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Psychosocial functioning and social cognitive processing in girls with Turner syndrome

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INTRODUCTION

Turner syndrome (TS) is a common genetic disorder characterized by the complete or partial absence of an X chromosome. The disorder affects approximately 1/2000 females with typical physical features including short stature, webbed neck, cardiovascular abnormalities and endocrine problems related to ovarian dysgenesis, such as amenorrhea and infertility.¹ Females with Turner syndrome often demonstrate a distinctive neurocognitive profile characterized by full-scale IQs in the average range, with relative strengths in verbal abilities and weaknesses in visual-spatial skills and executive function.^{2, 3} There is also increasing evidence for deficits in the domain of social function in TS. While studies largely suggest that adult women with TS do not have increased incidence of psychiatric illness,⁴ there is some indication that global psychosocial functioning may be impaired.^{5, 6} Though outcome studies of adult women with TS are not always consistent,⁷⁻⁹ the extant literature indicates that relative to age-matched peers, these individuals experience higher incidence of anxiety, depression, poor body image, low self-esteem and self-perception of impaired social competence.^{7, 9} Investigation of other metrics of social function, such as achievement of independent living and successful romantic relationships, also indicate that a subset of adult women with TS are more socially impaired relative to their peers.^{10, 11}

Studies of girls and adolescents with TS using parental ratings and self-report suggest similar difficulties in the form of immaturity, impaired social relationships and poor self-concept compared to peers.^{6, 12-15} There are also data suggesting that rates of ADHD and social anxiety may be higher in girls with TS relative to age-matched controls.^{16, 17} Though these data are compelling and of potential clinical importance, detecting the underlying cause of impaired social competence in TS has proven challenging. Studies to date indicate that impaired social function in TS is not related to IQ alone, nor to overall stigmata of disease, such as short-stature.^{5, 18} Data from studies of sex hormone replacement are similarly inconclusive, but also suggest that while induction of puberty improves self-concept and other aspects of cognition such as working memory,^{13, 19} difficulties in social competence continue to persist after sex hormone replacement.^{6, 9, 10} More recently, evidence of cognitive and neural correlates of dysfunctional social behavior in TS have been

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reported, including findings of aberrant face recognition abilities^{20, 21} and affect recognition, particularly for fearful or angry faces.^{18, 20, 22}

As yet, an overarching framework linking these findings to X-monosomy has not emerged, however such a framework is likely to involve complex interactions between genetic, hormonal and environmental influences. Animal studies have implicated estrogen as an integral component of social behavior,^{23, 24} making sex hormone deficiency in TS a compelling model for elucidating the effects of estrogen on human social cognitive processing. However, previous studies investigating social cognition in TS have focused primarily on adolescents or adult women with TS, presumably after exposure to exogenous estrogen, which is typically initiated by the age of 12-14 years in girls with TS who do not undergo spontaneous puberty.²⁵ As such, previous research on social cognition in TS is potentially confounded by pubertal changes and hormone replacement therapy. The study presented here is one of the first of its kind to specifically include a sample of girls with TS in the prepubertal/pre-estrogen age range, between 3 and 12 years of age. By examining social competence in girls with TS prior to administration of estrogen, potential state-dependent influences of sex hormones on social cognition are minimized.

The purpose of this exploratory study was to examine elements of social competence and cognition in a pre-estrogen population of girls with TS (3-12 years), and to investigate if explanatory links exist between the domains of social competence and cognition. Studies of very young girls with TS can also provide critical knowledge about early development, and thus begin to fill existing gaps in our understanding of cognitive and behavioral trajectories across the lifespan of females with TS. Our *a priori* hypothesis was that girls with TS would perform more poorly on measures of social behavior and social cognition compared to peers. Furthermore we predicted that severity of deficits in social cognition would correlate with outcomes of social behavior. To the best of our knowledge, this is the first study of its kind to investigate these measures in a pre-estrogen cohort of young girls with TS.

