

## Social Interaction Style of Children and Adolescents with High-Functioning Autism Spectrum Disorder

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**Abstract** Qualitative differences in social interaction style exist *within* the autism spectrum. In this study we examined whether these differences are associated with (1) the severity of autistic symptoms and comorbid disruptive behavior problems, (2) the child's psycho-social health, and (3) executive functioning and perspective taking skills. The social interaction style of 156 children and adolescents (6–19 years) with high-functioning autism spectrum disorder (HFASD) was determined with the Wing Subgroups Questionnaire. An active-but-odd social interaction style was positively associated with symptoms of autism, attention deficit and hyperactivity. Furthermore, an active-but-odd social interaction style was negatively associated with children's psycho-social health and positively with executive functioning problems. Social interaction style explains part of the heterogeneity among children with HFASD.

**Keywords** Autism spectrum disorder · Social subtype · Social interaction

Human development can deviate in many different ways.  
(Lorna Wing 2005)

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All individuals with a diagnosis of an autism spectrum disorder (ASD) show qualitative impairments in social interaction, as stated in the DSM-IV (APA 2000). Yet, the social interaction impairments of children with ASD can take many different forms (e.g., Jones and Klin 2009; Mundy et al. 2007). Diversity in social interaction style likely yields diversity in intervention needs and responsiveness (Beglinger and Smith 2005). In the current study we therefore focus on individual differences in social interaction style in ASD and associated factors.

The child with autism was first described by child psychiatrist Leo Kanner as a withdrawn child who does not seek interaction with others (Kanner 1943). Indeed, empirical studies on peer interaction of children with ASD have repeatedly shown that children with ASD show less social play, fewer social interactions, and lack reciprocal friendships compared to typically developing children (Bauminger et al. 2003; Hauck et al. 1995; Kasari et al. 2011; Macintosh and Dissanayake 2006; Sigman and Ruskin 1999). However, considerable individual differences have also been documented between children with ASD in the quality and quantity of interaction with peers (Kasari et al. 2011; Sigman and Ruskin 1999).

Wing and Gould (1979) first differentiated individuals with ASD based on their social interaction style. They systematically described three different social subtypes of autism. First, the aloof child seeks no social interactions, nor does the child respond socially to the approaches of others. The passive child does not initiate social interaction, but responds appropriately to the social initiatives of others. Finally, the active-but-odd child actively seeks interactions with others, albeit in an unusual way (e.g., holding a monologue about a particular interest, or standing too close to a conversation partner). The Wing's social subtype of a child with ASD can be reliably ascertained by

observations (Roeyers 1997) or a parental questionnaire (Wing Subgroups Questionnaire; Castelloe and Dawson 1993).

The different social interaction styles may be associated with different degrees of autism severity. To date, research with primarily children with ASD and an intellectual disability has shown that active-but-odd children tend to have a higher intelligence, better adaptive behaviors, and lower autism severity scores compared to aloof children (as measured by the Childhood Autism Rating Scale or the Autism Behavior Checklist), and they are more often diagnosed with PDD-NOS or Asperger's Syndrome instead of autism (Althaus et al. 1994; Castelloe and Dawson 1993; Ghaziuddin 2008; O'Brien 1996; Roeyers 1997; Waterhouse et al. 1996). However, medical records also suggest that active-but-odd children have a higher rate of comorbidity, defined by deficits in attention, motor control, and perception, than passive and aloof children (Bonde 2000). Overall, the passive subtype appears to hold an intermediate position between the aloof and active-but-odd group. For instance, passive children are generally reported to be more intelligent than aloof children, but less intelligent than the active-but-odd group (Borden and Ollendick 1994). Yet, a limitation of the aforementioned studies is that none made a distinction between low-functioning (IQ < 70) and high-functioning (IQ > 70) children with ASD.

Intelligence could be a major confounding factor when examining the associated characteristics of the social interaction styles. Research has already shown that children with high-functioning ASD (HFASD) are generally more active in initiating of and responding to social interactions and show more developmental progress in social interaction skills than children with ASD and an intellectual disability (Bauminger et al. 2003; Eagle et al. 2010). Furthermore, aloofness could be confounded by an intellectual disability given the overlap in characteristics (e.g. inability to use speech effectively). Therefore, research within a sample of children with low-functioning ASD does not lead to conclusive results about the associated characteristics of social interaction styles. Research on the social interaction styles of children with HFASD would provide a better understanding of these issues.

