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Formal Thought Disorder and the Autism Spectrum: Relationship with Symptoms, Executive Control, and Anxiety

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Abstract

This study investigated whether children with autism spectrum disorders (ASDs) exhibit formal thought disorder (FTD), and whether this is related to ASD symptoms, executive control, and anxiety. Participants aged 8–17 with ASDs exhibited significantly more illogical thinking and loose associations than matched typically developing control subjects. In participants with ASDs, illogical thinking was related to aspects of cognitive functioning and to executive control. Loose associations were related to autism communication symptoms and to parent reports of stress and anxiety. When FTD is present in ASDs, it generally is not a co-morbid schizophrenia symptom, but is related to pragmatic language abnormalities found in ASDs. The clinical and neurobiological significance of this work is discussed.

Keywords

Autism spectrum disorders; Schizophrenia; Thought disorder; Executive functions; Anxiety

Autism and schizophrenia are heterogeneous disorders with presentations that vary across severity-graded spectra. There has been longstanding interest in understanding the

relationship between these two disorders. Initially, it was believed that autism was the earliest manifestation of schizophrenia, which then presented fully in late adolescence or early adulthood (Bender 1947). Later, Kolvin (1971) and Rutter (1972) suggested the two disorders were functionally distinct, and empirical research demonstrated that individuals diagnosed with autism did not develop schizophrenia at a rate higher than the general population (Mouridsen et al. 1999; Sporn et al. 2004; Volkmar and Cohen 1991).

More recently, it has been proposed that the presence of an autism spectrum disorder (ASD), including high functioning autism, Asperger's Disorder, and Pervasive Developmental Disorder Not Otherwise Specified (PDDNOS), may be a nonspecific marker of severe early abnormal neurodevelopment present in disorders including schizophrenia. Consistent with this view, multiple studies have documented premorbid childhood social difficulties and oddness in individuals later diagnosed with schizophrenia (Schiffman et al. 2004; Walker et al. 1993); and Sporn et al. (2004) found that ASD was present in 25% of a cohort of children diagnosed with early onset schizophrenia.

Developing a better understanding of differences between the autism and schizophrenia is important both clinically and scientifically. For clinicians, early accurate diagnosis of both disorders is imperative given its association with improved language and social functioning in autism (Ozonoff et al. 2007) and the relationship between untreated illness duration and poor outcome in schizophrenia (Keshavan and Amirsadri 2007). Differential diagnosis of schizophrenia and ASDs can be challenging, however, because symptoms may be difficult to distinguish or even overlap (Sheitman et al. 2004; Solomon et al. 2006). For example, Konstantareas and Hewitt (2001) point out that both disorders may present with "negative" symptoms (social withdrawal, reduced motivation, emotional expression and ideational richness expressed in language); and disorganization symptoms (odd behavior and/or appearance, attention problems, sleep disturbance, and impaired stress tolerance). While individuals with ASDs do not typically have problems with reality testing, their unusual sensory interests or sensitivities may look superficially similar to hallucinations and their poor social judgment and theory of mind skills may make them appear paranoid or delusional. Furthermore, deficits frequently recognized to be cardinal symptoms of ASDs including those related to theory of mind (Irani et al. 2006; Leitman et al. 2006) and social orienting and face processing (Sasson et al. 2007) increasingly are being documented in schizophrenia.

Language disturbances also are observed in both autism and schizophrenia. The study of these atypicalities offers a novel potential means of improving understanding of similarities and differences in the neurodevelopmental processes underlying both disorders. Many individuals with schizophrenia are impaired in their ability to communicate due to problems with fluent speech. They may skip from topic to topic without warning; join words together because they are semantically or phonologically similar; exhibit a slow and steady slippage in their speech from one topic to another; reply to questions in oblique or tangential ways; and make illogical statements (Andreasen 2000). Historically, these schizophrenia-related communication problems have been referred to as a "positive" symptom called formal thought disorder (FTD), reflecting an underlying assumption of schizophrenia researchers that thought and language are closely related. More specifically, FTD has been viewed as a

symptom of executive control impairments (Kerns and Berenbaum 2002) related to the ability to use situational context to guide goal directed action across multiple functional domains including language (Cohen and Servan-Schreiber 1992).