METHOD

Subjects

Forty-two subjects with Turner syndrome and 32 typically developing control girls were recruited through referrals from pediatric endocrinologists, advertisements in local parent organizations and the national Turner Syndrome Society network, and the Center for Interdisciplinary Brain Sciences Research (CIBSR) website (<http://cibsr.stanford.edu>) as part of a larger study examining genetic and neurobiological correlates of the cognitive-behavioral phenotype in TS. Participants ranged in age from 3 to 12 years. All participants were in good overall medical health. None of the study participants had evidence of current or past major neurological and psychiatric problems (TS participants with diagnoses of ADHD or anxiety were not excluded from the sample, however none of the girls with TS fulfilled full DSM-IV-TR criteria for these diagnoses). Only subjects with a monosomic 45X karyotype were included, confirmed by standard karyotype assessment. TS participants on growth hormone were included (26 of 39 participants), however none of the participants had started estrogen replacement. Parents of the TS group provided information about pubertal development based on Tanner staging; none of the participants scored >3 on breast or pubic hair scales. Socioeconomic status (SES) was derived from reported household income divided by median household income for the family's area based on U.S. Census data by zip code (<http://factfinder.census.gov/home/saff/main.html>). All research was conducted at Stanford University. Informed consent and assent were obtained from all participants and study parameters were approved by the institutional IRB.

Intelligence testing measures

Participants between the ages of 3 to 5 years were administered the Wechsler Preschool and Primary Scale of Intelligence Third Edition (WPPSI)²⁶ while the Wechsler Intelligence Scale for Children 4th Edition (WISC)²⁷ was used for subjects aged 6-12 years. In addition to Full-scale IQ (FSIQ) scores, Verbal IQ (VIQ) scores were generated as defined by the Verbal Comprehension Index from the WISC-IV or the Verbal IQ score from the WPPSI. Performance IQ (PIQ) scores were defined by the Perceptual Reasoning Index from the WISC-IV or the Performance IQ score from the WPPSI. Participants were included if their full-scale IQ scores fell in the non-intellectually disabled range, $IQ \geq 70$. To preserve relative matching for cognitive level with girls in the TS group, healthy control girls with $FSIQ > 130$ were excluded.

Neuropsychological Functioning

Neuropsychological functioning was assessed using the NEPSY²⁸, a comprehensive cognitive/neuropsychological assessment tool for individuals age 3 to 12 years. The NEPSY generates scores for five domains: Attention/Executive Functions, Language, Sensorimotor Functions, Visuospatial Processing, and Memory and Learning. During the course of study recruitment, the NEPSY-II²⁹ was released, which introduced a new Social Perception Domain score, including Affect Recognition and Theory of Mind subscales. Thus, while most subjects were assessed with the NEPSY, only a subset of later participants received the NEPSY-II Social Perception tests. Subscales contributing to the assessment of social cognition include the Memory for Faces task from the original version of the NEPSY, and the Affect Recognition and Theory of Mind subscales from the NEPSY-II. For the Theory of Mind subscale, conversion of raw scores to scaled values resulted in a significant decrease in reported values due to a low ceiling threshold, reducing total responses from 24 to 12 in TS participants and 22 to 11 in controls.

Psychosocial Assessments

Thirty-six TS and 21 control participants' primary caregivers completed the Social Responsiveness Scale (SRS).³⁰ The SRS is a 65-item questionnaire that assesses specific and observable elements of social behavior based on frequency of occurrence. Domains include Social Awareness, Social Cognition, Social Communication, Social Motivation and Autistic Mannerisms. Participants were also assessed with the Revised Children's Manifest Anxiety Scale: Second Edition (RCMAS-2)³¹ a 49-item self-report inventory used to measure symptoms of anxiety. RCMAS-2 subscales of interest were Physiological Anxiety, Worry, Social Anxiety, Defensiveness and Inconsistent Responding index. The scale is normed for ages 6-19 years, so younger participants did not receive a scaled score. Finally, the Behavioral Assessment System for Children (BASC-2)³² was used. The BASC is a parent report questionnaire that assesses emotional and behavioral functioning in individuals ages 2 to 18 years. For RCMAS and BASC assessments, T-scores are reported with a mean of 50 and standard deviation of 10.