In the present study, differences in social interaction styles are examined in a large sample of children and adolescents with HFASD. In a clinical setting, the differentiation of individuals is still strongly based on a categorical system (presence or absence of the disorder). However, we believe a dimensional approach may refine our perspective on the heterogeneity within the autism spectrum (Pellicano 2010; Volkmar et al. 2009), which is in line with proposals for the upcoming DSM-V (APA, 2011). Therefore, rather than forming social subtype categories to distinguish and compare individuals with ASD,

we use a continuous measure of each social interaction style. Furthermore, to be able to understand the unique contribution of each social interaction style, the influence of age, gender, verbal IQ, and all other social interaction styles are statistically controlled for.

Different social interaction styles may be linked with different needs for and responsiveness to interventions (Beglinger and Smith 2005). Therefore, in the current study we first explore whether the degree to which a child with HFASD shows each social interaction style is associated with his/her needs for intervention, by examining (1) the severity of the child's psychopathology in terms of autistic symptoms and comorbid disruptive behavior problems and (2) the child's psycho-social health. Secondly, we want to shed light on possible cognitive underpinnings of the social interaction styles to encourage customized intervention methods and enhance intervention responsiveness. More specifically, associations are examined between social interaction styles on the one hand and executive functioning and perspective taking skills (Theory of Mind) on the other hand. Information about the child's competence and behavior was obtained in a multi-method (observation, test performance, questionnaires) and multi-informant design (children, parents and teachers).

## Methods

### Participants

Participants were 214 (183 boys; 31 girls) Dutch children and adolescents with HFASD. Participants were recruited via a specialized school for normally intelligent children and adolescents with an ASD diagnosis. The diagnostic classification of ASD was given by a psychiatrist according to established DSM-IV-TR criteria and based on examination by multiple experienced clinicians (psychologists, psychiatrists and educationalists). The diagnostic process included anamneses, heteroanamneses, and psychiatric, neuropsychological and logopedic examinations.

The following inclusion criteria were used for the data analyses: (1) the child has a verbal IQ of 70 or higher, as shown by performance on the Dutch version of the Peabody Picture Vocabulary Test-III (Dunn and Dunn 2004), and (2) parents completed the Wing Subgroups Questionnaire (WSQ). Consequently, 156 of the original 214 participants (73%) were included in the analyses. The final sample consisted of 134 boys and 22 girls with a clinical diagnosis of autism ( $n = 29$ ), Asperger's Syndrome ( $n = 22$ ), or PDD-NOS ( $n = 105$ ). Mean age of the final sample was 13.4 years (SD = 3.0; range = 6.4–18.9) and mean receptive verbal IQ was 105 (SD = 12.8; range = 72–132). Children of the final sample were

significantly younger ( $p < .01$ ) than children whose parents did not complete the WSQ, but no differences were observed in verbal IQ, gender ratio or clinical diagnosis.

All participants were assessed with the Autism Diagnostic Observation Schedule (ADOS; Lord et al. 2000). Despite the extensive diagnostic procedures, only thirty-seven percent of the participants ( $n = 57$ ) received a total score on the ADOS at or above the cutoff point for ASD ( $\geq 7$ ). Earlier studies have already shown a relatively poor sensitivity of the ADOS (ranging from .49 to .80) in classifying individuals with PDD-NOS (Bastiaansen et al. 2010; Gotham et al. 2008). Therefore, all statistical analyses were repeated to check whether results differed between individuals scoring below or at/above the ADOS cutoff point.

## Measures

Below are the measures described for social interaction style, severity of psychopathology, psycho-social health, and cognitive factors respectively. Internal consistencies for the different measures in the study sample are indicated in the final column in Table 1.

## Social Interaction Style

### Wing Subgroups Questionnaire (WSQ)

The WSQ (Castelloe and Dawson 1993) is a parent or teacher questionnaire to determine the Wing social subtype of a child with ASD. For the present study the WSQ was translated into Dutch with a forward-backward-translation method. The WSQ contains 13 descriptions of each of the three Wing subtypes (active-but-odd, passive, aloof) and 13 descriptions of typical socio-communicative behaviors. Parents or teachers evaluate how well each statement describes the child's behavior in everyday activities on a 7-point Likert scale ranging from 0 (never) to 6 (always). All item-scores belonging to one subtype add up to a scale-score. Traditionally, a child is assigned to that particular social subtype with the highest scale-score. However, instead of assigning participants to a specific category, in the present study all continuous scale-scores are included in the analyses. Internal consistency of the four WSQ scales was moderate to good in previous samples with ASD and an intellectual disability (Castelloe and Dawson 1993; O'Brien 1996). Pearson correlations between the different

