Published in final edited form as:

J Autism Dev Disord. 2014 February ; 44(2): 283–293. doi:10.1007/s10803-011-1278-x.

Early-Emerging Social Adaptive Skills in Toddlers with Autism Spectrum Disorders: An Item Analysis

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Abstract

Individuals with ASD have significant impairments in adaptive skills, particularly adaptive socialization skills. The present study examined the extent to which 20 items from the Vineland Adaptive Behavior Scales—Socialization Domain differentiated between ASD and developmentally delayed (DD) groups. Participants included 108 toddlers with ASD or DD under the age of 3 years. Nine of the 20 items significantly distinguished the groups. The ASD group demonstrated significantly weaker socialization skills, including deficits in basic social behaviors. The results support the notion that (a) socialization deficits in ASD impact foundational social skills typically emerging in the first year of life, (b) examination of specific social adaptive behaviors contribute to differential diagnosis, and (c) foundational social behaviors should be targeted for intervention.

Keywords

Autism; Adaptive behavior; Vineland Adaptive Behavior Scales; Item analysis; Early emerging social skills; Toddler social development

Autism Spectrum Disorders (ASD) are social disabilities, with delays and deficits in social development manifesting within the first year of life. In recent years, interest in early diagnosis and intervention for autism spectrum disorders (ASD) has increased, with research showing that infants later diagnosed with autism have limited eye contact, imitation, and social smiling, decreased social interest and affect, delayed language skills, and a certain pattern of temperament including passivity at age 6 months and decreased positive affect by 12 months (Chawarska et al. 2007; Zwaigenbaum et al. 2005; Rogers 2009). Additionally, they look at people and social stimuli for shorter durations than infants with developmental delay or typically developing infants, and they look longer at physical objects or physical cues in the environment than the two other groups, demonstrating severely attenuated social orientation (Swettenham et al. 1998; Klin et al. 2003, 2009).

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Although diagnosis of ASD in toddler-aged children has proven to be reliable and stable across time (Chawarska et al. 2007; Cox et al. 1999; Gillberg 1990; Kleinman et al. 2008; Lord 1995; Stone et al. 1999a), toddlers with non-autistic developmental delays can have similar presentations to toddlers with ASD, thus complicating differential diagnosis in this age group. For example, both toddlers with ASD and toddlers with non-autistic developmental delays (ages 1–3 years) have impaired or delayed language, social interaction, and pretend play skills (Charman et al. 1998; Ventola et al. 2006). Nonetheless, these skills are significantly more impoverished in ASD, particularly in the areas of joint attention, imitation, empathy, interest in other children, and range of facial expression (Charman et al. 1998; Ventola et al. 2007; Dawson et al. 2010). Young children with ASD also use fewer conventional gestures and are less likely to initiate or respond to verbal communication (Lord et al. 1993; Lord 1995; Loveland et al. 1988). Thus, although there is some overlap in symptom presentation, certain characteristics, particularly those related to early-emerging social skills, do distinguish children with ASD from children with non-autistic developmental delays.

Less well known are the varying profiles of adaptive functioning in young children with and without ASD. Adaptive behavior is defined as one's ability to translate cognitive potential into real-life skills (Sparrow and Cicchetti 1985), a crucial construct when considering the specific deficits in children with ASD. The most widely used and studied instrument for the measurement of adaptive behavior is the Vineland Adaptive Behavior Scales (Vineland; Sparrow et al. 1984, 2005), particularly in the area of autism research (e.g., Klin et al. 1992; Volkmar et al. 1987, 1993; Klin et al. 2007a, b; Kanne et al. 2010). The Vineland, and subsequent second edition—the Vineland II (Sparrow et al. 2005), is a standardized assessment that measures adaptive behavior in four general domains: Communication (receptive, expressive, and written), Daily Living (personal, domestic, and community), Socialization (interpersonal relationships, play and leisure time, and coping skills), and Motor (fine and gross).