Statistical Analyses

All data were first inspected for parametric properties. Independent two-tailed Student's t-tests were initially used to analyze between-group differences in overall intelligence scores. As social competency and social cognition variables were correlated (see Table 1), we utilized univariate and multivariate analyses of covariance (M/ANCOVA) to assess predicted between-group differences for selected behavioral and cognitive variables related to social cognition and social function. Similar to studies of other genetic groups with visual-spatial dysfunction³³, Verbal IQ was used as the primary covariate for intelligence in these ANCOVA models as PIQ scores are disproportionately biased by visual perceptual and

visual spatial deficits present in girls with TS. Separate models assessing interaction effects of Group $\times$ Age and Group $\times$ VIQ were also conducted when appropriate. As the SRS is not specifically age-normed, age (centered around the mean age for the entire sample) was included as a covariate for MANCOVA analyses using SRS subscale scores as dependent variables. Statistical significance was defined as $p < .05$ and all analyses were performed using SPSS version 18 software.

RESULTS

Descriptive Statistics

After excluding individuals with IQs in the intellectually disabled and gifted ranges, participants included in the final analysis consisted of 39 girls with TS and 29 female controls. Groups were similar in demographic characteristics, including socioeconomic status, as measured by adjusted household income. Ethnicity of participants in both groups was primarily Caucasian (TS: 76%; Controls: 85%), Pearson's chi-square test demonstrated that proportions of White and non-White participants were not significantly different between groups ($\chi^2 = .824$, $df = 2$, $p = .364$). Mean age in the two groups was similar as shown in Table 2. Age distributions in girls with TS (3-6 years: 43.6%, 7-9 years: 33.3%, 10-12 years: 23.1%) were similar to those of the control group (3-6 years: 44.8%, 7-9 years: 27.6%, 10-12 years: 27.6%). Pearson's chi-square indicated that these frequencies were not significantly different between groups ($\chi^2 = .319$, $df = 2$, $p = .853$).

Independent t-tests showed significant between-group differences in all IQ score measures, where girls with TS had lower scores compared to control peers. As expected, between-group differences were less apparent for WPPSI VIQ and WISC-IV VCI scores relative to WPPSI PIQ and WISC-IV PRI scores for girls with TS relative to controls. The means and standard deviations for demographic and cognitive data are listed in Table 2.

Behavioral Measures

SRS—Using univariate analysis and age and VIQ as covariates, the TS group had significantly higher ratings on the SRS total score relative to healthy controls ($F_{1,54} = 6.724$, $p = .012$), indicating greater overall impairments in social function. All SRS subscale scores were subsequently entered as dependent variables into a multivariate model with age and VIQ as covariates. The overall model was significant (Wilks Lambda $F_{5,50} = 3.396$, $p = .010$). Between-group effects were significant for all subscales (see Table 2) with the notable exception of the Social Motivation subscale at a threshold of $p < .05$. Using a conservative Bonferroni adjustment for multiple comparisons at a threshold of $p < .01$ (.05/5 subtests), differences for Social Cognition ($p = .004$) and Autistic Mannerisms ($p = .001$) remained significant, and approached significance for Social Awareness ($p = .018$) and Social Communication ($p = .014$). Effects of age ($p = .826$) and VIQ ($p = .488$) were not significant, nor was the interaction term of Age $\times$ Group ($p = .274$).

Univariate analysis of RCMAS-2 Total Anxiety score using VIQ as a covariate did not show significant between-group differences ($F_{1,40} = 0.825$, $p = .369$). The multivariate model using VIQ as a covariate and all RCMAS subscales as dependent variables was also not significant (Wilks Lambda $F_{5,36} = 1.135$, $p = .360$). In contrast, the multivariate model for the BASC-2 subscale scores was significant (Wilks Lambda $F_{12,51} = 3.433$, $p = .001$). Follow-up univariate analyses demonstrated significant differences for the Hyperactivity, Atypicality, Attention, Social Skills, Activities of Daily Living and Functional Communication subscales, even when accounting for VIQ. There were no significant interaction effects of Group $\times$ Age or Group $\times$ VIQ for the RCMAS and BASC assessments.