**Table 1** Descriptive statistics for the predictors (WSQ scales) and main outcome measures

	<i>M</i> (SD)	Range	<i>Cronbach's</i> $\alpha$
<i>Social interaction styles</i>			
WSQ-active-but-odd (P)	33.0 (10.1)	2–56	.84
WSQ-passive (P)	37.6 (12.6)	6–71	.73
WSQ-aloof (P)	21.0 (9.3)	2–53	.69
WSQ-typical (P)	35.3 (11.7)	4–63	.86
<i>Autistic symptoms</i>			
ADOS module 3 (C)	6.3 (4.4)	0–19	.82
ADOS module 4 (C)	5.6 (3.9)	0–16	.88
SRS total (P)	80.6 (22.4)	23–133	.93
<i>Comorbid disruptive behavioral problems</i>			
DBD attention deficit (P)	11.4 (5.1)	0–25	.82
DBD hyperactivity (P)	9.2 (5.2)	0–24	.84
DBD attention deficit (T)	8.9 (5.5)	0–24	.85
DBD hyperactivity (T)	7.2 (5.6)	0–23	.87
<i>Psycho-social health</i>			
PedsQL total (C)	75.6 (12.1)	34–99	.84
PedsQL total (P)	64.7 (12.1)	22–97	.84
<i>Executive functioning</i>			
BRIEF total (P)	155.0 (20.1)	103–196	.95
<i>Perspective taking</i>			
Theory of mind task (C)	3.5 (1.2)	0–5	.46
IRI fantasy (C)	12.9 (5.4)	0–23	.72
IRI perspective taking (C)	11.8 (4.8)	0–22	.77

(C) Child informant, (P) Parent informant, (T) teacher informant, ADOS Autism diagnostic observation schedule, SRS social responsiveness scale; DBD disruptive behavior disorders rating scale, PedsQL pediatric quality of life inventory, BRIEF behavior rating inventory of executive function, IRI interpersonal reactivity index

WSQ scales were: .28 (active-but-odd–passive), .25 (active-but-odd–aloof),  $-.46$  (active-but-odd–typical), .58 (passive–aloof),  $-.37$  (passive–typical), and  $-.42$  (aloof–typical).

### Psychopathology

#### *Autism Diagnostic Observation Schedule-Generic (ADOS-G)*

The ADOS (Lord et al. 2000) is a semi-structured diagnostic observation measure to assess the presence and severity of the main problem areas in autism: social reciprocity, communication, fantasy, and repetitive interests and behaviors. The ADOS-interviewer offers several playful activities (e.g. reading a story book) and topics of discussion (e.g. peer problems) to assess the socio-communicative abilities of the participant. The ADOS has excellent internal consistency, interrater reliability, test-retest reliability, and discriminant validity (Lord et al. 2000).

#### *Social Responsiveness Scale (SRS)*

The SRS (Constantino and Gruber 2007) is a parent- or teacher questionnaire which assesses autistic traits. The SRS consists of five scales: social awareness, social cognition, social communication, social motivation, and autistic mannerisms. Each of the 65 statements about the child's behavior can be answered on a 4-point scale ranging from 0 (never true) to 3 (almost always true). A higher total score indicates more autistic traits. Good reliability and validity have been reported (Constantino and Gruber 2007).

#### *Disruptive Behavior Disorders Rating Scale (DBD)*

The DBD (Pelham et al. 1992) is a parent or teacher questionnaire developed to assess externalizing problem behaviors in children. It consists of symptom descriptions of four disorders: ADHD Inattentive subtype, ADHD Hyperactive/Impulsive subtype, Oppositional Defiant Disorder, and Conduct Disorder. Each statement has to be rated on how well it describes the child's behavior on a 4-point scale ranging from 0 (not at all) to 3 (very well). A higher score indicates more symptoms of externalizing problem behaviors. Adequate psychometric properties of the DBD have been reported (Pelham et al. 1992). Pearson correlations between parent and teacher scores on the DBD in this study were .49 for the inattention scale, .47 for the hyperactivity scale, .53 for the ODD scale, and .13 for the CD scale, which compare favorably to expectable correlations between parent and teacher ratings (cf. Achenbach et al. 1987).