Schizophrenia is believed to involve a generalized higher-order deficit in the ability to integrate individual elements of linguistic context to form a coherent gestalt (Kuperberg et al. 2006). Support for this assertion comes from functional magnetic resonance imaging (fMRI) studies of language tasks in individuals with schizophrenia that have shown FTD is associated with atypical neural recruitment patterns in the inferior prefrontal and temporal cortices—areas involved in cognitive control and language production (Kuperberg et al. 2007). FTD also has been associated with faster and less controlled neural activation across semantic networks in an event-related potentials (ERPs) study (Kreher et al. 2007).

In some individuals with schizophrenia, disorganized communication worsens in conditions of negative affect and/or stress (Docherty et al. 1994) that may emanate from the family environment, life events, psychophysiological arousal, or laboratory induction (Docherty 1996). This is known as affective reactivity of language. In individuals who exhibit affective reactivity, level of language disturbance correlates with the severity of positive symptoms.

FTD is in many ways similar to the pragmatic language impairments and unusual verbal behavior that is part of the core diagnostic criteria for autism. Pragmatic language problems associated with autism include those associated with exhibiting lack of reciprocity in conversations such as making abrupt topic changes, failing to provide context for the listener, going off on tangents, and lecturing about favorite topics. Use of stereotyped, idiosyncratic, overly-concrete, and/or metaphorical language also is common (Prizant et al. 2006).

There have been several empirical studies of FTD in autism. Dykens et al. (1991) investigated 11 adults with a mean IQ of 83 with HFA, who exhibited more poverty of content, but less illogical thinking than individuals with schizophrenia. Volden and Lord (1991) examined use of neologisms and idiosyncratic language in 80 autistic, mentally handicapped, and typically developing adolescents. Participants with autism produced neologisms and idiosyncratic language at a rate positively associated with overall language level. Van der Gaag et al. (2005) studied 72 children with ADHD, anxiety disorders, multiple complex developmental disorder (MCDD), autism, and typical development and found that children with autism (mean age of 10 and VIQ of 85) and MCDD exhibited more aspects of FTD, including illogical thinking and loose associations than typically developing children. Impairments in the use of cohesive structures that tie language utterances together also have been found in children and teenagers with autism (Baltaxe and D'Angiola 1992; Fine et al. 1994). Thus, there is growing body of work that suggests that individuals with autism spectrum disorders exhibit language disturbances similar to those found in individuals with schizophrenia.

Autism, like schizophrenia, involves deficits in executive functions (Ozonoff et al. 2006) and executive control (Solomon et al. 2007). Some studies have demonstrated a relationship between overall language abilities and performance on tasks of executive functions (Joseph

and Tager-Flusberg 2004) including those related to cognitive flexibility (Bishop and Norbury 2005a) and response inhibition (Bishop and Norbury 2005b). However, there has been relatively little investigation of the relationships between executive control and autism related pragmatic language problems or executive functions and language production in a relatively unstructured task using neuropsychological, neuroimaging, or electrophysiological assays.

While a high level of co-morbid anxiety has been documented in individuals with ASDs (Leyfer et al. 2006), to our knowledge, the relationship between anxiety and autism related pragmatic language disturbances, also has yet to be studied empirically. A similar pattern of “affective reactivity” of language that has been found in schizophrenia, however, has been documented in individuals with fragile X syndrome (Belser and Sudhalter 2001; Sudhalter and Belser 2001), many of whom also exhibit autism symptoms. The speech of these individuals with fragile X becomes tangential and perseverative when they are under stress. This has been attributed to physiological arousal caused by hypersensitivity to social and sensory stimuli. Hyperarousal is thought to decrease inhibitory control and to thereby increase activation in the language production system resulting in tangential speech. Prepotent lexical elements such as previously selected or highly associated words then may be inappropriately selected because of insufficient time for activation of these elements to decay resulting in repetition and perseveration.

The overarching goal of this preliminary pilot study was to use insights from schizophrenia research regarding the relationship between FTD, executive control, and anxiety to further investigate FTD in individuals with ASDs. This approach has the potential to improve differential diagnosis; to provide new leads for the study of the neurobiology of the two disorders; and to eventually inform treatment. First, it investigated the presence of FTD in children with ASDs. Given recent findings of Van der Gaag et al. (2005), we hypothesized that children with ASDs would exhibit illogical thinking and loose associations—two forms of positive FTD. Second, it explored the relationship between executive control and thought disorder in participants with ASDs. Consistent with the schizophrenia literature, we hypothesized higher rates of executive control deficits in individuals with ASDs would be related to FTD. Third, the study explored anxiety symptoms in children with ASDs and their relationship to thought disorder. Given findings in schizophrenia and fragile X syndrome, it was hypothesized that FTD in children with ASDs would be positively correlated with anxiety ratings made by parents.

