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From lumping to splitting and back again: Atypical social and language development in individuals with clinical-high-risk for psychosis, first episode schizophrenia, and autism spectrum disorders

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Abstract

Objective—Individuals with autism and schizophrenia exhibit atypical language and social symptoms. The extent to which these symptoms are evident during development and in current functioning is unclear.

Method—Three groups of patients aged 11–20 diagnosed as clinical-high-risk for psychosis (CHR; n = 15), first episode psychosis (FEP; n = 16), and autism spectrum disorders (ASD; n = 20), plus typically developing individuals (TYP; n = 20) were compared on common autism parent-report questionnaires assessing social and language development and current functioning including the Social Communication Questionnaire, the Children's Communication Checklist, and the Social Reciprocity Scale.

Results—All clinical groups demonstrated atypical social and language development, with social impairment highest in ASD. Twenty percent of participants with CHR and FEP met diagnostic criteria for ASD as assessed by parent-report. ASD exhibited greater current syntactic, and pragmatic language symptoms including delayed echolalia, pedantic speech, and deficits in appreciating irony and sarcasm. All clinical groups exhibited current deficits in social functioning. CHR and FE had similar and intermediate levels of functioning relative to ASD and TYP, with CHR generally scoring closer to TYP, providing construct validity for the CHR diagnostic label.

Conclusions—The results of this study suggest that ASDs, CHR, and FEP share common features of atypical neurodevelopment of language and social function. Evidence of impaired social reciprocity across both disorders and distinct language symptoms in ASDs provides important information for differential diagnosis and psychosis prevention, as well as leads for future investigations of comparative genetics and pathophysiology.

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Keywords

language; social; neurodevelopment; schizophrenia; autism; thought disorder

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1.0 Introduction

Autism and schizophrenia are complex neuropsychiatric disorders involving atypical cognitive, linguistic, and social functioning. Although the developmental courses of the two disorders are quite different -- autism presents in early childhood, while schizophrenia typically is not diagnosed until adolescence or early adulthood -- many of their symptoms are at least superficially similar. Consequently, there has been longstanding interest in better articulating the comparative symptom profiles, genetics, and pathophysiology of the disorders, although this has proven challenging.

Until the mid-20th century, autism was thought to be an early manifestation of schizophrenia, which presented more fully in late adolescence or early adulthood. Kolvin (1971) and Rutter (1972) then suggested the two disorders were distinct, and empirical research demonstrated that individuals with autism did not develop psychosis more frequently than members of the general population (Volkmar and Cohen, 1991). More recent studies show that frank psychosis is a relatively infrequent co-morbid diagnosis in individuals with autism spectrum disorders (ASDs) (Leyfer et al, 2006).

The idea that autism and schizophrenia are discrete syndromes, however, is somewhat at odds with the prominent “neurodevelopmental” view of schizophrenia (Rapoport et al., 2005), which proposes that schizophrenia specific brain abnormalities are present in early life (or even in utero), even though clear psychotic illness does not emerge until adolescence or early adulthood. Indeed a substantial minority of schizophrenia patients exhibit significant premorbid behavioral abnormalities (Neumann et al., 1995; Schiffman et al., 2004). Studies of childhood onset schizophrenia (COS), also suggest the disorders have similar early symptoms, and estimate that between 28% (Rapoport et al., 2009) and 39% (Watkins et al., 1988) of individuals with COS meet ASD criteria before the age of 30 months.

1.2 Language deficits

Grammatical and pragmatic language impairments are prominent in both disorders. Diagnostic criteria for ASDs include deficits in the ability to initiate or sustain conversations, where they change topics abruptly, fail to provide listener context, make tangential comments, and “lecture” about favorite topics. Individuals with ASDs also show stereotyped, repetitive, idiosyncratic, overly-formal, and concrete language. These language symptoms resemble formal thought disorder (FTD), a feature of schizophrenia (Bleuler and Zinkin, 1950), which is included as a positive symptom in the diagnostic criteria (APA, 2000). When evidencing FTD, individuals with schizophrenia join semantically or phonologically similar words; exhibit unexplained “slippage” from one topic to another; reply to questions in oblique or tangential ways; and make illogical statements (Andreasen et al., 1998). Schizophrenia patients with “negative” thought disorder display a lack of verbal initiation, and a poverty of speech content. Aspects of FTD including poverty of content (Volden and Lord, 1991); illogical thinking (Van der Gaag et al., 2005); and loose associations (Solomon et al., 2008); have been documented in ASDs.