### Psycho-Social Health

#### *Pediatric Quality of Life Inventory (PedsQL)*

The PedsQL (Varni et al. 2001) is a 23-item questionnaire about the quality of life of children and can be filled in by parents and children. The PedsQL assesses the occurrence of problems in the past 4 weeks in several domains of functioning: physical, social, emotional, and school-functioning. Each item can be answered on a 5-point scale ranging from 100 (never) to 0 (almost always). Good reliability and validity have been reported (Varni et al. 2001).

### Cognitive Underpinnings

#### *Behavior Rating Inventory of Executive Function (BRIEF)*

The BRIEF (Gioia et al. 2002) is an 86-item parent questionnaire about children's executive functioning in daily life. The BRIEF assesses several domains: inhibition, cognitive flexibility, emotion regulation, initiative, working memory, planning, orderliness, and behavioral evaluation. Each item is coded 1 (never), 2 (sometimes), or 3 (often). A higher score indicates more executive functioning problems in daily life. Adequate psychometric properties have been reported (Gioia et al. 2002).

#### *Theory of Mind Task*

The Theory of Mind task used in the present study consists of five social stories, derived from Sullivan et al. (1994), Begeer et al. (2011) and Kaland et al. (2008). Each story is read out loud to the participant and is followed by a question about the mental state of one of the story characters. The stories assess understanding of second order false belief, emotional display rules, violation of social rules, double bluff, and irony. Each of five mental state questions is rewarded one point (correct) or zero points (incorrect or 'don't know') and add up to a total score of 0–5. One of the social stories is about a man, Johan, who makes a faux pas while talking to an old lady. An example of a mental state question in this story would be: 'How do you think Mrs. Smit is feeling when she hears what Johan tells her?' Interrater reliability of the mental state questions was moderate to very good (20% of the data was coded double), with kappa's ranging from 0.57 (story 4) to 1.00 (story 1).

#### *Interpersonal Reactivity Index (IRI)*

Two subscales of the IRI (Davis 1983), Perspective Taking and Fantasy, assess the tendency of an individual to adopt the perspectives of others in real life, books or movies. The

IRI is a self-report questionnaire with adequate psychometric properties (Davis 1983). For this study an adapted child version of the IRI was used, consisting of 24 instead of 28 items. The child has to evaluate how well each statement describes him/her on a 5-point scale ranging from 0 (not at all) to 4 (very well). An example of a statement is: ‘When I’m angry at someone, I also try to imagine how he/she is feeling.’ A higher score indicates more perspective taking.

### Procedure

We received parental informed consent for participation as well as children’s consent when the child was 12 years or older at the time of testing. Each participant went to two individual test sessions at school, separated by 1 week to 1 month. During one session the ADOS was presented. The other session involved a complete battery of tests, including the Theory of Mind task and two self-report questionnaires (PedsQL and IRI). After the test sessions parents and teachers received questionnaires about the participant’s behavior.

### Statistical Analysis

Because age, gender, and verbal IQ were found to correlate significantly with one or more WSQ scales and/or total scores on the main outcome measures, it was decided to statistically control for the confounding influence of age, verbal IQ and gender. For instance, age correlated negatively with the active-but-odd WSQ scale ( $r = -.23$ ,  $p < .01$ ), but positively with the passive WSQ scale ( $r = .24$ ,  $p < .01$ ). To test the extent to which each of the WSQ scales was uniquely related to the child characteristics, a series of multiple regression analyses was conducted with each WSQ scale as independent variable, and measures of autism severity, disruptive behavior problems, psycho-social health, executive functioning, and perspective taking as dependent variables, controlling for age, gender, and verbal IQ, and for all other WSQ scales. Age, verbal IQ and gender were entered in the first step of the model, all three non-targeted scales of the WSQ in the second step, and the fourth scale of the WSQ (the scale of interest) in the final step (for descriptive statistics of the WSQ scales and outcome measures see Table 1). The analyses were repeated, with each WSQ scale as final predictor in the model, to examine the unique contribution of each social interaction style to the outcome measures above and beyond the predictive power of the other social interaction styles. The results of the multiple regression analyses are shown in Table 2. All analyses with significant outcomes were repeated while controlling for possible

group differences between individuals scoring below and at/above the ADOS cutoff point for ASD (score  $\geq 7$ ).