Methods

Participants

Two groups of children aged 8–18 were recruited for this study. See Table 1 for a summary of their characteristics. The groups were matched on age, gender, and full scale IQ. Participants with autism spectrum disorders were recruited from the M.I.N.D. Institute, local psychiatrists, neurologists, general practitioners, psychologists, speech and language pathologists, and occupational therapists.

Participants with autism spectrum disorder ($n = 17$) met criteria for Autistic Disorder, Asperger's Disorder, or Pervasive Developmental Disorder NOS (PDDNOS) according to DSM-IV-TR (American Psychiatric Association 2000); autism spectrum disorder or autism according to the Autism Diagnostic Observation Schedule (ADOS-G; Lord et al. 2000); and autism spectrum disorder according to the Social Communication Questionnaire (SCQ; Berument et al. 1999). The decision to include individuals with high functioning autism, Asperger's Syndrome, and autism spectrum disorder in this study, derives from work showing that it is difficult to reliably distinguish between high functioning autism and Asperger's Disorders (e.g. Howlin 2003; Macintosh and Dissanayake 2004; Ozonoff and Griffith 2000) and PDDNOS (Towbin 2006), and that there is no empirical distinction in symptomatology and outcome by the time children reach the age of participants in this protocol (Howlin 2003; Szatmari et al. 2003). The sample consisted of 9 children with Asperger's Disorder, 7 children with high functioning autism and 1 child with PDDNOS. Children with ASDs were excluded if their parents reported they had clinically significant psychopathology.

Typically developing participants ($n = 22$) were recruited from local schools, pediatricians, and M.I.N.D. Institute's Subject Tracking System (STS) database, which is part of the M.I.N.D. Institute's funded Participant Recruitment and Qualification core. They did not have clinically significant psychopathology as reported by their parents. They also did not have a history of autism spectrum or other neurodevelopmental disorder, and had a score of less than 11 (below the autism spectrum cutoff) on the Social Communication Questionnaire. Children were excluded if they had a Full Scale IQ score of less than 75 on the Wechsler Abbreviated Scales of Intelligence for Children (WASI; Wechsler 1999).

The study was approved by the Institutional Review Board of the University of California, Davis, and conducted in accordance with its policies.

Qualification Measures

Wechsler Abbreviated Scales of Intelligence (WASI; Wechsler 1999 and PsychCorp 1999)—This measure was developed to provide a short and reliable means of assessing intelligence in individuals aged 6–89. The WASI produces the three traditional Verbal, Performance, and Full Scale IQ scores. It consists of four subtests: Vocabulary, Block Design, Similarities, and Matrix Reasoning. These scales were chosen due to their strong association with overall intellectual functioning. The WASI is nationally standardized, and exhibits strong psychometric properties. It has exhibited acceptable levels of internal consistency, and test-retest reliability, as well as validity (Wechsler 1999).

Autism Diagnostic Observation Schedule-Generic (ADOS-G; Lord et al. 2000)—Participants with ASDs were administered module 3 or 4 of the ADOS-G, a semi-structured interactive session and interview protocol. Each module has approximately 10 standardized interactional “presses.” Participants are rated based on their responses to these social presses, and scored for communication, reciprocal social behavior, and repetitive behaviors and stereotyped interest patterns. It offers a standardized observation of current

social-communication behavior. Inter-rater, test-retest, and internal consistency reliability, as well as interater agreement in diagnostic classification all are at acceptable levels.

Social Communication Questionnaire (SCQ; Berument et al. 1999)—All parents completed the SCQ, a 40-item parent-report screening questionnaire that evaluates communication, social skills, and repetitive behaviors. It contains parallel questions to those included on the Autism Diagnostic Interview-Revised (ADI-R; Lord et al. 1994), presented in a briefer yes/no format. Based on a total sample of 200 (160 with ASDs and 40 typically developing children), Berument et al. (1999) reported that the mean SCQ score for non-intellectually impaired individuals was 11.2, while that of individuals with ASD was 22.3 and that of individuals with autism was 24. Thus in the present study a score of 15 was used for inclusion in the ASD group and a score of 11 or below for inclusion in the typical group. The SCQ was also used to construct autism symptomatology scores for correlational analyses. We aggregated items loading onto the ADI-R domains of reciprocal social interaction, communication, and restricted and repetitive patterns of behavior and interests. If items were indicative of the construct assessed by the domain, we assigned a score of “1” to the item. These were tallied to form a composite score for the three domains. Internal consistency reliability (Cronbach’s Alpha) across these social, communication, and repetitive behavior scales were .95, .88, and .92, respectively.