1.3 Social deficits

Problems with reciprocal social interaction are considered the hallmarks of ASDs (Losh et al., 2009). Deficits in eye contact and nonverbal behavior; failure to develop age-appropriate peer relations; lack of spontaneous sharing of enjoyment with others; and reduction in social and emotional reciprocity are included in the diagnostic criteria. Studies show that affected individuals display deficits in affective reciprocity (Hobson, 1996), theory of mind (Saxe and Baron-Cohen, 2006), face processing (Losh et al., 2009), and imitating/mirroring the actions of others (Rizolatti and Fabbri-Destro, 2008).

Persistent and severe social deficits also are observed in individuals with schizophrenia (Kraepelin, 1919), and clinically significant social impairment figures prominently in diagnostic criteria. Several meta-analyses now have documented deficits in Theory of Mind (Bora, Yucel, & Pantelis, 2009; Sprong et al., 2007). There also are documented deficits in face processing (Pinkham et al., 2008), correct application of social rules, and social perception (Sprong et al., 2004) in individuals with schizophrenia. Recent studies have begun to examine social cognitive functioning including recognition of facial expressions and affective prosody, and theory of mind in both disorders, with some highlighting differences between the disorders (Sasson et al., 2007); and others stressing their similarities (Couture et al., 2010).

The overarching goal of the current study was to provide insights about differential diagnosis and psychosis prevention, and ultimately, leads for studies of comparative genetics and pathophysiology. To this end, we examined both the development and current expression of language and social symptoms in ASDs (autism and Asperger's disorder), and individuals from two groups on the schizophrenia spectrum including clinical-high-risk for psychosis (CHR), and first episode schizophrenia (FEP) patients (collectively referred to as the "psychotic disorder groups"), and compared them to typically developing individuals (TYP) using common measures of development and current functioning from ASD research. Consistent with a neurodevelopmental model of schizophrenia, our first hypothesis was all clinical groups would evidence atypical language and social development, although ASDs would exhibit greater social impairment, and the rate of ASD diagnosis in the psychotic disorder groups would be lower than those found in COS, which is known to be particularly severe. Second, we hypothesized the patient groups would exhibit developmental and current language deficits resembling FTD, but that these would be worse for FEP. Finally, we hypothesized that ASDs would exhibit the most severe current social deficits, given the primacy of social deficits to ASDs.

2.0 Experimental Materials and Methods

2.1 Participants

As shown in Table 1, 71 individuals ages 11–20 years participated in this study. This included patients with FEP ($n = 16$), CHR ($n = 15$), and ASD ($n = 20$), and typically developing comparison subjects (TYP; $n = 20$). FEP and CHR individuals were recruited from the UC Davis EDAPT Clinic. FEP participants met DSM-IV-TR criteria for a recent onset (i.e. within past 12 month) schizophrenia spectrum disorder according to the Structured Clinical Interview for DSM-IV-TR (SCID-I/P) (First et al., 1997). In our sample, 10 individuals met criteria for schizophrenia; 3 for schizophreniform disorder; 2 for schizoaffective disorder; and 1 for psychosis NOS. CHR individuals met criteria for the attenuated positive symptom (APS) risk state according to the Structured Interview for Prodromal Syndromes (Miller et al., 2003). Participants with ASD were recruited from the UC Davis MIND Institute and met criteria for autism ($n=13$) or Asperger's disorder ($n=7$) as determined by the Social Communication Questionnaire (Rutter et al., 2003), Autism

Diagnostic Observation Schedule, Module 4 (Lord et al., 2000) and a DSM-IV symptom checklist. TYP participants were recruited in the community and enrolled in the study if they had no known diagnosed psychopathology by parent report, and either had SCQ scores of below 11 ($n=13$) or no prior psychiatric diagnosis according to the SCID-I/P ($n=7$). Exclusion criteria included: A Wechsler Abbreviated Scales of Intelligence for Children (WASI) (Wechsler, 1999) Full Scale IQ less than 70 or a history of substance dependence or abuse within 3 months prior to study enrollment. After complete description of the study to the subjects, written informed consent was obtained. Study protocols were approved by the University of California Davis Institutional Review Board.