## Results

### Psychopathology

The active-but-odd scale of the WSQ accounted for a small, but significant amount of variance on the ADOS above and beyond the explained variance by age, verbal IQ, gender, and the three other WSQ scales ( $\beta = -.18$ ,  $\Delta R^2 = .02$ ,  $p = .05$ ). The active-but-odd scale also explained a significant amount of variance on the SRS above and beyond all other variables ( $\beta = .35$ ,  $\Delta R^2 = .09$ ,  $p < .001$ ; all SRS subscales with the exception of Social motivation:  $\beta > .28$ ,  $\Delta R^2 > .05$ ,  $p < .001$ ). Analyses with the passive WSQ scale as final predictor in the regression model failed to show any meaningful associations with the psychopathology outcome measures, with the exception of a small positive association with the Social Motivation subscale of the SRS ( $\beta = .18$ ,  $\Delta R^2 = .02$ ,  $p < .05$ ). The aloof scale of the WSQ also contributed modestly, yet significantly to variance in total score of the SRS ( $\beta = .21$ ,  $\Delta R^2 = .03$ ,  $p < .001$ ). The typical scale of the WSQ, which indicates the degree of normal social interactions, was negatively associated with total scores on the ADOS ( $\beta = -.28$ ,  $\Delta R^2 = .05$ ,  $p < .01$ ) and the SRS ( $\beta = -.46$ ,  $\Delta R^2 = .14$ ,  $p < .001$ ).

With regard to disruptive behavior problems, the active-but-odd scale was most strongly and positively associated with symptoms of hyperactivity on the DBD (parent report:  $\beta = .58$ ,  $\Delta R^2 = .24$ ,  $p < .001$ ; teacher report:  $\beta = .32$ ,  $\Delta R^2 = .07$ ,  $p < .01$ ). The other WSQ scales did not contribute to variance in disruptive behavior problems.

### Psycho-Social Health

Variance on the active-but-odd scale did not account for any significant variance on self-reported quality of life (PedsQL). Yet, when children’s quality of life as reported by parents was taken as dependent variable in the regression analysis, the active-but-odd scale showed a significant negative association with quality of life ( $\beta = -.34$ ,  $\Delta R^2 = .08$ ,  $p < .001$ ). All other WSQ scales did not contribute to variance in quality of life reports.

### Cognitive Underpinnings

Firstly, the active-but-odd scale explained a significant amount of all variance on the total score of the BRIEF ( $\beta = .51$ ,  $\Delta R^2 = .19$ ,  $p < .001$ ), particularly the Inhibition scale ( $\beta = .61$ ,  $\Delta R^2 = .27$ ,  $p < .001$ ). This indicates that a

**Table 2** Outcome of a series of multiple linear regression analyses with the unique contribution of each scale on the Wing Subgroups Questionnaire while controlling for age, verbal IQ, gender and the three other WSQ scales