Executive Control Measure

Preparing to Overcome Prepotency “POP” Task (Barber and Carter 2005; Rosano et al. 2005; Snitz et al. 2005)—The POP task was administered using a Compaq Presario 2500 laptop computer, with subjects seated 60–75 cm from the monitor. In the POP task (see Fig 1), a colored cue presented for 500 ms instructs subjects to perform one of the two task conditions. A green cue signals the subject to press the key on the same side that the target (an arrow) points to. A red cue signals the subject to press the key on the opposite side that the arrow points to. Green “prepotent” trials involve a response that is compatible with the stimuli (an arrow pointing right means respond with a right button press), occur more often (70% of the time), and are primed at the beginning of each block by three repeated presentations of the green stimulus. Red trials involve an incompatible response (an arrow pointing left means respond with a right button press). Red trials occur less often (30% of trials) and necessitate inhibition of a pre-potent response tendency, since green trials are more frequent and primed. In these context processing trials, red reaction times (RTs), the conflict effect (red RT-green RT), and error rates are the critical dependent variables. Each subject performed a brief practice block followed by four blocks of 24 trials. Blocks were administered continuously. Within each block, trials of the POP task were presented in a pseudorandom order.

Thought Disorder Measure

FTD was assessed using the Story Game procedure developed by Caplan and colleagues at the University of California, Los Angeles (Caplan et al. 1989). This consisted of administration of the Story Game, which is scored using the Kiddie Formal Thought Disorder Rating Scale (K-FTDS).

The Story Game (Caplan et al. 1989)—An audiotape is played for the child. It consists of three parts. In the first and the last, the child listens to an audiotaped story, and asked to retell it, as well as to answer a set of open-ended questions about the narrative. In the middle part, the child is asked to select one of four topics (a dream about a friendly ghost, an ostracized boy, a bad child, and an unhappy child), and make up a story about it. The topics of the stories in the Story Game, which are mildly disturbing, were chosen because of their potential to elicit pathological thought content in children.

Kiddie Formal Thought Disorder Rating Scale (K-FTDS)—According to procedures outlined by Caplan et al. (1989), we coded four aspects of FTD—Illlogical Thinking (ILL); Loose Associations (LA); Poverty of Content of Speech (POC); and Incoherence (IN). Table 2 contains descriptions and examples of these codes. The first author was trained to reliability in administration of the Story Game and coding of the Kiddie Formal Thought Disorder Rating Scale in Dr. Caplan's laboratory. Subsequently, Dr. Solomon trained two raters in her lab using Dr. Caplan's training tapes. Raters were blind to whether the participants were diagnosed with an ASD. Inter-rater reliability was maintained through regular coding meetings aimed at maintaining 80% or better percentage agreement. Utterance counts over the first 5 min also were calculated. Scores consisted of frequency counts of each of the four aspects of FTD, divided by the number of utterances.

Anxiety Measures

Behavioral Assessment Scale for Children Parent Rating Scale (BASC; Reynolds and Kamphaus 1992)—The BASC Parent Rating Scale measures positive (adaptive) as well as negative (clinical) dimensions of behavior and personality. The clinical behaviors assessed include hyperactivity, aggression, conduct problems, anxiety, depression, somatization, atypicality, withdrawal, and attention problems. The BASC has exhibited acceptable levels of internal consistency, test-retest reliability, and validity (Reynolds and Kamphaus 1992). In this study, the scaled scores for Anxiety and Internalizing Problems were used.

Stress Survey Schedule (SSS; Groden et al. 2001)—The SSS is an instrument designed to assess sources of stress in the lives of persons with autism. It consists of 47 items, which load onto 8 factors. These factors include stress related to: change and social threats; disrupted rituals; pleasant events; social/environmental interactions; unpleasant events; anticipation and uncertainty; sensory stimuli and/or human contact; and food and reinforcement. In this study it was completed by parents. Respondents are instructed to rate the intensity of the stress reaction of the participant to various events using a 5-point scale in optical-scan format, where “1” indicates none to mild reaction, “3” indicates a moderate reaction, and “5” indicates a severe reaction.