Adaptive Behavior Profiles in Autism

Though the Vineland was created to assess normative rather than deviant adaptive development, it has been widely used to evaluate the level of functioning in children and adults with ASD. Adaptive behavior may be as, if not more, useful as a measure of outcome than assessments of cognitive abilities in some respects. For example, in children under 3 years of age, adaptive behavior scores are more stable than cognitive scores throughout childhood and are better predictors of language acquisition in nonverbal children than intelligence tests (Lord and Schopler 1989). Treatment studies have also demonstrated improvements in adaptive behavior that persist even beyond the termination of the treatment protocol (e.g., Williams et al. 2006; Dawson et al. 2010). A recent finding from a longitudinal study also found that adaptive skills, as opposed to cognitive variables, are more highly associated with positive outcome in adulthood (Farley et al. 2009).

Deficits in adaptive behavior are well documented in individuals with ASD, and adaptive skills are below what might be expected based on cognitive level, at least for individuals with ASD with average or above average intellectual abilities (Bolte et al. 2008; Freeman et

al. 1988, 1991; Klin et al. 2007a, b). The gap between cognitive and adaptive skills also seems to widen with age (Klin et al. 2007a, b; Szatmari et al. 2003; Klin et al. 2008a, b). Profiles of adaptive functioning in ASD have shown the highest scores in motor and daily living skills, weakest scores in socialization, and intermediate scores in communication skills (Carter et al. 1998). Similarly, studies have found that individuals with ASD have lower socialization and communication scores than age and mental-age matched individuals with intellectual disabilities or learning disabilities (Carpentieri and Morgan 1996, Loveland and Kelley 1991; Perry et al. 2009; VanMeter et al. 1997; Volkmar et al. 1987). This profile, however, may be mediated by cognitive ability: in lower functioning individuals with autism and cognitive delays, some studies have shown that adaptive behavior is at or above mental age (e.g., Fenton et al. 2003; Perry et al. 2009; Kanne et al. 2010).

Adaptive Behavior Profiles in Children with Autism Compared to Children with Developmental Delays

As adaptive behavior profiles in ASD may change with age, studies on early adaptive skills in toddlers with and without ASD can provide insight into the development of functional social skill acquisition, as well as into possible specific behaviors that differentiate social impairments associated with autism from those resulting from non-autistic forms of developmental delay. For example, Stone et al. (1999b) investigated adaptive functioning in toddlers under the age of 36 months (23–35 months). They examined 30 children with autism and 30 children with developmental delays or developmental delays with language impairment matched on chronological age (CA) and mental age (MA). Adaptive behavior profiles for children with autism were, in fact, distinct from profiles of children with developmental delays without autism. Children with ASD scored lower in the Socialization and Communication domains than the children with developmental delays, thus downward extending typical findings of the autism profile to the toddler age, even though socialization and communication skills were lower than MA for both groups. Daily living skills and motor skills were higher than the children's mental age for both the children with autism and the children with developmental delays. Additionally, compared to the developmentally delayed group, children with autism had more significant adaptive behavior-MA differences for communication, socialization, and motor skills. Given the complexity of these profiles, more research on adaptive profiles in toddlers with developmental delays with and without autism involving larger and more varied samples is needed.

Few studies have compared adaptive behavior in children with ASD and children with developmental delays at the level of item analysis, which is crucial for a comprehensive understanding of specific behaviors that might predict functional outcome. Klin et al. (1992) compared children with autism and non-autistic, developmentally disabled children aged 7 years and younger (mean age for ASD sample = 4.31, SD = 1.35; mean age for DD sample = 4.02, SD = 1.63) on adaptive behavior. All children in that study had significant levels of intellectual disabilities. Participants were matched on CA, MA, and IQ. The study used the first 20 items from the Socialization domain of the Vineland to examine the social deficits that were specific to autism (those with a less prototypical diagnosis of Pervasive Developmental Disorder, Not Otherwise Specified were excluded from the study). Children

with autism obtained lower scores on the Socialization domain than the non-autism group, often failing to demonstrate certain social skills that typically developing children acquire in the first few months of life. Of the 20 items, nine differentiated children with autism from children with global developmental delay, and of these items, six were skills performed before 8 months of age in the Vineland standardization sample. The items that had the highest discriminative value related to basic social interaction (e.g., “shows affection toward familiar people”), providing evidence that the Vineland can detect the unique social deficits in children with prototypical autism that are early-emerging and foundational to social development.