Dependent variable	Predictor								Total R <sup>2</sup>
	Active-but-odd scale		Passive scale		Aloof scale		Typical scale		
	β	R <sup>2</sup> change	β	R <sup>2</sup> change	β	R <sup>2</sup> change	β	R <sup>2</sup> change	
<i>Autistic symptoms</i>									
ADOS total (C)	-.18	.02*	-.04	.00	.11	.01	-.28	.05**	.18***
SRS social awareness (P)	.29	.06***	-.14	.01	.10	.01	-.45	.14***	.48***
SRS social cognition (P)	.29	.06***	.15	.01	.17	.02*	-.15	.02	.41***
SRS social communication (P)	.37	.09***	.04	.00	.15	.01*	-.46	.15***	.63***
SRS social motivation (P)	-.01	.00	.18	.02*	.26	.04**	-.46	.14***	.51***
SRS autistic mannerisms (P)	.46	.15***	-.07	.00	.22	.03**	-.36	.09***	.58***
SRS total (P)	.35	.09***	.05	.00	.21	.03***	-.46	.14***	.70***
<i>Comorbid behavioral problems</i>									
DBD attention deficit (P)	.26	.05**	-.17	.02	.03	.00	-.12	.01	.11**
DBD hyperactivity (P)	.58	.24***	-.16	.02	.13	.01	.03	.00	.38***
DBD ODD (P)	.21	.03*	-.08	.00	.13	.01	-.01	.00	.10*
DBD CD (P)	.08	.01	-.01	.00	.12	.01	-.02	.00	.04
DBD attention deficit (T)	.13	.02	-.15	.01	.00	.00	.08	.01	.09
DBD hyperactivity (T)	.32	.07**	-.17	.02	-.05	.00	.15	.02	.25***
DBD ODD (T)	.11	.01	.09	.01	-.06	.00	.03	.00	.06
DBD CD (T)	-.17	.02	-.09	.00	-.07	.00	.03	.00	.07
<i>Psycho-social health</i>									
PedsQL social scale (C)	-.13	.01	.04	.00	-.09	.01	.12	.01	.07
PedsQL emotional scale (C)	-.09	.01	-.05	.00	.12	.01	-.03	.00	.08
PedsQL total (C)	-.07	.00	.06	.00	-.07	.00	.08	.00	.05
PedsQL social (P)	-.45	.14***	.02	.00	.03	.00	-.01	.00	.19***
PedsQL emotional (P)	-.25	.05**	-.06	.00	-.08	.00	.00	.00	.19***
PedsQL total (P)	-.34	.08***	.06	.00	-.16	.02	.11	.01	.28***
<i>Executive functioning</i>									
BRIEF inhibition (P)	.61	.27***	-.05	.00	.08	.00	.10	.01	.39***
BRIEF cognitive flexibility (P)	.19	.03*	.14	.01	.30	.06**	-.06	.00	.30***
BRIEF emotion regulation (P)	.19	.03*	.02	.00	.17	.02	-.08	.00	.23***
BRIEF initiative (P)	.12	.01	.16	.02	-.03	.00	-.28	.05**	.18***
BRIEF working memory (P)	.37	.10***	-.05	.00	.21	.03*	.11	.01	.17**
BRIEF planning (P)	.29	.06**	-.12	.01	.12	.01	.09	.01	.13**
BRIEF orderliness (P)	.47	.16***	-.26	.04**	.20	.03*	.10	.01	.26***
BRIEF behavior evaluation (P)	.50	.18***	-.10	.01	-.02	.00	.00	.00	.24***
BRIEF total (P)	.51	.19***	-.07	.00	.20	.03*	.01	.00	.32***
<i>Perspective taking</i>									
Theory of mind task (C)	.13	.01	-.14	.01	-.01	.00	.06	.00	.19***
IRI Fantasy (C)	.11	.01	-.14	.01	.03	.00	.06	.00	.07
IRI Perspective taking (C)	.07	.00	-.16	.02	-.02	.00	.09	.01	.11*

\*  $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .001$ , Beta's are standardized beta's for the full model, i.e. the value of the beta when all predictors were included. (C) Child informant, (P) parent informant, (T) teacher informant, ADOS Autism diagnostic observation schedule, SRS social responsiveness scale, DBD disruptive behaviour disorders rating scale, ODD oppositional defiant disorder, CD conduct disorder, PedsQL pediatric quality of life inventory, BRIEF behavior rating inventory of executive function, IRI interpersonal reactivity index

higher degree of an active-but-odd social interaction style is associated with a higher degree of executive dysfunctioning. The passive scale only had a negative association

with the Orderliness subscale of the BRIEF ( $\beta = -.26$ ,  $\Delta R^2 = .04$ ,  $p < .01$ ). Furthermore, the aloof scale also had a modest positive association with the BRIEF ( $\beta = .20$ ,



$\Delta R^2 = .03$ ,  $p < .05$ ), particularly the BRIEF-subscale cognitive flexibility ( $\beta = .30$ ,  $\Delta R^2 = .06$ ,  $p < .01$ ). Finally, a negative association was noted between the typical scale and the BRIEF-subscale Initiative ( $\beta = -.28$ ,  $\Delta R^2 = .05$ ,  $p < .01$ ). All other associations were found not significant. Variance on any of the WSQ scales did not account for significant variance on the Theory of Mind task nor self-reported perspective taking (IRI).

### Control Analyses

Additional analyses were performed to check for a possible interaction effect between the active-but-odd predictor and ADOS status (i.e. score below or at/above the cutoff point for ASD) on the outcome measures. No significant interactions were found between the active-but-odd scale and ADOS status on the outcome measures with the exception of Theory of Mind task performance ( $\beta = .16$ ,  $\Delta R^2 = .02$ ,  $p = .05$ ). This signifies that only for the group at/above the ADOS cutoff point the active-but-odd scale is modestly and positively associated with Theory of Mind task performance.

Finally, to rule out the possibility that associations between WSQ scales and several outcome measures (SRS, DBD hyperactivity scale, BRIEF) were due to an overlap in item-content, the analyses were repeated exclusive of overlapping items. Positive associations between the active-but-odd scale and the outcome measures all remained significant. Associations between other WSQ scales and outcome measures remained stable, except for the association between the aloof scale and total score on the BRIEF, which became non-significant.