Results

Thought disorder variables are expressed as percentages of utterances (percent of disordered utterances divided by the percent of total utterances), and have low values in both samples. This is typical of studies of children and adolescents with schizophrenia, ADHD, autism,

and typical development using the K-FTDS (Caplan 1994; van der Gaag et al. 2005). Since this is an exploratory study, in addition to presenting traditional statistical tests, we examine effect sizes to minimize the chance of committing Type II error. As suggested by Cohen (1988), for group differences in presence of FTD, we categorize effects of 0–.49 as small effect sizes; .50–.79 as medium effects; and .80 and above as large effects. Relationships among the FTD variables, executive control variables, and anxiety variables were examined using Pearson correlation coefficients (two-tailed). For correlations, .10 is considered indicative of a small effect; .3 of a medium effect; and .5 of a large effect (Cohen 1988). Given that typically developing individuals produced relatively few examples of illogical thinking and no loose associations, they are not displayed in most correlational analyses. Analyses were completed using SPSS 15.0 for Windows.

Thought Disorder

As shown in Table 3, given that FTD ratings were not normally distributed in the two groups, Kruskal–Wallis one-way Analyses of Variance (ANOVAs) were used. There were significant differences between the groups in the amounts of loose associations ($H = 12.79$, 1 df, $p < .001$), illogical thinking ($H = 8.32$, 1 df, $p < .005$), and poverty of content ($H = 4.16$, 1 df, $p < .05$). Although the frequency of FTD was relatively low for both samples, at least one individual with an ASD exhibited each type of symptom. Effect sizes for the differences between the ASD and typically developing groups were large for illogical thinking ($d = 1.054$) and loose associations ($d = .943$). In each case, the ASD group evidenced more communication disturbance. Illogical thinking was the most common form of communication disturbance exhibited by each group. Almost one quarter of typically developing children said something illogical (24%), but this figure was 65% for the ASD group with 53% producing more than one illogical utterance. While none of the typically developing individuals produced a loose association, close to half of the participants with ASDs produced at least 1 (47%), with 29% producing two or more. The correlation between the presence of illogical thinking and loose associations was close to zero.

Cognitive and Autism Variables

Correlational analyses between utterance counts and thought disorder variables, and age, IQ, and autism symptoms were conducted for the entire sample. See Table 4. For the ASD group, the only group for whom ADOS-G scores were available, total mean utterances were statistically significantly negatively correlated with the ADOS-G communication domain score at a level indicative of a large effect size ($r = -.54$, $p = .04$), suggesting that children with more language-related autism symptoms produced less language during the Story Game. There also was a negative relationship indicative of a large effect size that approached significance between utterances and total ADOS score ($r = -.50$, $p = .06$) and the relationship between utterances and ADOS social interaction was indicative of a medium sized effect ($r = -.43$, $p = .11$). In the whole sample there were statistically significant correlations and medium effect sizes for the relationship between illogical thinking and SCQ total ($r = .37$, $p < .03$), social ($r = .37$, $p = .03$), and repetitive behavior ($r = .45$, $p = .01$) domain scores. Negative correlations above the .30 level indicative of a moderate effect size were found between illogical thinking and Full Scale IQ ($r = -.30$, $p = .07$), and SCQ the communication domain score ($r = .30$, $p < .08$). These relationships were driven by the

typically developing group, as none were statistically significant for the autism group alone. The relationship between loose associations, which only were produced by the ASD group, and the ADOS-G algorithm ($r = .51, p = .05$) and language domain scores ($r = .51, p = .06$), were large effects.

Executive Control

We examined relationships between illogical statements and loose associations and executive control variables from the POP Task including RTs for correct red trials, RTs for correct green trials, the conflict effect (mean RT for red trials-mean RT for green trials), red error rates, and green error rates. (See Table 5) In the participants with ASDs, there were several positive relationships between executive control variables and illogical thinking that exceeded the .30 statistical threshold indicative of a moderate effect size. The relationship between illogical thinking and mean RT for red trials achieved a traditional level of statistical significance ($r = .52, p = .05$). Other correlations indicative of a medium effect size included green trials ($r = .43, p = .16$), the conflict effect ($r = .49, p = .12$), and the error rate for green trials ($r = .49, p = .09$). None of the relationships between executive control variables and loose associations were at this level. For the typically developing participants, there was one statistically significant correlations between illogical thinking and the red trial error rate ($r = .56, p < .01$).