Social Cognitive Measures

NEPSY Memory for Faces—36 girls with TS and 23 controls completed the Memory for Faces subtest. Univariate analysis indicated a significant difference between groups with TS performing at a lower level than controls after controlling for VIQ ($F_{1,56}=22.16$, $p<.001$). There were no significant interaction effects.

NEPSY-II Affect Recognition—25 girls with TS and 22 controls completed the Affect Recognition subtest. Girls with TS exhibited lower performance compared to peers. However, between-group differences were not statistically significant after controlling for VIQ ($F_{1,44}=1.235$, $p=.272$). No significant interaction effects were noted.

NEPSY-II Theory of Mind—As with the Affect Recognition task, this scale was only administered to participants after the release of the NEPSY-II, and has a low ceiling score. Twelve girls with TS and 11 controls were given scaled scores on the Theory of Mind subtest. Results showed that girls with TS had lower scores compared to controls when using VIQ as a covariate ($F_{1,20}=7.69$, $p=.012$).

Growth Hormone Effects—Exploratory analyses were conducted within the overall TS group to determine if behavioral effects were associated with growth hormone treatment ongoing at the time of the evaluation (26 out of 39 participants). There were no significant differences on any behavioral or cognitive measure between these TS subgroups.

DISCUSSION

As predicted, we found that girls with TS performed more poorly than their peers on several measures of social competence and social cognition. In particular, girls with TS were found to have overall difficulty in social competence, with mean Total SRS scores in the clinically significant range (i.e., T score > 60).³⁰ Moreover, effect sizes for these analyses were moderately large with the exception of the Social Motivation subscale. Girls with TS similarly placed in the mild-to-moderate range of clinical significance for the Social Cognition and Autistic Mannerisms SRS domains, which are designed to assess an individual's ability to interpret social cues and the presence of restricted interests or stereotypic behaviors, respectively. Performance on SRS areas of Social Awareness and Social Communication also approached the clinical range, and represent an individual's ability to sense reciprocal social behaviors and utilize expressive social communication. These ratings by parents of girls with TS indicate a perception of significant difficulty with social competence encompassing a broad range of social function.

Importantly, we also found dissociation in ratings for TS subjects on the Social Motivation subscale of the SRS versus other SRS subscale scores. Specifically, the Social Motivation subscale was the only domain in which the performance of girls with TS did not differ from their peers. This subscale is designed to measure motivation to engage in social behavior, as well as elements of social anxiety and inhibition. This SRS subscale profile suggests comparable levels of socially motivated behavior in TS relative to typically developing peers; however, this appetitive drive for social interaction appears to occur in the context of an impaired ability to implement effective social functioning. These findings provide a potential link between impaired social performance and observed decreases in self-esteem and self-concept in young girls with TS as reported in previous literature.^{17, 34} The extent to which this dissociation in social cognition/behavior contributes to subjective distress and impaired social function merits further investigation, with an emphasis on appetitive social behavior as a discriminating construct in the social cognitive profile of TS as compared to other conditions with social impairment.

Our findings contrast with earlier literature that have interpreted impairments of social functioning in TS to be analogous to those observed in individuals with autism spectrum disorders (ASD).^{35, 36} Our data instead suggest an alternative framework in which the social competency profile observed in TS might be discriminated from a more 'typical' profile associated with ASD based on differences in appetitive social behavior. Our findings also raise the larger question of understanding to what extent shared social behavioral symptomatology in TS and ASD reflects a common pathophysiological process. Certainly, the dissociation of scores on the SRS demonstrates the potential utility of this assessment instrument in girls with TS. One of the advantages of utilizing the SRS is that it is specifically designed to evaluate critical dimensions of social function in contrast to more generalized measures of adaptive function and behavior, such as the Child Behavior Checklist, which have been used in previous studies of TS.^{34, 37} Though originally designed and validated for screening and diagnosing children with ASD, the SRS has also been used for assessing social impairments in other conditions, such as mood and anxiety disorders.³⁸ The unique social cognitive profile described in this study suggests its potential utility for identifying social impairments in TS.

