

Stability and Change in Social Interaction Style of Children with Autism Spectrum Disorder: A 4-Year Follow-Up Study

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Children with autism spectrum disorder (ASD) show atypical social behavior but vary in their social interaction style (SIS), ranging from social aloofness to awkward social approaches. In a 4-year follow-up study, we examined longitudinal stability and change of SIS in children and adolescents with ASD and a normal intellectual ability ($n = 55$; mean age Time 1: 13 years; mean age Time 2: 17 years). Children's SIS was assessed with a parent questionnaire, the Wing Subtypes Questionnaire. As expected, most participants (69%) showed SIS stability across the 4-year interval. Some participants (18%) shifted to a more typical or more active (but odd) SIS, while others (13%) shifted to a less typical or less active (but odd) SIS. A decrease in ASD symptoms predicted a shift toward a more typical or active SIS, but children's age and receptive verbal ability did not. SISs may be a meaningful way to create ASD subgroups and thus offer a promising research venue to further disentangle the heterogeneous autism spectrum. *Autism Res* 2020, 13: 74–81. © 2019 The Authors. *Autism Research* published by International Society for Autism Research published by Wiley Periodicals, Inc.

Lay Summary: People with autism spectrum disorder (ASD) demonstrate different social interaction styles (SIS), ranging from social aloofness to awkward social approaches. We examined if and how SIS changes across a 4-year period in 55 children and adolescents with ASD (mean age Time 1 = 13 years; mean age Time 2 = 17 years). Most children (69%) showed the same SIS at both time points, indicating that SIS might be a relatively stable trait across adolescence.

Keywords: autism spectrum disorder; social interaction style; social development; longitudinal design; adolescence

Introduction

Originally, children with autism were described as children who prefer to play by themselves and who show no apparent interest in others as social partners [Kanner, 1943]. Even though this description still applies to some children with an autism spectrum disorder (ASD), others do make social contact and may even cross social boundaries while doing so (e.g., crawl on a stranger's lap). Thus, while atypical social interaction forms the crux of an ASD diagnosis [APA, 2013], children with ASD show large individual differences in the manifestation of these atypicalities [Jones & Klin, 2009]. In the late 1970s, Wing and Gould [1979] were the first to differentiate and label autistic social interaction styles (SISs), including: (a) the aloof style; the child does not respond to the social bids of others, (b) the passive style; the child engages in social interaction when initiated by others, and (c) the active-but-odd style; the child actively seeks social contact but does so in a clumsy or peculiar way. Wing and Gould's distinction between passive and active SISs has

not only been confirmed by later behavioral studies [Mundy, Henderson, Inge, & Coman, 2007; Roeyers, 1997; Scheeren, Koot, & Begeer, 2012], but groups with different SISs also show distinct neuronal activity patterns [Burnette et al., 2011; Dawson, Klinger, Panagiotides, Lewy, & Castelloe, 1995] and differences in genetic make-up [Crespi & Hurd, 2014]. However, the developmental course of SISs in normally intelligent children and adolescents with ASD has not been studied before. In the current study, we examined stability and change of SIS over a 4-year period in children and adolescents with ASD.

There are three potential developmental paths for the SISs of children and adolescents with ASD. First, children with ASD may remain stable in their SIS. In this case, SIS may show overlap with the construct of temperament or particular temperamental aspects. Temperament is a biologically based and developmentally stable behavioral style visible from early childhood [Sanson, Hemphill, & Smart, 2004; Shiner & Caspi, 2003]. Second, children with ASD may shift from an aloof or passive SIS to a more active (but odd) SIS as they grow up. In the literature, the