Current Study

Building on the work of Klin et al. (1992) and Stone et al. (1999b), the present study evaluates the extent to which the first 20 items from the Socialization domain of the Vineland discriminate between toddlers with ASD and toddlers with developmental delay without ASD. Our goal was to identify difference in specific social adaptive behaviors distinguishing well-matched samples of children with ASD and non-autistic developmental delays under the age of 3 years. We also aimed to explore the diagnostic value of early-emerging social adaptive behaviors for early identification of autism, and to single out specific, early-emerging social adaptive behaviors for special attention in early intervention.

Method

Participants

Participants included children under the age of 3 years with ASD and non-autistic DD evaluated at the Yale Child Study Center. They were recruited through the Yale STAART Center (Studies to Advance Autism Research and Treatment) and completed research protocols focused on the social neuroscience of autism. From a larger sample of children with ASD and DD, participants were included in the study with a view to create samples of well-matched children. Given the common discrepancies between language and nonverbal abilities in children with ASD and to maximize the similarities between the groups, they were matched both on the basis of nonverbal functioning (Nonverbal Match) and verbal functioning (Verbal Match). Data were analyzed separately in these two sets of comparisons. This approach resulted in slightly different groups of children in the two comparisons (see Tables 1 and 2 for chronological age, nonverbal and verbal age equivalents, and summary scores on standardized diagnostic testing for the nonverbally- and verbally-matched samples, respectively). There was a total of N = 108 children in the Nonverbal Match comparison (N = 68 with ASD: 28 PDD-NOS; 40 Autistic Disorder, 54 boys, 14 girls and N = 40 with DD: 21 Language Delay; 19 Global Developmental Delay, 29 boys and 11 girls), and a total of N = 106 in the Verbal Match comparison (N = 66 with ASD: 28 PDD-NOS; 38 Autistic Disorder and N = 40 with DD: 21 Language Delay; 19 Global Developmental Delay). In both comparisons, male:female ratios were comparable across the ASD and DD groups. Children included in the ASD group carried the diagnosis of Autistic Disorder and Pervasive Developmental Disorder, Not Otherwise Specified (PDD-NOS). Nonverbal matching was accomplished using the developmental age equivalents on the Visual Reception subtest of the *Mullen Scales of Early Learning* (Mullen 1995). Verbal matching was accomplished

using the mean developmental age equivalents obtained for the Receptive and Expressive Language domains of the Mullen. In both comparisons, the ASD and DD groups did not differ on measures of developmental functioning obtained with the Mullen, and were very closely matched on the measures of interest. As expected, in both comparisons, the ASD and DD groups did differ on a standardized measure of autistic symptomatology—the *Autism Diagnostic Observation Schedule* (ADOS; Lord et al. 2000), with children with ASD exhibiting significantly higher level of autistic symptomatology (indicated by higher scores on the ADOS).

Clinical Characterization Procedures

Children with ASD were included in the study to the extent that they met all three of the following conditions: (1) met criteria for either autism or an autism spectrum disorder (ASD) on the ADOS; (2) met criteria for autism on the *Autism Diagnostic Interview* (ADI Third Edition, Toddler Form; Lord et al. 1994); and (3) be assigned—independently, by two experienced clinicians upon review of all available data including standardized testing and direct observation or review of videotaped material of diagnostic examination—a diagnosis of autism or ASD. Children with non-autistic developmental delays (DD) were included in the study if the clinicians' diagnostic impressions ruled out the presence of an ASD. As noted, developmental data on nonverbal and verbal functioning were obtained with the Mullen (1995). Finally, the *Vineland Adaptive Behavior Scales, Expanded Edition* (Sparrow et al. 1984) was used to assess adaptive functioning (The *Vineland Adaptive Behavior Scales —2nd edition*, Vineland II; Sparrow et al. 2005, had not yet been published at the time of data collection). The Vineland is a semi-structured interview administered to the child's primary caregiver. It is nationally standardized and assesses personal and social sufficiency from birth to age 18 years old. It consists of four domains of adaptive functioning: Communication, Daily Living Skills, Socialization, and Motor Skills. Both the administration and scoring of Vineland items are manualized. In this study, the procedure was carried out by trained interviewers with established reliability.