The absence of significant anxiety as measured by the RCMAS-2 provides further support for a characteristic behavioral profile in TS that does not include wide-ranging elevated levels of psychopathology. BASC-2 scores similarly reflected the absence of group differences on scales of anxiety or depression. This instrument did demonstrate significant between-group differences on a cluster of measures related to ADHD and impaired executive function (Hyperactivity, Atypicality and Inattention), an area known to be a vulnerability for girls with TS. However, unlike the SRS, the average BASC subscale scores in the TS group did not reach a clinical threshold. Interestingly, girls with TS performed significantly more poorly on BASC-2 subscales of Activities of Daily Living and Functional Communication subscales, which generally measure overall adaptive functioning. The mean TS scores for these domains were also in the sub-clinical range.

Significant between-group differences in performance on the Social Perception domain of the NEPSY also provide evidence for social impairments in TS. Our data demonstrated significant deficits in this dimension, including differences on the Theory of Mind and Memory for Faces subscales. Furthermore, these differences survived covarying by VIQ suggesting that deficits are not due solely to problems with general cognitive level, but instead represent a more specific neurocognitive characteristic of TS. Our findings are also consistent with earlier evidence suggesting a pattern of social deficits in individuals with TS^{21, 39} and convergent data from neuroimaging studies that identify putative neurobiological correlates for these deficits. In particular, individuals with TS have enlarged amygdalae^{40, 41} and possible aberrant connectivity between the amygdala and fusiform face area⁴², regions which are integral to encoding the social salience of emotional stimuli.⁴³

We were surprised to find that Affect Recognition was the only subscale that did not show a significant between-group difference (after controlling for VIQ). Deficits in affect recognition have been previously reported for both adolescents and adult women with TS^{20, 44} particularly for fearful or angry faces.^{18, 20, 22} Similarly, problems with other components of face processing such as abnormal eye-tracking scanpaths when viewing faces²¹ and gaze fixation and cueing difficulties^{45, 46} have been reported in TS. The fact that we did not detect affect recognition abnormalities in our sample may be attributed to several factors, the foremost being that the relatively small sample sizes of cohorts may not have provided sufficient power to observe a clinically significant difference on this measure. Another potential interpretation may arise from the younger age range of participants in our study and the estrogen-naïve status of the present cohort. As hormone replacement has become the standard course of clinical treatment for girls with TS who do not achieve

spontaneous puberty,⁴⁷ assessment of younger girls with TS represents a unique paradigm for furthering our understanding of the effects of sex hormones on the development of social cognition. Interestingly, studies of affect recognition in typically developing females over the course of the menstrual cycle indicate that phases with lower levels of estrogen correlate to higher accuracy in recognition of angry faces.⁴⁸ While these findings contrast with the results in our prepubertal sample, they emphasize the need for further investigation into dosage effects of sex hormones on social behavior and cognition, particularly in regard to their influence on pubertal development and how this may impact a population of girls with typically absent or low levels of circulating sex hormones. We were not able to analyze this hypothesis more closely as Tanner staging data were only collected from the TS cohort and not from control participants, making it difficult to fully control for pubertal status. It is possible that some control participants included in our study may have experienced early pubertal changes. However, the presence of social competency deficits throughout the age range of our TS sample makes it unlikely that differences in social cognition can be attributed to potential pubertal changes alone, although this area certainly warrants closer examination in future studies.

Another limitation of our study includes the relatively broad range of ages of the participants. While analyses were appropriately controlled for age, social development represents a dynamic process, particularly when considering physiological and psychological changes occurring during puberty. Our results emphasize the need for longitudinal studies to further elucidate age-related influences on social cognitive processes in larger samples of girls with TS undergoing estrogen treatment. Investigation of the potential effects of parent-of-origin (i.e., X chromosome imprinting) on social cognition in larger TS cohorts would also be of interest.⁴⁹ Lastly, our data relied largely on parent observation of social behaviors in children, which is a common method for assessment of social competency in both the clinical and research settings. However, these findings would be further enhanced by conducting direct observation of child social competency in future studies.