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active-but-odd SIS is generally considered more advanced than the passive and aloof SIS, because in samples of children with mixed intellectual abilities, the active-but-odd SIS has been associated with higher intellectual abilities, better adaptive functioning, and lower autism severity rates compared to the passive and aloof SISs [Castelloe & Dawson, 1993; Eagle, Romanczyk, & Lenzenweger, 2010; Ghaziuddin, 2008; Roeyers, 1997; Waterhouse et al., 1996]. Third, some children with ASD might “outgrow” their autistic SIS (aloof, passive or active-but-odd) and show a predominantly typical SIS. A typical SIS means that the child or adolescent mostly shows typical behavior during social interactions, although active-but-odd and passive social behaviors may also be present. Some longitudinal studies suggest that a minority diagnosed with ASD in childhood no longer meets the clinical criteria for ASD at a later stage in life [Fein et al., 2013; Louwse et al., 2015].

Previous longitudinal studies have provided empirical support for all of the above-described developmental paths in samples with ASD and mixed intellectual abilities (including severe intellectual disabilities). Beadle-Brown et al. [2002] found that 75% of a sample of children with intellectual disabilities and/or ASD remained stable in SIS after 12 years ($n = 144$; mean age Time 1: 9 years; mean age Time 2: 21 years). Of the ones who changed style, most moved from aloof to passive or passive to active-but-odd. These outcomes suggest overall stability as well as change to a more active SIS. However, results may be confounded due to informant differences at the two time points and may not generalize to children and adolescents with an ASD diagnosis and normal intellectual abilities. Also, an intellectual disability may be confounded with an aloof SIS given the overlap in characteristics. More recently, in an exceptionally large longitudinal study ($n = 6,975$) different social developmental trajectories were observed in children with ASD and mixed intellectual abilities from age 2–14 years [Fountain, Winter, & Bearman, 2012]. Based on repeated parent/caregiver interviews, most children showed improvement in their social interaction, which was defined as a shift from aloof or passive social behavior toward more active (but not socially odd) and typical social behavior. Most dramatic change was found before the age of 6 years. From 6 onward, the quality of social interactions stabilized. Also, a group of “bloomers” was identified showing aloof social behavior in toddlerhood, but active social behavior at the age of 14. It is thus far unknown if and how adolescents with ASD and a normal intellectual ability change in their SIS as they approach adulthood. Adolescence is expected to be a particularly challenging period for individuals with ASD, because of the associated developmental tasks with high social demands [e.g., formation of friendships and romantic relationships; Picci & Scherf, 2015]. Therefore, it is a relevant and mostly unexplored period to study potential changes in SIS.

Increased insight into the social developmental trajectories of children and adolescents with ASD will also promote diagnostic accuracy. If SIS is a stable trait across development, all SISs could be used as diagnostic markers for ASD at different ages. Yet, if there is a developmental change in SIS, social atypicalities will be different at different ages. For instance, school-aged children with ASD may behave more socially aloof compared to adolescents and young adults with ASD. In this example, social aloofness may be a valuable diagnostic marker for ASD in school-aged children, but not so much for ASD in adolescents and young adults. The clinical relevance of children’s SIS is further highlighted by associations found between children’s SIS and their need for and responsiveness to treatment. Beglinger and Smith [2005] found that children with an active-but-odd SIS benefitted more from an intensive behavioral intervention than children with an aloof SIS. However, differences in treatment responsiveness in this study might also stem from differences in intellectual abilities. More recently, Begeer et al. [2015] found that a passive SIS moderated the treatment effect of a Theory of Mind based intervention for children with ASD. Children with low or high levels of passive social behavior both decreased in ASD symptoms (mostly in the social communication domain) after the intervention, but the intervention effect (compared to the wait-list) was bigger among the children with a low level of passive social behavior. Summing up, preliminary evidence suggests that SIS may be used as a target for treatment and may be a predictor of treatment success in children with ASD.