Results

We began analysis by examining Vineland adaptive skill profiles in children with ASD and DD on the four domains of adaptive behaviors and on their respective subdomains, eleven in all. Summary scores for the ASD and DD groups in both sets of comparisons—nonverbally- and verbally-matched—were very similar. Therefore, only scores for the nonverbally-matched groups are given here, on Table 3. The ASD group scored significantly lower on the Socialization Domain of the Vineland ($p < 0.001$) but scores on the other three domains were comparable. Comparisons across subdomains revealed significantly lower scores for the ASD group relative to the DD group in the Interpersonal Relationships ($p < 0.01$) and Play and Leisure Time ($p < 0.001$) subscales of the Socialization Domain. Interestingly, although a comparison on the Communication Domain overall was not significant, the ASD and DD groups differed significantly on both the Receptive Language ($p < 0.001$) and the Written (pre-writing skills) ($p < 0.001$), with the ASD group being significantly lower on receptive language skills and significantly higher on knowledge of letters and numbers. While both of these findings are expected from the adaptive behavior profiles of children with ASD

reported in the literature (Klin et al. 1992; Stone et al. 1999b), no other studies had documented this profile in children as young as 2 years of age. The written subdomain in the toddlers with ASD is the only area of adaptive functioning in which skills exhibited are commensurate with chronological age. This 'preserved' area of skills appear to be related to the typical fascination of young children with ASD with letters and numbers and common strength in rote learning (Klin et al. 2007a, b; Saulnier and Klin 2007).

We then proceeded to analyze scores for the first 20 items of the Vineland Socialization domain. Table 4 lists these items and the median age of acquisition of the given skill according to the Vineland standardization data (Sparrow et al. 1984).

These items were analyzed in order to determine the extent to which they differentiate the ASD from the DD groups. The Vineland items are scored as "2", "1", "0", "N", or "DK". A score of "2" means the activity is usually or habitually performed independently (i.e., without supports or prompts), "1" means it is performed sometimes, and "0" refers to an activity that is never performed. When there is no opportunity to observe an activity, "N" is used, and when the respondent does not know if the individual can perform an activity, "DK" is used. In this sample, only the scores of 0, 1, and 2 occurred. As for our earlier study (Klin et al. 1992), the three possible scores were condensed into two discrete categories: fail, meaning not usually performed (a score of 0 or 1) and pass, meaning usually performed (a score of 2). For each individual item, a 2 × 2 contingency table was created: the rows correspond to the number of ASD and DD children performing or not the activity described in the item; the columns indicated the two collapsed dichotomized scoring possibilities (pass or fail). We cast this analysis developmentally by including, for each item, only those children whose developmental age was at or above the median age of acquisition for the given item (and, therefore, were expected to have acquired that particular skill). For each contingency table a Fisher's exact test was performed in order to determine the exact probably of observing the particular set of frequencies in the ASD and DD groups (Klin et al. 1992).

Tables 5 and 6, for the nonverbally- and verbally-matched groups, respectively, list the results of analyses performed for the 20 contingency tables corresponding to the first 20 items of the Vineland Socialization domain. The column designated by $N+/N_{total}$ corresponds to the number of children exhibiting the behavior described in each item (numerator) over the total number of children included in each contingency table (denominator) for each sample. As noted, only children whose developmental age was equal or higher than the median age obtained from the standardization sample for each item (indicated in Table 5 as 'mental age (MA) cut-off') were included.

For the nonverbally-matched groups (Table 5), nine items differentiated ASD children from non-ASD children. Four items differentiated at the significance level of $p < 0.05$ (items 8, 9, 12, and 19), three items differentiated ASD children from non-ASD children at $p < 0.01$ (items 4, 6, and 14), and two items distinguished between the two groups at $p < 0.001$ (items 2 and 13). Similarly, for verbally matched subjects, nine items differentiated between ASD and non-ASD groups (items 12, 14, 18, and 19 differentiated at the level of $p < 0.05$; item 6 differentiated at $p < 0.01$; and items 2, 4, 8, and 13 distinguished between the groups at $p <$

0.001). All items found to significantly differentiate the ASD from the DD groups are normatively acquired at or before the age of 8 months, thus corresponding to very early-emerging social adaptive skills. Later-emerging items lacked discriminative power primarily because deficits were seen in both the ASD and DD groups. Table 7 summarizes the power of each of the 20 Vineland Socialization items to discriminate the ASD from the DD groups as obtained for the nonverbally- and verbally-matched group comparisons.