2.2 Measures

2.2.1 Diagnostic and Qualification Measures

WASI (Wechsler, 1999): The four-subtest (Vocabulary, Block Design, Similarities, Matrix Reasoning) version of the WASI was used to provide a short and reliable assessment of intelligence. It produces Verbal (VIQ), Performance (PIQ), and Full Scale IQ (FSIQ) Standard Scores with means of 100 and *SDs* of 15. The WASI is nationally standardized and has strong psychometric properties. Test-retest reliability for IQ scales ranges from .88–.93.

Structured Interview for Prodromal Symptoms (SIPS; Miller et al., 2003) is a semistructured diagnostic interview, whose criteria emphasize onset or worsening in the past 12 months of attenuated positive symptoms in 1 or more of the 5 categories including unusual thought content, suspiciousness/paranoia, perceptual disturbances, grandiosity, and disorganized communication. A 7-point scale is used for each symptom. Levels of 0 to 2 indicate normal to sub-prodromal functioning; levels of 3–5 indicate a prodromal state; and a level of 6 indicates a fully psychotic state. To qualify, subjects may exhibit onset in the past 3 months of attenuated positive (APS) or brief intermittent psychotic symptoms (BIPS), or by have genetic risk (GRD) and functional decline. The SIPs exhibited high levels of sensitivity (100%), and specificity (>70%) for detecting conversion to psychosis, when assessed at 6, 12, 18, and 24 months. Inter-rater reliability (kappa) achieved across 6 sites on the SIPs after 2-day rater training workshop was .857. Validity of findings was buttressed by the fact that conversion rates were comparable to those published by other groups, and a diagnosis of “not prodromal” was strongly predictive (100%) of not converting to psychosis within a year.

The Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I/P) is a semistructured interview for making most of the major DSM-IV Axis I psychiatric diagnoses. The SCID-I/P is divided into six modules that can be administered in sequence: mood episodes; psychotic symptoms; psychotic disorders; mood disorders; substance use disorders; and anxiety, adjustment, and other disorders. Results of a recent joint reliability study (Lobbestael, Leurgans, & Arntz, 2010) showed that SCID-I/P validity was high and that interrater reliability ranged from .60 to .83.

Autism Diagnostic Observation Schedule-Generic (ADOS-G): 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,” and participants are rated based on their responses to them. Lord et al. (2000) showed that for modules 3 and 4, mean inter-rater agreement was 88%. Inter-rater reliability on all item domains ranged from .82 (restricted and repetitive behaviors) to .93 (social behaviors). Test-retest reliability ranged from .59 (repetitive behaviors) to .78 (social behaviors). Internal consistency reliability ranged from .91 to .94 for social and communication items. Inter-rater agreement in diagnostic classification based on the ADOS algorithm exceeded 90%.

Social Communication Questionnaire (SCQ): Parents completed the SCQ, a brief 40-item screening questionnaire to evaluate communication and social skills in individuals 4 years of age and older. The Lifetime Form, which focuses on the child's entire developmental history was used. Berument et al. (1999) reported the mean SCQ score for non-intellectually impaired individuals was 11.2, while that of persons with PDD was 22.3, and that of individuals with autism was 24. A cutoff of 15 or over gave a sensitivity of .96 and a specificity of .80 for autism vs. other diagnoses. High correlations between SCQ and the "gold-standard" ADI algorithm scores, constitute evidence for validity. Based on the mean score for non-intellectually impaired individuals, a cutoff score of 11 or below was used to screen for exclusion.