### Discussion

The present study examined to what extent the social interaction styles of children with HFASD are associated with their level of autistic symptoms, disruptive behavior problems and psychosocial health. A second focus of the study was to explore the relations of social interaction styles with executive functioning and perspective taking skills. Results showed that both an active-but-odd social interaction style as well as an aloof social interaction style were positively associated with ASD symptoms on the SRS. Yet, a modest negative association was found between an active-but-odd social interaction style and ASD symptoms as measured by the ADOS. As would be expected, the level of a typical social interaction style was negatively related to both measures of autism severity. Furthermore, an active-but-odd social interaction style was positively associated with characteristics of ADHD, ODD, and socio-emotional problems as reported by parents. Also,

the active-but-odd style was strongly related to executive functioning problems, particularly inhibition problems. Additional analyses showed that children's performance on the Theory of Mind task was only related to an active-but-odd social interaction style in the group of individuals with ADOS scores above the cutoff point for an ASD. All associations with a passive social interaction style lacked significance after statistically controlling for age, verbal IQ, gender and other social interaction styles.

Previous research with low-functioning samples of ASD found active-but-odd children to be more intelligent and to have less severe forms of autism than passive and aloof children (Borden and Ollendick 1994; Castelloe and Dawson 1993; O'Brien 1996; Roeyers 1997). However, in the present sample active-but-odd behavior was both negatively (ADOS) and positively (SRS) associated with autistic symptoms. One must note that the basis for ADOS and SRS ratings is different in several important ways: informant (researcher/clinician vs. parent), relevant time frame (1 h vs. 6 months), and purpose of the measure (categorical vs. dimensional differentiation). The ADOS intends to differentiate between typical development and autistic development, and is less focused on a differentiation *within* the autism spectrum. Therefore, corresponding to DSM-IV criteria, most item descriptions in the ADOS are globally formulated and would fit a passive child as well as an active-but-odd child. However, the social approaches of a child with an active-but-odd interaction style may not be as readily recognized as socially deviant behavior during a 1 h session, which might explain the modest negative association found in this study between ADOS and the active-but-odd style. The SRS is specifically designed to measure the severity of autistic symptoms, implying a sensitivity to mild variations within the autism spectrum. Even after excluding overlapping items between SRS and WSQ, an active-but-odd social interaction style was positively associated with autistic symptoms on the SRS. This indicates that parents observe more autistic symptoms in children with a high degree of active-but-odd social behavior.

Consistent with earlier reports of more deficits in attention, motor control, and perception in active-but-odd children (Bonde 2000), an active-but-odd social interaction style was associated with elevated levels of disruptive behaviors such as ADHD-symptoms. The question that is raised by this result is whether the social approaches of active-but-odd children are driven by an overall higher level of activity. Associations of an active-but-odd social interaction style with increased ASD and ADHD-symptoms as reported by parents underline the clinical relevance of social interaction style as a dimension to distinguish children and adolescents with HFASD.

Despite a general increase in autistic and disruptive behaviors, an active-but-odd social interaction style was

not related to an increase in self-reported psycho-social problems. In fact, average quality of life scores of all HFASD participants in this study were comparable to previous reports of typically developing peers (Bastiaansen et al. 2004). Thus, children and adolescents did not experience the psycho-social problems their ASD-diagnosis seems to imply. A lack of self-reported psycho-social concerns in ASD has been supported by previous studies (Foley Nicpon et al. 2010). Parents in this study generally did report more psycho-social problems of their children with HFASD. This discrepancy between children's and parents' reports could have been the result of children comparing themselves to other peers with HFASD (all children in this sample received specialized education) and their parents comparing them to typically developing children. Parents reported that particularly children with an active-but-odd interaction style showed more social and emotional problems. This agrees with the clinical observation by Wing and Gould (1979) that active-but-odd children were sometimes rejected by their peers because of their peculiar behavior.