Discussion

Recent literature has focused on the early diagnosis of ASD and on identifying certain early symptoms in young toddlers. While studies have demonstrated the reliability of diagnosing ASD at an early age, few studies have examined the varying adaptive behavior profiles between developmentally delayed toddlers with and without ASD, despite the increasing studies highlighting the association between adaptive skills and positive outcome (e.g., Farley et al. 2009; Kanne et al. 2010; Williams et al. 2006; Dawson et al. 2010). Moreover, the specific social deficits or delays detectable at such a young age with instruments like the Vineland remain unclear. The present study compared Vineland profiles between toddlers with and without ASD of the same mental age, and evaluated the extent to which 20 items from the Socialization domain differentiated between the groups. These findings have important implications for the early recognition and diagnosis of ASD, as well as for considerations of key areas for early intervention.

Consistent with Stone et al.'s study (1999b), the toddlers with ASD scored lower overall on the Socialization domain than the non-ASD toddlers, highlighting that these delays are above and beyond what would be expected based on developmental delays alone. Also consistent with Klin et al.'s findings on older children (1992), nine items differentiated between the ASD and non-ASD developmentally delayed or language delayed toddlers matched on both verbal and nonverbal mental age. These items, extracted from the Interpersonal Relationships and from the Play and Leisure Time subdomains, were foundational and earlyemerging social skills, which are expected to be acquired and exhibited consistently on a day-to-day basis in typical development within the first 8 months of life or so. Given that the study conducted by Klin et al. focused only on children with classic autism who were also older and all had significant intellectual disabilities, the current study expanded the work considerably by focusing on toddlers with a much more varied diagnostic and developmental manifestations of ASD. The present study, therefore, indicates that these differences in social adaptive profiles are present in younger children and across the autism spectrum.

Of the nine items that distinguished between the ASD and non-ASD toddlers, 8 of 9 in the nonverbally-matched comparison, and 7 of 9 in the verbally-matched comparison, were among the earliest-emerging social adaptive behaviors assessed by the Vineland according to standardization data. For both the verbally and nonverbally matched groups, items 2, 4, 6, and 8 were absent in significantly more of the ASD toddlers than the non-ASD toddlers. These behaviors (e.g., responding to the voice of another person; showing interest in new people; anticipating being picked up by a caregiver; showing interest in other children) typically appear in the first 4 months of life. Thus, as emphasized in our previous study

(Klin et al. 1992), these foundational social deficits are evident extremely early on in development and, if adequately identified within the first year of life, could have significant implications not only for intervention priorities and, possibly, a more positive outcome, but also for diagnostic identification.

Analyzing the individual items of the Vineland also helps us appreciate the real-life manifestations of symptoms of autism that have been primarily described in the context of clinical observational or experimental studies. For example, children with ASD typically do not respond to the voice of a caregiver or another person (item 2), a behavior found to be among the best early predictors of a diagnosis of autism (Klin 1991, 1992; Lord 1995; Zwaigenbaum et al. 2005). Item 4 involves demonstrating interest in novel objects or new people. Though toddlers with autism may demonstrate interest in novel objects, they often lack social interest in other people. This distinction is reiterated in later items: many toddlers failed item 6 (shows anticipation of being picked up by caregiver) and item 8 (shows interest in children or peers other than siblings), which collectively, suggest that the most visible symptoms in autism involve spontaneous interest in, and self-driven initiation of involvement with, the social world around them (Klin et al. 2003). Even interest in caregivers or familiar people was more limited in toddlers with ASD, as item 6 and 9 (reaches for familiar person) demonstrate. Imitation and joint attention skill deficits were also observed, as indicated in results for item 14 (imitates simple adult movements, such as clapping hands or waving good-bye, in response to a model).

It may not be surprising that certain Vineland items did not distinguish between the ASD and the non-ASD groups. Item 5 relates to the expression of emotions such as pleasure, sadness, fear, or distress and many of the ASD toddlers did pass this item. However, as noted in our previous work (Klin et al. 1992), this item does not specify if the emotions occur in a social context and in full contingency with, and attunement to, the affective approaches and responses of others. Also, toddlers with ASD may express emotions such as distress in a maladaptive or abnormal manner; for example, Zwaigenbaum et al. (2005) found decreased positive affect by 12 months of age in toddlers with ASD, although again, this behavior may originate from sources other than a social adaptive or social communicative reaction to another person. Similarly, item 10 (plays with toy or other object alone or with others) did not distinguish between the two groups, as children with ASD often play alone with objects, but in a stereotyped, ritualized fashion.