2.2.2 Social and Language Measures

Children's Communication Checklist-2 (CCC-2) (Bishop, 2003): The CCC-2 assesses children ages 4 to 16 years 11 months' current communication skills in the areas of grammar and pragmatics. It consists of 10 scales. The first four scales are Speech, Syntax, Semantics, and Coherence. They assess articulation and phonology; imprecise word use; atypical word ordering; and failure to provide listener context, respectively. While not traditional measures of FTD, Syntax, Semantics, and Coherence capture aspects of it. The next four scales -- Initiation (starting interactions), Scripted Language (delayed echolalia/ pedantic speech), Context (use of humor and irony and using language in a concrete fashion) and Nonverbal Communication (constriction in range of affect) -- address pragmatics. The Context scale also is related to FTD. Scales assessing Social Relationships (ability to have friends), and Interests (autistic mannerisms and circumscribed interests), also are included. A Social Interaction Difference Index (SIDI) is computed by subtracting the sum of the first four scales from the rest. Children with SIDI less than or equal to -11 should be referred for ASD diagnostic follow-up. Subscale reliability estimates range from .66-.80 in TYP children.

Social Responsiveness Scale (SRS) (Constantino, 2002): The SRS is a 65-item gender-normed questionnaire that queries behavior over the last 6 months, for children aged 4 to 18. It has five subscales that assess cognizance of social cues (Awareness); ability to interpret and respond to social cues (Cognition); interpersonal expressiveness and conversational give-and-take (Communication); interest in socialization and emotional closeness and empathy (Motivation); and stereotyped behaviors and restricted interests (Autistic Mannerisms). Standardized scores of 76 are in the severe range and indicate a strong likelihood of an ASD. Scores of 60-75 indicate less severe impairment such as that found in children with PDDNOS and Asperger's Disorder. Scores of 59 or less are considered normal. The SRS has acceptable levels of internal consistency (.93-.97) and test-retest reliability (.77-.85).

2.3 Data Analysis

Analyses were performed in SPSS 17.0. Groups differed significantly in age and IQ. To account for effects of age, age-normalized scores were used for measures that required them (CCC-2 and SRS). To correct for IQ differences, FSIQ was used as a covariate in all analyses by regressing FSIQ on each variable and using the residuals in the analysis. We used univariate One Way Analyses of Variance (ANOVA) to compare scores by diagnostic Group (ASD, CHR, FEP, TYP). Distributions of all dependent variables were positively skewed, and were logarithmically transformed. For scores with a significant group main effect, Tukey's multiple comparison procedure was used to identify significant group differences. For each measure (SCQ, CCC-2, SRS), a Bonferroni correction was used to control the Type I error rate at 0.05 across the analyses of several scores within the measure. Then, the pairwise comparisons for each score were adjusted via Tukey's procedure to

maintain the Type I error rate at the Bonferroni corrected error rate for each score. This procedure maintained the overall Type I error rate for each measure at 0.05 across all scores in the measure and pairwise comparisons within scores.

3.0 Results

3.1 Atypical development

There was a main effect of group for the total SCQ score [$F(3, 67) = 33.69, p = .001, \eta_p^2 = .61$], and for all the domain level scores including Communication [$F(3, 67) = 16.13, p = .001, \eta_p^2 = .42$], Repetitive Behaviors [$F(3, 67) = 40.87, p = .001, \eta_p^2 = .65$], and Social Behaviors [$F(3, 67) = 31.53, p = .001, \eta_p^2 = .59$]. Across all these domains, pairwise comparisons with Tukey's correction revealed that the scores for the FEP and CHR groups were not significantly different than each other. For Communication, there was a trend level group difference between CHR (but not FEP) and TYP ($p = .07$), while ASD scored worse than all groups ($ps = .001$). For Repetitive Behaviors, scores for FEP and CHR were intermediate to and significantly different from TYP ($p = .001$) and ASD ($p = .001$). On the Social domain the FEP, CHR, and TYP groups scored comparably, while ASD scored significantly worse ($ps = .001$). See Table 2.

Twenty percent of individuals with CHR, and 19% of FEP met SCQ criteria for PDDNOS (≥ 15), with none meeting full criteria for autism (≥ 24). However, on the SRS, which assesses current behavior, 31% of FEP and 40% of CHR scores in the severe range, while 50% of FEP and 33% of CHR scored in the moderate range, indicating the psychotic disorder groups currently demonstrated autism-like social deficits. See Table 3.