Overall, our findings build on previous literature by demonstrating significant differences in social competence and cognition in TS in a cohort of young girls with TS who have not yet received estrogen replacement therapy. Evidence of social cognitive differences in this population, even after controlling for differences in IQ, suggest increased risk for a characteristic profile of social behavioral problems that is emerging even in the earliest phases of development. These findings suggest that social deficits in TS are present early in development, and are independent from physiological and psychological changes that occur during induction of puberty with estrogen replacement. However, the actual trajectory of social cognitive development associated with induced puberty in TS is currently unknown, as this is a period of dramatic behavioral and neurobiological changes that is only just beginning to be understood in typically developing females as well.⁵⁰ As such, future research is critical for determining whether behavioral differences observed in prepubertal girls with TS are later mitigated or influenced by administration of hormone replacement. Another strength of this study is the use of a specific instrument for assessing social behavior. Rather than relying on general behavioral assessments, the SRS allowed us to define more specific dimensions of social function and establishes a profile of social cognition that may increasingly help discriminate social difficulties in TS from other disorders with social dysfunction. Although previous studies of psychosocial function in TS have demonstrated global psychosocial problems, our data pinpoints specific components of social cognition impairments in a cohort of young girls prior to estrogen treatment. The observed differences provide a novel perspective into social cognition and functioning and provides a framework for better understanding the complex interaction between sex hormones and behavioral differences in TS. This comprehensive approach may allow for the

future development of more clinically relevant assessments and treatment planning for young girls with TS.

Conclusions

Findings from our study underscore important differences in social cognition and performance in young girls with TS with estrogen deficiency. These data indicate the potential use of standardized assessments for social competence and social cognition in clinical treatment planning for girls with TS. A better understanding of social development is critical for school-age children to successfully deal with complex social demands throughout this age range, and even more so for girls with TS who may have significant impairments in this domain. The results of our study should encourage clinicians to pay greater attention to areas of social functioning in girls with TS as potential targets in an overall treatment plan. Furthermore, the implication of a distinct social cognitive profile in TS argues for a comprehensive, developmental approach to future research in this area.

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Table 1

Correlation Matrix for Social Measurement Variables

	NEPSY Memory Faces	NEPSY Affect Recognition	NEPSY Theory of Mind	SRS Social Awareness	SRS Social Cognition	SRS Social Communication	SRS Social Motivation	SRS Autistic Mannerisms
NEPSY Memory for Faces	Correlation Significance	.327* .042	.694** .004	-.222 .122	-.369** .008	-.358* .011	-.182 .205	-.440** .001
NEPSY Affect Recognition	Correlation Significance	--	.373 .087	.154 .342	-.073 .657	-.036 .825	-.015 .925	-.172 .288
NEPSY Theory of Mind	Correlation Significance	--	--	-.395 .077	-.319 .159	-.281 .218	-.092 .692	-.548* .010
SRS Social Awareness	Correlation Significance			--	.675** .000	.759** .000	.399** .002	.696** .000
SRS Social Cognition	Correlation Significance				--	.838** .000	.559** .000	.824** .000
SRS Social Communication	Correlation Significance					--	.626** .000	.829** .000
SRS Social Motivation	Correlation Significance						--	.570** .000
SRS Autistic Mannerisms	Correlation Significance							--

* Correlation is significant at the 0.05 level (2-tailed)

** Correlation is significant at the 0.01 level (2-tailed)

Table 2

Characteristics of Age, SES, and Cognitive Scores, by Group

Independent T-test comparisons of demographic and IQ measures between TS and control groups demonstrate comparable age and SES characteristics, and lower performance on all IQ measures.