Anxiety

We examined the relationship between parent reports of anxiety symptoms as assessed by the BASC anxiety and internalizing problems subscales and the Stress Survey Schedule for the ASD group (See Table 6). In the ASD group, there were large effect sizes and statistically significant correlations for the relationship between loose associations and parent reported stress associated with anticipating changes ($r = .55, p = .02$) on the SSS and BASC anxiety scale ($r = .64, p = .01$). Several correlations exceeded the .30 threshold for medium effect sizes including those between loose associations and the BASC internalizing scale, as well as the changes, social/environmental, rituals, and total score of the SSS.

Discussion

Similar to Van der Gaag et al. (2005), children with ASDs in our sample exhibited significantly more illogical thinking and loose associations than typically developing children when responding to the mildly disturbing fantasy-related materials presented in the Story Game. Roughly two thirds of individuals with ASDs in this study evidenced illogical thinking versus one quarter of typically developing ones. Close to one half of children with ASDs produced loose associations, whereas none of the typically developing participants did. Thus, positive FTD in children with ASDs in this age range appears to be more common than generally recognized. Few children with ASDs and no typically developing ones produced negative symptoms of FTD including poverty of content and incoherence.

Negative correlations between illogical thinking and IQ for both groups approached statistical significance. These results are similar to those of Caplan et al. (2001) who found that children with ADHD exhibited illogical thinking that was inversely related to Verbal

and Full Scale IQ. This was interpreted as being indicative that FTD in children without schizophrenia was a result of cognitive deficits as opposed to those involved in higher-order linguistic processing where context is required to process thought. Unlike the Caplan et al. (2001) ADHD study, however, in children with ASDs, we found a statistically significant relationship between illogical thinking and RTs on red trials. In children with typical development, there was a relationship with illogical thinking and red trial error rates. We view both of these as measures of the higher-order process of cognitive control. Although they did not achieve traditional levels of statistic significance, in the ASD group, other control-related variables including the RT for green trials, the RT for the conflict effect, and the error rate for green trials, also exhibited medium effect sizes. This suggests that individuals who require more time to overcome a prepotent response tendency may be more likely to exhibit illogical thinking, and that as in schizophrenia (Cohen and Servan-Schreiber 1992; Kuperberg et al. 2006), context processing deficits may underlie illogical thinking and its linguistic manifestations in individuals with ASDs.

For the entire sample, we found that parent reported total, social, and repetitive behavior symptoms on the SCQ were statistically significantly related to illogical thinking. This relationship was more prominent for participants with typical development. On the ADOS, a clinician report measure only available for individuals with autism, there were no statistically significant relationships between autism symptoms and illogical thinking. There were, however, large and medium effect size relationships between loose associations and the total ADOS, communication, and social interaction scores. There also were trend level negative relationships with the amount of utterances produced by participants. This suggests that clinicians perceive a relationship between speech involving loose associations and the autism diagnosis, and that low verbal output also is associated with this diagnosis.

For the typically developing participants, there was a statistically significant relationship between illogical thinking and the BASC anxiety scale, and a moderate effect size for BASC internalizing. In the children with ASDs, anxiety was related to loose associations and not illogical thinking. There was a statistically significant relationship between loose associations and parent-reported child anxiety. Medium effect sizes were found in the relationships between loose associations and the internalizing problems scale from the BASC, as well as scales from the SSS assessing changes, social and environmental stressors, rituals, and the total score. Further study will be required to tease apart cause and effect, however, given that pragmatic language impairments are a frequent target for intervention, improved understanding of their relationship with anxiety could provide important insights for treatment strategies.

Conceptualizing the co-morbidity of ASDs and schizophrenia based on the common symptom of FTD is central to interpreting our findings. Caron and Rutter (1991) point out co-occurring disorders may be viewed as categories or dimensions; contain overlapping diagnostic criteria; be artificial subdivisions of syndromes; represent early manifestations of the other; and/or be part of each other. According to this framework, we believe that schizophrenia and ASDs contain overlapping symptoms. When aspects of FTD are present in ASDs, they are not necessarily co-morbid schizophrenia spectrum symptoms, but likely are evidence of symptomatic overlap with the pragmatic language abnormalities inherent in

autism (Tager-Flusberg et al. 2005). In this sample, in individuals with ASDs, impairments in cognitive control appear to be related to making illogical statements, whereas anxiety and autism symptoms appear to be more related to making loose and tangential statements.