3.2 Structural and Pragmatic Language

On the Structural Language subscale (grammatical abilities) of the CCC, there was a main effect of diagnostic group for the Speech [$F(3, 67) = 4.37, p = .007, \eta_p^2 = .16$], Semantics [$F(3, 67) = 9.19, p = .001, \eta_p^2 = .29$], Syntax [$F(3, 67) = 4.35, p = .007, \eta_p^2 = .16$] and Coherence [$F(3, 67) = 12.06, p = .001, \eta_p^2 = .35$] scales, which assess articulation and phonology; imprecise word use; atypical word ordering; and failure to provide listener context, respectively. Pairwise comparisons with Tukey's correction showed that for the Speech, Semantics, and Coherence subscales, FEP, CHR, and TYP did not differ from each other, but did differ significantly from ASD (all $ps = .01$). On the Syntax scale, again FEP, CHR, and TYP did not differ from each other. Here, ASD was significantly more impaired than TYP ($p = .01$) and CHR ($p = .02$), but not FEP. In sum, across structural language subscales most reminiscent of FTD (Semantics, Syntax, and Coherence), there were no significant differences between FEP, CHR, and TYP, while ASD showed significantly greater impairment. See Table 4.

There was a main effect of group on all Pragmatic language scales including Scripted language, which assesses stereotyped language including pedantic speech and delayed echolalia [$F(3, 67) = 22.33, p = .001, \eta_p^2 = .50$]; Context, which assesses the understanding of humor and irony, and ability to use abstract versus overly concrete and literal language [$F(3, 67) = 16.31, p = .001, \eta_p^2 = .42$]; Initiation, which assesses inappropriate and excessive social overtures [$F(3, 67) = 14.02, p = .001, \eta_p^2 = .39$]; Non-Verbal communication, which assesses constriction in non-verbal responsiveness and range of affect (i.e. flat affect) [$F(3, 67) = 10.85, p = .001, \eta_p^2 = .33$]; Social Relations, which assesses the ability to have friends [$F(3, 67) = 10.59, p = .001, \eta_p^2 = .32$]; and Interests, which assesses autistic mannerisms and circumscribed interests [$F(3, 67) = 13.69, p = .001, \eta_p^2 = .38$]. Pairwise comparisons, with Tukey's correction, showed that on Scripted Language, Context, and Non-Verbal Communication, FEP, CHR, and TYP had comparable scores, and were significantly less

impaired than ASD ($p = .01$). On the Initiation scale, FEP and CHR did not differ, however, FEP scored similarly to TYP, whereas CHR scored significantly differently ($p = .005$), and both FEP and TYP differed from ASD ($p = .001$). A similar pattern of findings was evident for Interests. On Social Relations, the FEP and CHR groups scored similarly. The FEP group differed significantly from TYP ($p = .005$), although the CHR group did not. The FEP and ASD groups resembled one another, but were significantly different than CHR ($p = .01$), and TYP ($p = .001$). In sum, although pragmatic language findings were complex, ASD exhibited some unique language deficits related to using scripted language; failing to provide listener context, and having limited range of responsiveness.

3.3 Social Reciprocity

There was a main effect of diagnostic group across all domains of the SRS: Awareness [$F(3, 67) = 18.73, p = .001, \eta_p^2 = .46$], Cognition [$F(3, 67) = 14.66, p = .001, \eta_p^2 = .40$], Communication [$F(3, 67) = 17.04, p = .001, \eta_p^2 = .43$], Motivation [$F(3, 67) = 10.97, p = .001, \eta_p^2 = .33$], and Mannerisms [$F(3, 67) = 16.76, p = .001, \eta_p^2 = .43$]. Paired comparisons with Tukey's correction revealed there were two patterns of relationships. Across all subscales, FEP resembled CHR. However, for Awareness and Communication, FEP and CHR scored in the middle. They were significantly different from both TYP ($p = .001$) and ASD ($p = .05$). For Cognition, Motivation, and Mannerisms, each clinical group was significantly more impaired than TYP ($p < .01$) across all domains See Table 5.