We performed a follow-up study 4 years after a large cross-sectional study of children and adolescents with ASD and a normal intellectual ability (mean age Time 1: 13 years; mean age Time 2: 17 years). In line with previous empirical findings, we expected that a majority of children and adolescents with ASD remained stable in their SIS. A minority was expected to move to a more active SIS or to a dominantly typical SIS. A regression analysis was used to identify possible predictors for change in SIS. Factors that were considered as predictors are receptive verbal ability, age, and change in severity of ASD symptoms. Childhood language ability and childhood cognitive ability (IQ) are most consistently found predictors of (social) development in individuals with ASD (see the systematic review of Magiati, Tay, & Howlin, 2014), therefore we expected that children with a high receptive verbal ability at Time 1 were more likely to change to a typical or more active SIS at Time 2. Also, given the continued progress in social behavior in most individuals with ASD during adolescence [Magiati et al., 2014; Picci & Scherf, 2015], we expected that older participants at Time 1 were more likely to develop a typical or more active SIS over a period of 4 years. Finally, we expected that participants showing an overall decrease in

ASD severity over 4 years also showed a shift to a more typical or active SIS. To our knowledge, this is the first longitudinal study on stability and change in SIS across the period of adolescence in children with ASD (and intellectual abilities within the normal range). Studying longitudinal stability and change in SIS contributes to a better understanding of the social developmental trajectories in ASD and may in turn improve diagnostic assessments of ASD in children and adolescents with normal intellectual abilities.

Method

Participants

In 2009/2010, a large-scale study in the Netherlands was performed to assess the social and empathic abilities of children and adolescents in specialized education with a clinical ASD diagnosis. SIS data of 156 children were obtained in this initial study [Scheeren et al., 2012]. All participants had received a clinical ASD diagnosis from psychologists/psychiatrists prior to and independent from the study based on DSM-IV-TR criteria [APA, 2000]. In the Netherlands, it is standard procedure that a clinical ASD diagnosis is established based on a multi-method (e.g., observation, interview, and neuropsychological tests) and multi-informant approach (clinical psychologist, educationalist, parent, and child). Furthermore, participants were presumed to have intellectual abilities within the normal range as they all had entered specialized education that only admitted children with a normal intellectual ability ($IQ > 70$) and a clinical diagnosis of ASD. The educational procedures in the Netherlands offer strict guidelines for admittance to education settings based on extensive teacher reports and children's performance on a standardized nationwide exam (CITO exam). Additionally, we checked verbal receptive ability of all participants. All had a verbal receptive IQ of 72 or higher (see Table 1) as ascertained with the Peabody Picture Vocabulary Test-III [Dunn & Dunn, 2004], a measure known to correlate highly with more general measures of verbal IQ and full-scale IQ [Hodapp & Gerken, 1999].

Table 1. Background Characteristics of the Participants with ASD ($n = 55$)

	<i>M (SD)</i>	Range
Age Time 1 (in years)	13.2 (3.03)	7.9–18.9
Age Time 2 (in years)	17.0 (3.13)	11.6–23.3
Receptive verbal IQ Time 1	104.6 (13.90)	72–130
Gender (boy; girl)	52; 3	
SRS total Time 1 ($n = 53$)	82.6 (20.92)	44–128
SRS total Time 2	74.5 (26.68)	14–132
SRS t-score Time 1 ($n = 53$)	73.8 (10.22)	55–95
SRS t-score Time 2	69.7 (12.75)	41–97

In 2013, 4 years after the initial study, online questionnaires were sent out to parents whose children had participated in the original study to obtain longitudinal data on children's SIS. Parents were contacted via email addresses provided to the researchers during the first study. In total, 55 parents filled in the online questionnaire at Time 2. At both time points parents also filled in the Social Responsiveness Scale [SRS; Constantino & Gruber, 2007], a questionnaire on the severity of children's autism symptoms. Both the original study as well as the follow-up study followed the ethical standards of the Helsinki Declaration (2000). The average interval between Time 1 and Time 2 was 45 months (3.8 years). Characteristics of the 55 children and adolescents are described in Table 1. A large majority of these 55 children with ASD was living with both biological parents at Time 1 (93%), had a mother (96%) and a father (96%) who were born in the Netherlands, and all (except for one child with missing values) were born in the Netherlands themselves. The highest level of completed education of parents at Time 1 ranged between primary school (1) and university education (7) with a mean level of 5. Occupational level of parents at Time 1 ranged from having no profession (0) to a scientific profession (5), with an average level of 3. The proportion of parents with a low (0–2), middle (3), or high (4–5) level occupation was 18%, 46%, and 36% respectively.