While the vast majority of individuals with autism do not have schizophrenia, it is noteworthy that approximately 25% of individuals with childhood onset schizophrenia meet lifetime diagnostic criteria for PDD (Sporn et al. 2004). Future comparative studies of individuals with schizophrenia spectrum disorders and ASDs may further understanding of the relationships between context processing, disordered communication, restricted and repetitive behaviors, and the social impairment that is part of both disorders.

The current study had several limitations. First, the sample was small, and thus our statistical power was low. Second, our investigation would have been more comprehensive if we had evaluated other forms of FTD and discourse cohesion not assessed by the K-FTDS. A third limitation is that we only compared children with ASDs with a group of typically developing children. A fourth limitation was that since this is a sample of highly able individuals with ASDs, findings may not generalize to lower functioning individuals with the disorders. Finally, only parent reports of trait anxiety were used in this study. It has been suggested that biologically derived assays of anxiety such as heart rate, skin conductance, and/or cortisol levels may produce different results than behavioral observations (Corbett et al. 2006). Also our measures of anxiety were trait versus state measures, whereas affective reactivity of language may be more evident in a stressful state.

Caplan et al. (2001) suggested that FTD might be a common final pathway for disorders differentially involving frontotemporal brain networks. It now is popular in both the autism (Geschwind and Levitt 2007) and schizophrenia (e.g. Symond et al. 2005) fields to view the disorders as “disconnection” syndromes. FTD in autism and schizophrenia could be viewed as evidence of abnormal connectivity between frontal brain areas involved in context maintenance and “top down control,” and posterior brain areas involved in language production and processing. This theme has been echoed in other studies such as those by Kuperberg and colleagues reviewed above. Given that anxiety may be associated with exacerbation of FTD, parts of the limbic system, such as the amygdala and regions of the anterior cingulate cortex, also may be involved in the neural circuitry mediating language disturbance. The study of recruitment and activation patterns in the brain regions potentially underlying FTD in both populations offers a potential novel way to tease apart differences in the neurobiology of these disorders, as well as other forms of developmental psychopathology.

Future studies should include larger samples; stronger and more language-based tests of cognitive control; state-based biological assays of stress reactivity; comparison groups with other neurodevelopmental disorders including schizophrenia to both validate findings about executive control and anxiety in matched subjects with schizophrenia and to establish the specificity of findings to autism; and neuroimaging to ascertain differences in frontotemporal connectivity and their relationship to language disturbances in both populations. This approach holds the promise of improving differential diagnosis, enhancing

understanding of pathophysiology; and providing an empirical foundation for the development of interventions.

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Fig. 1.
Schematic of preparing to overcome prepotency (POP) task

Table 1

Participant characteristics

	ASD group (<i>n</i> = 17)		Typically developing group (<i>n</i> = 21)	
	M (SD)	Range	M (SD)	Range
Age (Years)	13.00 (2.30)	10.00–17.33	11.88 (2.18)	8.25–16.75
VIQ	113.47 (19.20)	69.00–143.00	115.19(15.61)	89.00–143.00
PIQ	112.07 (18.21)	79.00–135.00	109.57 (7.76)	89.00–124.00
FSIQ	114.00 (18.76)	76.00–142.00	114.10 (11.25)	99.00–134.00
SCQ total	24.47 (6.57)	15.00–35.00	2.05 (2.18)	0.00–8.00
SCQ social behavior domain	10.47 (3.50)	2.00–15.00	0.52 (0.75)	0.00–3.00
SCQ repetitive behavior domain	6.33 (2.06)	2.00–9.00	0.57 (0.81)	0.00–3.00
SCQ communication domain	7.07 (2.89)	2.00–12.00	0.95 (1.12)	0.00–4.00
ADOS comm. + Social interaction	12.20 (4.49)	7.00–23.00	–	–
ADOS communication domain	3.80 (2.08)	2.00–9.00	–	–
ADOS social interaction domain	8.40 (2.61)	5.00–14.00	–	–
ADOS restricted Interests domain	3.20 (1.57)	1.00–7.00	–	–

Table 2

Examples of formal thought disorder coded by the kiddie formal thought disorder rating scale

Code	Description	Example
Illogical thinking	Inappropriate or immature use of causal utterances	"I went to school today because my name is Tom."
	Unfounded reasoning in non-causal utterances	"Sometimes I go to school and when I am done singing, I start coughing and that is when I stop."
	Makes a statement and then refutes it	"I liked the book but I don't like books like that."
Loose associations	Abrupt topic changes without alerting the listener	"I have a lot of homework today and Mr. Conductor is my favorite character in Shining Time Station."
Incoherence	Contents of a statement cannot be understood due	"The boys day no boys fast running."
	To scrambled syntax	
Poverty of content	After two utterances, no content is expressed	"I suppose ...what? Maybe..Well yes, I see. I suppose that's all."