4.0 Discussion

Hypotheses of the study were largely confirmed. ASD, CHR, and FEP demonstrated developmental impairments in communication and social functioning, with ASD demonstrating the worst lifetime social problems. Consistent with our prediction that prevalence of ASD in CHR and FEP would be lower than that for individuals with COS, the rate was approximately 20%, and included no individuals meeting strict autism criteria. Contrary to prediction, ASD evidenced more current structural and pragmatic language deficits than the psychotic disorder groups. Aspects of language impairments reminiscent of FTD including imprecise and concrete word use; and failure to provide listener context were higher in ASD. They made poor word choices and failed to provide context for listeners. ASD also used more scripted and pedantic language, and had poorer understanding irony and humor. Finally, all clinical groups exhibited current reciprocal social interaction impairments. FEP and CHR were midway between TYP and ASD in their impairments related to social communication and awareness. However, they resembled ASD, in their limited social cognition, motivation, and autistic mannerisms. CHR and FEP also showed comparable levels of impairment across all measures (convergent validity); discriminant validity with respect to typically developing and autism patients; and the same pattern of results across diverse measures, providing support for the construct validity of the CHR diagnostic label (Campbell and Fiske, 1959).

This study had several limitations. Our sample was small thus limiting the power to detect statistically significant relationships, and increasing the propensity to commit Type I errors. The prevalence of males and females in the populations studied are different. We included approximately 25% females in each group since this is the ratio in ASD, however, our gender matching was not perfect and the ratio of males to females was largest for the ASD group. Both biological (Bital, Lifshitz, Breznitz, & Booth, 2010) and behavioral (Tenebaum, Ford, & Alkhedairy, 2010) studies suggest there are gender differences in language with women showing relative strengths in the integration of information and provision of context for listeners. Thus, the greater male to female ratio in the ASD group versus the other disorder groups may have biased us towards finding greater differences in context related language problems than would have been present if the groups all had a gender ratio of 4:1.

We elected to include the maximum possible number of subjects for the CHR group given that these patients are rare, and that the CHR gender ratio is unknown. The SCQ and CCC-2 do not have gender norms, suggesting these measures do not differ by gender, and we conducted analyses after adjusting for gender on the SRS. Reasoning that the disorders all included some developmental delay, and taking into account the fact that it is difficult to find measures that span the relevant age range, we elected to include subjects between 17 and 20 years of age, and age-normed measures for these individuals were not always available. Using artificially low age norms may have positively biased scores, and have somewhat distorted our findings. Finally, our investigation relied purely on parent reports, despite the fact that multiple informants would have been preferable. Again, overreliance on parent reports may have biased findings. Future studies should include a larger female cohort, more traditional measures of FTD, measures that cover a broader age range and group of informants as well as more thorough autism assessment in the psychotic disorder groups.

In conclusion, although they are not the same, both autism and schizophrenia involve similar atypical neurodevelopment. As suggested by Pennington (2002), developmental psychopathology can be conceptualized as a system whereby genes and environment interact to produce neural changes which then manifest as behavior and/or clinical symptoms. Our examination of language symptoms revealed fine-grained differences in symptoms resembling FTD, providing insights for differential diagnosis, and leads for future studies. In schizophrenia (Kerns et al., 2004), and autism (Solomon et al., 2008), FTD has been conceptualized as a cognitive control failure whereby context is not used to guide language production. A natural next step would be to examine disorder-specific differences in language using functional neuroimaging to link “symptom-level” findings to “neural level” differences. Coupled with emerging “gene-level” evidence that autism and schizophrenia involve similar rare copy number variations (CNVs) at genetic loci implicated in neurotransmission and synapse formation and maintenance (Guilmatre et al., 2009), such a program of research holds the promise of resulting in true “deep phenotyping” that links genes with neural circuits, and produces endophenotypes and/or behavioral phenotypes.

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Table 1

Participant Characteristics

	ASD (n=20)			FEP (n=16)			CHR (n=15)			TYP (n=20)		
	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
Age (year)	15.15	2.28	11--19	17.06	1.81	14--20	14.07	2.19	11--18	14.80	2.19	12--18
FSIQ (2scale)	106.10	15.39	73--132	98.69	15.45	73--131	102.13	12.06	86--122	114.20	7.79	99--127
Male (#)	16			12			10			13		
Female (#)	4			4			5			7		
M/F Ratio	4:1			3:1			2:1			1.9:1		