Participants included in the longitudinal study did not significantly differ from the participants whose parents did not fill in the online questionnaire at Time 2 with regard to age ($t(154) = 0.53, P = 0.60$), receptive verbal IQ ($t(154) = 0.32, P = 0.75$), autism severity based on the SRS ($t(150) = 0.89, P = 0.37$), gender ($\chi^2(1) = 2.16, P = 0.14$), or SIS at Time 1 ($\chi^2(3) = 1.76, P = 0.63$). Thus, our analyses did not indicate a selective dropout of participants. The relatively high attrition rate (65%) may be because the researchers did not initially plan to do a follow-up study. Therefore, there had been no intermittent notices about the study during the 4-year period. It is likely that the list of email addresses was no longer up to date and parents may have been less motivated to participate in the follow-up study.

Measures

Wing Subtypes Questionnaire. The Wing Subtypes Questionnaire (WSQ) is a standardized questionnaire developed by Castelloe and Dawson [1993] to determine the SIS of a child with ASD. The WSQ contains statements describing each of the four SISs (aloof, passive, active-but-odd, and typical). The parent or teacher (in the present study: parent) evaluates how well each of the statements describes the child's behavior in everyday activities on a 7-point Likert scale ranging from 0 (never) to 6 (always). Each SIS is covered by 13 statements. A

scale score for each SIS is calculated by adding the 13 item scores (with a potential range of 0–78). The child’s dominant SIS is based on the scale with the highest score. In case a child obtains equally high scores on two scales of the WSQ, the child does not show a dominant SIS. In the current study, participants with two equally high scale scores were assigned the “most advanced” SIS of the two. This hierarchy from most to least advanced (typical, active-but-odd, passive, and aloof) is based on associations reported in previous studies [Castelloe & Dawson, 1993; Eagle et al., 2010; Ghaziuddin, 2008; Roeyers, 1997; Waterhouse et al., 1996]. Internal consistency of the four WSQ scales was moderate to good in previous studies including our original large-scale cross-sectional study [Castelloe & Dawson, 1993; O’Brien, 1996; Scheeren et al., 2012]. In our follow-up study, internal consistency of the aloof scale of the WSQ is 0.71, 0.78 for the passive scale, 0.87 for the active-but-odd scale, and 0.90 for the typical scale. We also calculated intra class correlations (ICC’s) between the WSQ scale scores at the two time points. ICC between the aloof scale scores at Time 1 and Time 2 is 0.60, 0.42 for the passive scales, 0.63 for the active-but-odd scales, and 0.62 for the typical scales. These ICC’s all indicate good consistency, except for the passive scale with a fair consistency [Cicchetti, 1994].

Social Responsiveness Scale. The Social Responsiveness Scale (SRS) [Constantino & Gruber, 2007] is a parent or teacher questionnaire assessing ASD symptoms. It consists of 65 items describing children’s behavior. Items can be answered on a four-point scale ranging from 0 (never true) to 3 (almost always true). A higher total score indicates more ASD symptoms. The SRS has good psychometric properties.

Peabody Picture Vocabulary Test-III. The Peabody Picture Vocabulary Test-III (PPVT) [Dunn & Dunn, 2004] is a measure of receptive verbal ability and consists of 17 sets of 14 words increasing in difficulty. The participant is instructed to select one of four images that match the word given by the experimenter. Performance on the PPVT-III is highly correlated with general measures of verbal ability and intellectual ability [Hodapp & Gerken, 1999].