The potential benefits of using the Vineland to guide our approaches to early detection of autism in infancy and toddlerhood are best exemplified within a developmental psychopathology framework which we have advocated for elsewhere (Jones and Klin 2009; Klin et al. 2008a, b). The “gold-standard” diagnostic measures for autism and related disorders, such as the ADOS and ADI-R, focus on symptomatology—or atypical aspects of social and other forms of behavioral development. Yet, research on early detection has shown that atypical “autistic” behaviors may not be evident in the first year of life, as autism symptomatology tends to have a gradual developmental onset, with atypical and stereotypical behaviors emerging overtime (e.g., Rogers 2009). Thus, detecting infants and young toddlers at risk may required quantified measurements of normative behaviors, deviations thereof might signify risk for autism, which is then instantiated in autistic

behaviors later on (Jones and Klin 2009). Therefore, such an approach involves more than sampling observations of deviant behaviors; it requires close evaluation of absence of or delays in typically developing milestones. This is of greatest importance in pre-verbal and pre-intentional children (Chawarska et al. 2009; Zwaigenbaum et al. 2009). Our findings in this study point to foundational social adaptive skills that appear closely associated with highly conserved skills which are online in human infants from the first days and weeks of life, such as preferential orientation to the eyes of others (Jones et al. 2008), and, more generally, to the movement of living beings and social, not physical, contingencies in the environment (Klin et al. 2009).

From the standpoint of priorities for intervention, Vineland research in autism has revealed that social *disability* or level of autistic symptomatology (as measured on the ADOS) and social *ability* or level of social adaptive functioning (as measured on the Vineland) have fairly low levels of correlation (Klin et al. 2007a, b; Saulnier and Klin 2007; Kanne et al. 2010). Therefore, focusing solely on diminishing symptoms may not result in acquisition of real-life skills, so explicitly teaching adaptive behaviors is also a priority for educational programming. In the case of very young children with ASD, the early social adaptive behaviors identified in this study as particularly discriminating of autistic social disability—relative to other forms of developmental disability, may represent pivotal skills to prioritize in early intervention intended to foster social cognitive and communicative skill development.

In this context, early-emerging social adaptive behaviors may be powerful discriminators of autism relative to other forms of developmental delays because they are embedded in naturalistic (not structured), spontaneous (not prompted), daily social action (not contrived therapeutic settings), and because they require self-driven initiation of engagement with, rather than only reactions to, other people (Klin et al. 2003). The Vineland items studied here, therefore, show a direct link to behaviors such as joint attention skills, imitation, reciprocity, integrated gaze and gestures, social initiation and others, which have been repeatedly identified as amongst the best predictors of positive outcome and, thus, preferred targets for early intervention (Dawson et al. 2010; Rogers 2009). In their research on the Early Start Denver Model, Dawson et al. (2010) demonstrated that toddlers not only made significant gains in adaptive functioning over 2 years of treatment, but those toddlers without the intensive treatment exhibited significant drops in Vineland standard scores within the same time frame. The Vineland may, therefore, help identify and prioritize specific deficits for intervention that have ecological validity and treatment value.

The samples included in this study were extracted from consecutive clinical referrals. Children were thoroughly screened for the presence of significant clinical concerns prior to completion of assessment. Thus children completing our protocols were very likely to exhibit high levels of autistic symptomatology. Therefore, we should exercise caution in any attempt to generalize from current results to the population of individuals with ASD who are ascertained differently—for example, from population-based study designs, when children may show much lower levels of symptoms and a range of confounds impacting on socialization; or from prospective follow-up studies of ‘baby siblings’—infants at risk for autism given their status of being a sibling of a child with ASD—whose profiles may be

more complex and less severe, including manifestations of autistic vulnerabilities that vary over time and in severity. And yet it is in these particular contexts that the results of this study could have maximal benefit since the format of assessment lends itself to large population screens and to early monitoring of social development over time, respectively. Additionally, this data was collected before the revised version of the instrument was published. The Vineland-II has slight changes in the earliest behaviors of the Socialization domain, so an interesting future study would be to replicate these findings utilizing the Vineland-II.