	TS		Controls		P
	Mean	SD	Mean	SD	
Age	7.89 (n=39)	2.46	7.56 (n=29)	2.81	0.604
SES ^a	2.02 (n=39)	1.11	2.06 (n=29)	0.72	0.888
FSIQ ^b	92.18 (n=39)	13.33	116.45 (n=29)	8.30	<0.001
WPPSI VIQ ^c	99.36 (n=11)	12.66	114.10 (n=10)	12.91	0.016
WPPSI PIQ ^c	90.45 (n=11)	15.87	116.30 (n=10)	12.50	0.001
WPPSI PS ^c	91.17 (n=6)	13.60	112.20 (n=5)	11.95	0.025
WISC-IV VCI ^d	104.21 (n=28)	15.84	116.00 (n=19)	14.24	0.012
WISC-IV PRI ^d	88.46 (n=28)	13.91	114.63 (n=19)	8.12	<0.001
WISC-IV WM ^d	87.14 (n=28)	13.11	106.21 (n=19)	7.33	<0.001
WISC-IV PS ^d	88.15 (n=28)	12.28	108.68 (n=19)	11.16	<0.001

^a Socioeconomic status (reported household income divided by median household income for geographical area)

^b Full Scale IQ

^c WPPSI 3rd Edition Verbal IQ, Performance IQ, Processing Speed

^d WISC 4th Edition Verbal Comprehension Index, Perceptual Reasoning Index, Working Memory, Processing Speed

Table 3
Performance on Social Responsiveness Scale Scores, by Group

Multivariate analyses^a demonstrate significant between-group effects for total SRS score and all subscale scales, except for Social Motivation.

	TS (n=37)		Controls (n=21)		p	Cohen's d
	Mean	SD	Mean	SD		
SRS Total Score ^b	61.78	13.96	49.81	11.55	0.012	0.91
Social Awareness	57.74	12.92	47.71	8.29	0.018	0.59
Social Cognition	61.32	13.00	47.81	12.19	0.004	1.06
Social Communication	59.77	12.80	49.81	10.31	0.014	0.83
Social Motivation	54.49	10.34	52.19	11.41	0.753	0.21
Autistic Mannerisms	69.10	15.60	52.76	13.30	0.001	1.10

^a Age and Verbal IQ score were used as covariates. Age × Group interaction term was tested in a separate model

^b SRS – Social Responsiveness Scale

Table 4

Performance on BASC-2 Scores, by Group

There were no significant between-group differences on composite scores based on multivariate analyses^a. However, subscales assessing Hyperactivity, Atypicality, Attention, Social Skills, Activities of Daily Living and Functional Communication were significantly different between groups.

	TS (n=37)		Controls (n=28)		p	Cohen's d
	Mean	SD	Mean	SD		
BASC External Problems Composite	52.23	9.2	50.46	9.52	0.723	--
BASC Internal Problems Composite	54.43	9.39	50.36	11.11	0.141	--
BASC Behavioral Symptom Index	55.49	10.05	49.57	9.98	0.066	--
BASC Adaptive Skills Composite	49.01	7.99	52.68	8.27	0.143	--
BASC Hyperactivity	58	11	50.48	9.61	0.012	0.72
BASC Atypicality	57.14	12.48	47.38	10.16	0.006	0.85
BASC Attention	56.28	10.98	48.46	8.13	0.028	0.79
BASC Social Skills	55.39	7.79	50.36	7.97	0.042	0.64
BASC Activities of Daily Living	46.22	8.81	52.29	8.82	0.016	0.69
BASC Functional Communication	46.62	8.03	52.7	6.6	0.017	0.82

^aVerbal IQ score was used as a covariate

Performance on NEPSY Social Domain Scores, by Group

Table 5

Univariate analyses of covariance^a demonstrate significant between-group differences on NEPSY Memory for Faces and Theory of Mind subscale scores, however no differences were noted on the Affect Recognition subscale.

	TS		Controls		p	Cohen's d
	Mean	SD	Mean	SD		
NEPSY Memory for Faces	8.96 (n=36)	3.14	13.10 (n=23)	3.19	<0.001	1.31
NEPSY Affect Recognition	9.49 (n=25)	2.89	10.49 (n=22)	2.92	0.272	0.34
NEPSY Theory of Mind	8.69 (n=12)	2.08	11.34 (n=11)	2.10	0.012	1.27

^aVerbal IQ score was used as a covariate