Coding

Change in SIS is coded “0” if the participant has the same SIS at the two time points. Change in SIS is coded “1” if the participant shows a shift to a typical SIS or a more active SIS at Time 2 (e.g., participant has a passive SIS at Time 1 and an active-but-odd SIS at Time 2). Finally, change in SIS is coded “-1” if the participant changes from a typical SIS to one of the autistic SISs or a less active

SIS at Time 2 (e.g., participant has an active-but-odd SIS at Time 1 and a passive SIS at Time 2).

Statistical Analysis

First, we describe stability and change in SIS from Time 1 to Time 2. With a chi-square analysis, we check whether the distribution of SISs is significantly different at the two time points. Then we perform an exploratory multinomial logistic regression to predict change and stability in SIS based on participants’ receptive verbal IQ, age (at Time 1), and change in SRS score. All predictors were entered in a single step. Stability in SIS (change in SIS = 0) is used as a reference category.

Results

Descriptive Results

Four of 55 participants (7%) received equally high scores on two WSQ scales at one time point, so they were assigned to the most advanced SIS of the two. This resulted in one typical SIS and one active-but-odd SIS at each time point. At Time 1, a majority of the participants (47%) had a dominantly active-but-odd SIS (see Table 2). At Time 2, however, the majority (44%) had a dominantly typical SIS (see also Table 2). As expected, most participants ($n = 38$; 69%) showed stability in SIS from Time 1 to Time 2. Of the 17 participants who had changed SIS, 10 showed a shift to a more typical or more active (but odd) SIS, while seven showed a shift to a less typical or less active (but odd) SIS. In Table 3, we provide the background characteristics of the three groups of children with a different SIS development. In Table 4, we show the characteristics of participants with different SISs (passive, active-but-odd, and typical) at both time points. Please note that means and SDs of the aloof SIS are not included in Table 4 because the number of participants with an aloof SIS was too low at Time 1 ($n = 1$) and Time 2 ($n = 2$).

Table 2. Distribution of Social Interaction Styles at Time 1 (T1) and Time 2 (T2)

	Aloof T2	Passive T2	Active-but-odd T2	Typical T2	Total T1
Aloof T1	1	0	0	0	1 (2%)
Passive T1	1	6	1	2	10 (18%)
Active-but-odd T1	0	3	16	7	26 (47%)
Typical T1	0	2	1	15	18 (33%)
Total T2	2 (3%)	11 (20%)	18 (33%)	24 (44%)	55

Note. Gray boxes indicate stability of social interaction style.

Table 3. Characteristics of Three Groups with a Different Social Interaction Style (SIS) Development

	Decrease in typical/active SIS (<i>n</i> = 7) <i>M</i> (<i>SD</i>)	Stable SIS (<i>n</i> = 38) <i>M</i> (<i>SD</i>)	Increase in typical/active SIS (<i>n</i> = 10) <i>M</i> (<i>SD</i>)
Age T1	13.27 (3.80)	13.26 (3.02)	12.95 (2.81)
Age T2	17.06 (3.97)	17.08 (3.13)	16.79 (2.78)
Receptive verbal IQ T1	106.43 (9.54)	102.92 (15.00)	109.90 (11.29)
Gender (boys; girls)	7; 0	36; 2	9; 1
SRS total T1	78.43 (14.80)	81.64 (22.65)	88.92 (18.05)
SRS total T2	85.57 (11.62)	75.63 (30.15)	62.70 (13.73)
Change aloof WSQ scale (T2 – T1)	20.14 (8.34)	12.03 (8.17)	8.46 (7.75)
Change passive WSQ scale (T2 – T1)	17.29 (9.93)	13.61 (11.23)	7.50 (10.21)
Change active-but-odd WSQ scale (T2 – T1)	11.86 (10.92)	8.05 (10.89)	-1.74 (12.03)
Change typical WSQ scale (T2 – T1)	7.14 (7.06)	15.66 (11.26)	27.90 (5.84)