Table 2

SCQ Combined Scores by Group

	ASD (n=20)			FEP (n=16)			CHR (n=15)			TYP (n=20)		
	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
Communication	7.35	3.22	2--14	3.63	2.25	0--7	3.80	2.91	0--8	1.25	1.33	0--4
Repetitive Behaviors	6.30	2.20	3--9	2.63	2.28	0--7	2.07	1.34	0--4	0.15	0.37	0--1
Social	9.00	4.54	2--16	2.00	2.53	0--10	2.07	2.37	0--6	0.80	0.89	0--2
Total	23.65	7.22	15--37	8.69	5.96	0--22	8.67	5.42	2--17	2.25	2.40	0--8

Table 3

Percentage of Participants Meeting ASD Criteria on Different Measures

	ASD (n=20)		FEP (n=16)		CHR (n=15)		TYP (n=20)	
	%	#	%	#	%	#	%	#
SCQ	100%	20	19%	3	20%	3	0%	0
SRS-severe^a	70%	14	31%	5	40%	6	5%	1
SRS-moderate^b	20%	4	50%	8	33%	5	0%	0

^a Severe defined as SRS Total score of 76 or greater, based on ASD referral criteria.^b Mild/Moderate defined as SRS total score in the range of 60–75, based on ASD referral criteria.

Table 4

CCC-2 Subscale Scores by Group

	ASD (n=20)			FEP (n=16)			CHR (n=15)			TYP (n=20)			Significant Group Differences
	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	
Structural Language													
Speech	6.95	4.19	0--12	8.63	4.08	1--12	9.20	3.23	1--12	11.90	1.17	9--14	TYP,FEP,CHR>ASD
Semantics	5.40	3.22	0--12	8.31	2.85	2--12	8.00	3.44	2--13	11.40	2.93	7--18	TYP,FEP,CHR>ASD
Syntax	6.75	4.05	0--12	8.31	3.68	1--12	9.00	2.73	4--12	11.40	2.61	4--14	TYP=FEP=CHR; TYP, CHR>ASD
Coherence	4.60	3.22	0--12	7.31	3.18	1--12	7.60	3.20	1--13	11.40	2.70	7--18	TYP,FEP,CHR>ASD
Pragmatic Language													
Initiation	5.45	3.10	1--15	9.50	4.13	2--15	7.13	3.27	2--12	13.10	2.53	9--19	FEP=CHR; FEP=TYP>ASD
Scripted Lang	4.15	3.20	1--12	8.56	3.46	3--12	7.27	3.13	2--12	12.20	1.44	9--15	TYP=FEP=CHR>ASD
Context	4.60	2.62	1--10	8.44	3.33	1--12	8.00	2.89	3--12	11.75	2.25	8--16	TYP=FEP=CHR>ASD
Non-Verbal	4.35	3.23	1--13	6.87	3.79	1--12	7.93	3.20	2--13	10.95	2.40	4--14	TYP=FEP=CHR>ASD
Social Relations	4.45	3.09	1--12	5.81	3.83	1--12	6.93	2.40	2--10	11.25	2.22	5--14	FEP=CHR; FEP=ASD>CHR,TYP
Interests	5.45	3.20	1--15	8.62	3.79	2--15	7.33	3.72	3--12	13.25	2.81	6--16	FEP=CHR; FEP=TYP>ASD

Table 5

SRS combined scores by group.

	ASD (n=20)			FEP (n=16)			CHR (n=15)			TYP (n=20)			Significant group differences
	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	
Awareness	68.20	11.63	42–88	59.25	14.02	43–94	57.73	8.00	46–72	41.40	8.18	30–63	TYP>FEP, CHR>ASD
Cognition	76.10	13.58	45–90	68.31	20.13	41–105	67.00	16.69	45–94	44.40	7.41	36–72	TYP>FEP, CHR, ASD
Communication	75.10	13.95	45–90	66.31	17.39	39–103	68.37	13.10	42–85	43.50	8.35	36–69	TYP>FEP, CHR>ASD
Motivation	72.65	16.41	40–90	75.88	19.88	44–113	67.13	14.63	47–87	45.80	11.38	37–89	TYP>FEP, CHR, ASD
Mannerisms	78.05	12.75	47–90	71.69	20.17	42–103	71.00	16.06	49–96	45.10	9.13	40–79	TYP>FEP, CHR, ASD
Total	79.55	11.78	45–90	72.50	20.68	40–110	67.93	13.93	49–92	42.80	9.29	34–78	TYP>FEP, CHR, ASD