Table 3

Ratings for all K-FTDS variables

	ASD group (<i>n</i> = 17)		Typically developing group (<i>n</i> = 21)		χ^2
	M (SD)	Range	M (SD)	Range	
Utterance counts in the 1st 5 min	54.40 (17.05)	33.00–93.00	46.29 (11.36)	30.00–79.00	1.99 <i>NS</i>
Ratings for loose associations	0.02 (.03)	0.00–0.11	–	–	12.79 <i>p</i> < .001
Ratings for illogical thinking	0.06 (0.06)	0.00–0.20	0.01 (0.03)	0.00–0.15	8.32 <i>p</i> < .005
Ratings for poverty of content	0.00 (0.01)	0.00–0.03	–	–	4.16 <i>p</i> < .05
Ratings for incoherence	0.00 (0.01)	0.00–0.02	–	–	2.70 <i>NS</i>

^aKruskal–Wallis one-way ANOVA

FTD ratings are percentages of total utterances

Table 4Correlations between K-FTDS and demographic variables for all subjects ($n = 38$)

	Utterances	<i>p</i> -value	Illogical thinking	<i>p</i> -value	Loose assoc. ^a	<i>p</i> -value
Age	0.07	0.67	0.05	0.78	-0.07	0.80
VIQ	-0.03	0.85	-0.23	0.19	0.26	0.34
PIQ	0.17	0.34	-0.25	0.14	0.09	0.76
FSIQ	0.05	0.78	-0.30	0.07	0.19	0.50
SCQ Total	0.17	0.31	0.37	0.03	0.26	0.35
SCQ social Behavior domain	0.14	0.42	0.37	0.03	0.23	0.42
SCQ communication Domain	0.13	0.47	0.30	0.08	0.30	0.28
SCQ repetitive Behavior domain	0.15	0.39	0.45	0.01	0.23	0.41
ADOS total ^b	-0.50	0.06	-0.12	0.68	0.51	0.05
ADOS communication ^b						
Domain	-0.54	0.04	-0.02	0.94	0.50	0.06
ADOS social ^b						
Interaction domain	-0.43	0.11	-0.18	0.52	0.48	0.07

Correlations achieving traditional levels of statistical significance are shown in bold

^a $n = 17$; no typically developing subjects made a loose association^b Scores from the ADOS are only available for subjects with an ASD

Table 5Correlations between K-FTDS and POP variables for ASD subjects ($n = 17$)

POP variables	ASD			
	Illogical thinking	<i>p</i> -value	Loose assoc.	<i>p</i> -value
Mean RTs				
Red trials	0.52	0.05	−0.17	0.43
Green trials	0.43	0.16	−0.20	0.50
Conflict effect	0.49	0.12	0.10	0.30
Mean ERs				
Red trials	−0.04	0.62	−0.08	0.64
Green trials	0.49	0.09	0.25	0.23

Correlations achieving traditional levels of statistical significance are shown in bold

Table 6

Correlations between K-FTDS, BASC anxiety subscale and stress survey schedule categories for ASD subjects ($n = 17$)

	ASD			
	Illogical thinking	<i>p</i> -value	Loose assoc.	<i>p</i> -value
BASC-anxiety	0.11	0.67	0.64	0.01
BASC-internalizing	0.10	0.69	0.41	0.10
Stress survey				
Schedule categories:				
Changes	0.08	0.75	0.39	0.12
Anticipation	0.13	0.63	0.55	0.02
Unpleasant	0.00	0.99	0.20	0.44
Positive	-0.20	0.44	0.27	0.29
Sensory/Personal	-0.06	0.83	0.09	0.73
Food related	0.25	0.33	0.16	0.54
Social/environmental	-0.14	0.60	0.33	0.19
Rituals	0.08	0.77	0.46	0.06
Total	0.02	0.93	0.39	0.12

Correlations achieving traditional levels of statistical significance are shown in bold