Table 4. Characteristics of Children with a Passive, Active-But-Odd, or Typical Social Interaction Style at Time 1 (T1) and Time 2 (T2)

	Passive <i>M</i> (<i>SD</i>)	Active-but-odd <i>M</i> (<i>SD</i>)	Typical <i>M</i> (<i>SD</i>)
<i>Time 1</i>			
Age	13.67 (2.90)	12.83 (3.04)	13.57 (3.24)
Gender (boys; girls)	10; 0	25; 1	16; 2
Receptive verbal IQ	95.20 (13.78)	109.96 (11.77)	103.17 (13.90)
SRS total	77.82 (13.89)	96.76 (12.46)	61.89 (12.97)
<i>Time 2</i>			
Age	17.52 (3.26)	16.86 (3.21)	17.11 (3.17)
Gender (boys; girls)	11; 0	18; 0	21; 3
Receptive verbal IQ (T1)	100.18 (14.94)	108.17 (13.42)	105.17 (13.65)
SRS total	86.09 (14.29)	94.78 (16.10)	51.50 (18.33)

Note. The aloof social interaction style is not included in the table.

Table 5. Results of the Multinomial Regression Analysis

	<i>B</i> (<i>SE</i>)	Lower	Odds ratio	Upper
Increase in typical/active SIS vs. stability in SIS				
Intercept	-3.967 (3.572)			
Verbal receptive IQ	0.026 (0.031)	0.967	1.027	1.091
Age	-0.073 (0.138)	0.709	0.929	1.218
Change in SRS	-0.050 (0.022)*	0.911	0.951	0.994
Decrease in typical/active SIS vs. Stability in SIS				
Intercept	-5.694 (4.196)			
Verbal receptive IQ	0.028 (0.033)	0.963	1.028	1.097
Age	0.087 (0.155)	0.805	1.091	1.478
Change in SRS	0.046 (0.025)†	0.997	1.047	1.098

* $P < 0.05$; † $P < 0.10$.

Statistical Results

A chi-square analysis confirmed a significantly different distribution of SISs at Time 1 and Time 2 ($\chi^2(9) = 60.53$, $P < 0.001$, $\phi = 1.05$). The multinomial logistic regression model predicting change in SIS was significant ($\chi^2(6) = 13.84$, $P < 0.05$, Nagelkerke $R^2 = 0.28$, Cox & Snell $R^2 = 0.23$). Based on this model, SIS change was predicted correctly in 70% of all cases (94% of stable SIS cases was predicted correctly, 30% of cases with a shift to a more typical/active SIS, and 0% of cases with

a shift to a less typical/active SIS). As can be seen in Table 5, individuals with a decrease in their SRS score from Time 1 to Time 2 (decrease in ASD symptoms) were significantly more likely to change to a typical or more active SIS compared to staying stable in their SIS (Wald $\chi^2(1) = 4.96$, $P = 0.03$). Also, we found a (nonsignificant) trend that those decreasing in their SRS score were less likely to change to an autistic or less active SIS compared to a stable SIS (Wald $\chi^2(1) = 3.43$, $P = 0.06$). Counter to our expectations, children's receptive verbal IQ and their age were not unique predictors of change in SIS.

Discussion

In this article, we report the first longitudinal data on SISs as formulated by Wing and Gould [1979] in a group of children and adolescents with ASD and a normal intellectual ability. In line with our expectations, we found a majority (69%) of the children and adolescents showing developmental stability in their SIS. Some children (18%) shifted to a more typical or more active (but odd) SIS, while others (13%) shifted to a less typical or less active (but odd) SIS. Change in ASD symptoms predicted

change in SIS, but children's age and receptive verbal ability did not. Those with a decrease in ASD symptoms were also more likely to have changed to a typical or more active SIS.