The observed heterogeneity in social interaction style of children with HFASD may in part be produced by heterogeneity in cognitive underpinnings of autistic symptomatology. Indeed, the three proposed cognitive keystones of ASD—perspective taking difficulties, executive dysfunction, and weak central coherence—are not universally present in all children with ASD (e.g., Pellicano 2010). Our study extends these findings by showing that the degree of active-but-odd behavior was strongly related to the degree of executive functioning problems in daily life. A difficulty to inhibit impulses and regulate behavior could explain the active-but-odd social behaviors seen in some children with HFASD. For those individuals scoring at/above the ADOS cutoff point, an active-but-odd social interaction was also positively related to performance on the Theory of Mind task. Plausibly, the increased social interactions of active-but-odd children induces more feedback from the social environment, which in turn increases their opportunities to learn about social rules and stimulates social cognition as reflected in the Theory of Mind task.

The association between different social interaction styles and distinct patterns of strengths and weaknesses may be used as a starting point for interventions to improve social skills (see Schreiber 2011, for a review). The present study shows that children with HFASD and an active-but-odd social interaction style seem in special need of support and interventions given their autism severity, ADHD-symptoms, poor executive functioning and psycho-social problems as reported by parents. Since these children already actively seek contact with others, interventions that are specifically focused on increasing social motivation seem less appropriate. Furthermore, because perspective

taking abilities in this study were either independent of (in the less severely autistic group) or positively related to (in the more severely autistic group) an active-but-odd social interaction style, it seems unlikely that active-but-odd children will benefit more from social cognition interventions than passive or aloof children with HFASD. Interventions for children with an active-but-odd social interaction style may be particularly useful when they focus on executive functioning problems, for instance, self-regulation of behavior and control of impulses. These types of interventions may decrease the number of awkward social missteps of active-but-odd children.

The present study has several limitations. First, associations between social interaction style and outcome measures may in part be produced by overlap in informant (parent). Yet, this critique can be partly refuted, because teacher ratings of hyperactivity were similarly associated with the child's active-but-odd interaction style. Secondly, the results and implications of the present study only apply to children and adolescents with HFASD. Associations will need to be confirmed in ASD-samples with an intellectual disability, while controlling for the confounding influence of intelligence. Finally, it should be noted that more than half of the participants in this study did not meet the ADOS cutoff for having an ASD. Hence, our findings might not fully generalize to children and adolescents with more severe forms of ASD. Earlier studies have already shown a relatively poor sensitivity of the ADOS (ranging from .49 to .80) in classifying individuals with PDD-NOS (Bastiaansen et al. 2010; Gotham et al. 2008). However, it should also be noted that in the current study the distribution of clinical diagnoses (autism, syndrome of Asperger, PDD-NOS) was not significantly different for participants scoring above or below the ADOS cutoff for an ASD. Possibly, ADOS scores are more influenced by the level of intelligence of a child with ASD rather than its particular clinical diagnosis.

It is striking that the aloof and passive social interaction style lacked significant associations with a majority of the outcome measures. Both an aloof and a passive social interaction style were modestly related to a lower social motivation as shown by higher scores on the social motivation scale of the SRS. The lack of social initiations shown by some children with HFASD may be produced by social anxiety rather than an inability to start social interactions. As yet, aloof and passive social behavior remains multi-interpretable. Different causes may underlie a lack of social initiative, for example a lack of social motivation or a lack of social competence. Thus, the aloof and passive group may still be a rather heterogeneous group, leading to few significant associations with other behavioral measures.

A topic of ongoing debate is whether the current DSM-IV categorical system is a meaningful way to differentiate children within the autism spectrum (APA 2011; Volkmar



et al. 2009). More than 30 years ago, Wing and Gould (1979) proposed social interaction style as a clinically relevant distinction among children with ASD. The results of the current study confirm the clinical relevance of the different social interaction styles of children with ASD. While controlling for the confounding influence of intelligence, this study has provided new insights into the associated characteristics of different social interaction styles in HFASD, and has offered possible suggestions for interventions. Future studies will need to identify the mechanisms behind these findings. For instance, it would be useful to examine whether differences in social interaction styles are driven by differences in social motivation. Another important area of interest is change and continuity in social interaction style. Age was found to correlate negatively with an active-but-odd social interaction style, yet positively with a passive interaction style. To find out whether there is a true developmental shift in social interaction style, it is necessary to study the social interaction styles in a longitudinal design. Besides changes over time, children may also adopt different social interaction styles depending on their social partner. Research already indicates that children with ASD show more social interaction problems with peers than adults (Hauck et al. 1995). Therefore it would be useful in future studies to make a distinction between social partners. A combination of multiple settings, multiple informants, and multiple methods will promote a better understanding of the heterogeneity in social interaction styles among those with autism spectrum disorders.

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