagerman, R. J., Josol, C. K., & Abbeduto, L. (2017). Language Skills of Males with Fragile X Syndrome or Nonsyndromic Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders*, *47*(3), 728–743. https://doi.org/10.1007/s10803-016-3003-2

Volden, J. (2017). Autism Spectrum Disorder. In L. Cummings (Vol. 11), *Research in Clinical Pragmatics* (pp. 59-83). Cham, Switzerland: Springer International Publishing. https://doi.org/10.1007/978-3-319-47489-2_3

Williams, K. T. (2007). *EVT-2: Expressive vocabulary test*. Pearson Assessments.

Wolf-Schein, E. G., Sudhalter, V., Cohen, I. L., Fisch, G. S., Hanson, D., Pfadt, A. G., … Brown, W. T. (1987). Speech-language and the fragile X syndrome: Initial findings. *Asha*, *29*(7), 35.

Young, E. C., Diehl, J. J., Morris, D., Hyman, S. L., & Bennetto, L. (2005). The use of two language tests to identify pragmatic language problems in children with autism spectrum disorders. *Language, Speech, and Hearing Services in Schools*, *36*(1), 62–72.

.