Two-third of the present sample remained longitudinally stable in their SIS and this is in line with other research findings on children with ASD with mixed intellectual abilities after the age of 6 years [Beadle-Brown et al., 2002; Fountain et al., 2012]. We therefore find most support for the stability pathway. The tendency to approach or withdraw from social interactions may be a relatively stable trait across development (at least for the period covered by this study) and may thus share overlap with the construct of temperament. In typical development, children's temperamental make-up is known to have a large impact on their social development [Eisenberg, Wentzel, & Harris, 1998; Fox & Henderson, 1999; Sanson et al., 2004]. Children low in sociability (low tendency to seek out new situations and social interactions) tend to have poorer social skills compared to peers who are high in sociability [Fox, Henderson, Rubin, Calkins, & Schmidt, 2001; Sanson et al., 2009]. Also, children low in surgency (low tendency to actively and positively seek contact with others) display more internalizing and externalizing problems, and these associations have been found both in typically developing and autistic children [De Pauw, Mervielde, Van Leeuwen, & De Clerq, 2011]. SIS, or temperamental make-up, of children with ASD may also strongly impact their social development and the extent and quality of future social interactions. For instance, a child who actively approaches others may evoke more response and more correction from the social environment than a child who plays alone. An active-but-odd child may therefore get more social learning opportunities than a socially passive or aloof child. This might explain why the largest proportion of children who shifted to a typical SIS had an active-but-odd SIS at Time 1. Please note though that a majority of the children demonstrated an active-but-odd SIS at Time 1, thereby increasing (statistical) chances that children with a typical SIS at Time 2 had an active-but-odd SIS at Time 1.

A subgroup of children and adolescents (18%; $n = 10$) showed a shift to a more typical or more active (but odd) SIS at Time 2. Most of these children ($n = 9$) outgrew their autistic SIS and were characterized by a dominantly typical SIS at Time 2. Similarly, in the large-scale study of Fountain et al. [2012], most of the children with ASD and mixed intellectual abilities showed a developmental trend from an aloof or passive SIS toward a more typical SIS. However, this developmental shift was mainly noted in the first 6 years of life. The present study findings indicate a reduction of social atypicalities past early childhood. This is in line with other research suggesting overall improvement in social behavior across ASD

adolescence into young adulthood [Magiati et al., 2014; Picci & Scherf, 2015]. Meanwhile, and counter to our expectations, 13% ($n = 7$) of participants in the present study showed a decrease in typical or active (but odd) social interactions, with most of them showing a passive SIS at Time 2. It should be noted that a shift to a passive SIS does not necessarily mean a regression in social functioning, as a passive SIS may also be a consequence or even a flexible adaptation to changes in the social environment (e.g., bullying). Social interactions are by definition a dynamic, bidirectional process, meaning that a child's social behavior not only elicits certain responses from the environment, but the environment also shapes the child's social behavior. More research is needed to study individual as well as environmental influences on change and stability in SIS.

In the present study, we considered three individual factors as predictors of SIS development: change in ASD symptoms, age, and receptive verbal ability. As expected, a decrease in ASD symptoms (lower SRS score) predicted an increase in typical or active social interactions. Those adolescents who shifted to a typical or more active (but odd) SIS had the highest (more severe) SRS scores at Time 1 but the lowest SRS scores at Time 2. This corresponds with previous research indicating a bigger reduction in SRS score for children with higher baseline levels [Constantino et al., 2009]. Counter to our expectation, age did not affect the likelihood of changing or staying stable in SIS. However, in light of the global stability of SIS in this sample, it is not surprising that age did not impact SIS. Finally, children's receptive verbal ability did not predict stability or change in SIS. This implies a relative independency between children's level of receptive verbal ability and future changes in the quality of their social interactions. However, even though performance on the PPVT-III is highly correlated with a verbal IQ and global IQ measure in typically developing samples [Hodapp & Gerken, 1999], it remains possible that verbal expressive abilities or general cognitive abilities are associated with stability or change in SIS. Also, the nonsignificant impact of verbal receptive ability may in part be due to a restriction of range, because all participants had a minimum verbal receptive IQ of 72. Another individual factor that seems particularly worthwhile to examine in future studies is motivation. Because SIS is purely based on behavior, the intentions and emotions that possibly drive that behavior remain unclear. For instance, a child with a dominantly passive SIS could be socially anxious, but may also find social contact less rewarding. Likewise, a child with an active-but-odd SIS may be more intrinsically motivated to interact with others or may simply be less inhibited [Scheeren et al., 2012].

A strength of the present study is its longitudinal design. Despite ASD being a severe developmental disorder, longitudinal studies (especially across adolescence)

unfortunately remain an exception rather than a rule. Second, our research highlights qualitative differences in social behavior within the autism spectrum, thereby contributing to a varied image of ASD. A third strength of this study is the use of the WSQ, which is a validated and standardized measure specifically designed to measure SIS in children with ASD [Castelloe & Dawson, 1993; O'Brien, 1996]. Note though that recent validation studies of the WSQ are lacking. Another limitation of the present study is the rather small sample, which mostly contained boys with a normal intellectual ability including several cases who are on the mild end of the autism spectrum. Therefore, our findings cannot be generalized to girls with ASD, children with intellectual disabilities and to those with high ASD severity. Also, our study findings cannot be generalized to children with an aloof SIS, given the very few children with an aloof SIS in our sample. Large longitudinal studies are required covering a broad range of ASD symptomatology and intellectual ability to further examine the robustness of the study's findings. Furthermore, children's SIS was based on parental perspectives only. Although research shows that the WSQ is a valid and reliable measure of children's SIS [Castelloe & Dawson, 1993; O'Brien, 1996] and parents generally are reliable informants [Dirks & Boyle, 2010], we cannot rule out that a certain degree of bias has occurred. Moreover, during adolescence children commonly seek more autonomy and independence from their parents. By doing so, it may become increasingly difficult for parents to estimate their child's SIS. Finally, we cannot rule out that the found association between change in ASD severity and change in SIS may partly be influenced by informant overlap.

Summing up, this study offers preliminary evidence for both stability and change in SIS during adolescence in individuals with ASD and a normal intellectual ability. A better understanding of stability and change of SIS across development may ultimately help to improve ASD diagnostic assessments and ASD treatments. For instance, our findings of longitudinal stability of SIS suggest that SIS may be part of children's temperamental tendencies. Given that inherent behavioral tendencies might be difficult to change, SIS of children with ASD may be used as a predictor of treatment success rather than treatment outcome [Begeer et al., 2015; Beglinger & Smith, 2005]. Furthermore, our findings point to an increase in typical or active (but odd) social behavior in some individuals with ASD as well as a decrease in typical or active (but odd) social behavior in others. Adolescence may be a particularly challenging period for a subgroup of individuals with ASD [Picci & Scherf, 2015].

Empirical research has thus far validated the existence of different (active vs. passive) SISs in ASD [e.g., Burnette et al., 2011; Mundy et al., 2007; O'Brien, 1996; Roeyers, 1997], has demonstrated a profile of strengths and weaknesses of Wing and Gould's SISs [e.g., Scheeren et al., 2012;

Waterhouse et al., 1996], and has alluded to a different prognosis and responsiveness to treatment [Begeer et al., 2015; Beglinger & Smith, 2005]. Together with our evidence for overall developmental stability of SIS, these studies all support SISs as a potentially fruitful and clinically meaningful way to create ASD subgroups and offer a promising research venue for further disentangling and understanding individual differences within the autism spectrum.

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Conflict of Interest

The authors declare that they have no conflict of interest related to this work.

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