Acknowledgments

This work was supported by a grant from the National Institutes of Mental Health (U54-MH66494). We wish to thank the families of the children included in this study for their time and participation. We also wish to thank our colleagues Karyn Bailey, Diane Goudreau, and Rhea Paul for their contributions to the clinical characterization of the samples and for ongoing clinical and conceptual discussions. This study is dedicated to our teacher, colleague and friend, Dr. Sara Sparrow, whose gracefulness, love and generosity will be sorely missed. Together with her beloved husband, Dr. Dom Cicchetti, the Vineland was their labor of love.

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Table 1

Sample characteristics and *t* tests: groups matched on nonverbal developmental age equivalents

	ASD			Non-ASD			*t*	*df*	*p* <
	N	**Mean**	**SD**	**N**	**Mean**	**SD**			
Age (years-months)	68	2.23	0.55	40	2.03	0.55	1.83	106	NS
NV AE *	68	20.53	6.04	40	20.58	6.24	0.03	106	NS
NV T **	68	36.09	13.22	40	40.98	15.07	1.76	106	NS
ADOS Comm ***	68	5.00	1.41	39	2.38	1.84	8.16	105	0.000
ADOS social	68	10.65	2.97	39	5.18	3.56	8.50	105	0.000
ADOS combined	68	15.63	3.95	39	7.56	5.00	9.20	105	0.000

* Nonverbal developmental age equivalents corresponding to visual reception domain of the Mullen in months

** Nonverbal developmental T scores of the visual reception domain of the Mullen (Mean = 50, SD = 10)

*** ADOS scores Module 1: the higher the score the more atypical the child's presentation in the given domain (Communication, Social, and Combined)

Table 2

Sample characteristics and *t* tests: groups matched on verbal developmental age

	ASD			Non-ASD			*t*	*df*	*p* <
	N	**Mean**	**SD**	**N**	**Mean**	**SD**			
Age (years-months)	66	2.23	0.55	40	2.03	0.56	1.76	104	NS
Rec Lan T*	66	28.39	14.42	40	32.15	13.86	1.31	104	NS
Exp Lan T*	66	28.48	11.27	40	29.15	9.06	0.316	104	NS
Mean Lan AE**	66	14.36	8.47	40	14.75	7.06	0.242	104	NS
ADOS Comm***	66	4.94	1.41	39	2.36	1.87	7.99	103	0.000
ADOS social	66	10.62	3.01	39	5.03	3.57	8.57	103	0.000
ADOS combined	66	15.56	3.98	39	7.38	5.08	9.15	103	0.000

*Receptive and Expressive Language T scores on the Mullen (Mean = 50, SD = 10)

**Mean Language Developmental Age Equivalent corresponding to the averaging of the age equivalents of the receptive and expressive domains of the Mullen (in months)

***ADOS scores Module 1: the higher the score the more atypical the child's presentation in the given domain (Communication, Social, and Both combined)

Table 3

Adaptive functioning as measured with the Vineland for groups matched on nonverbal developmental age equivalents and *t* tests

	ASD			Non-ASD			*t*	*df*	*p* <*
	N	**Mean**	**SD**	**N**	**Mean**	**SD**			
Communication	68	1.14	0.55	40	1.29	0.37	1.50	106	NS
Receptive	**68**	**1.19**	**0.63**	**40**	**1.64**	**0.63**	**3.54**	**106**	**0.001**
Expressive	68	1.03	0.57	40	1.15	0.44	1.13	106	NS
Written	**68**	**2.14**	**1.27**	**40**	**1.39**	**0.35**	**−3.64**	**106**	**0.000**
Daily living skills	68	0.34	0.28	40	1.50	0.44	2.27	106	NS
Personal	68	1.30	0.35	40	1.46	0.50	1.96	106	NS
Domestic	68	1.52	0.29	40	1.67	0.50	1.99	106	NS
Community	68	0.91	0.47	40	1.15	0.57	2.32	106	NS
Socialization	**68**	**0.96**	**0.38**	**40**	**1.20**	**0.34**	**3.32**	**106**	**0.001**
Interpersonal	**68**	**0.78**	**0.50**	**40**	**1.03**	**0.42**	**2.54**	**106**	**0.01**
Play	**68**	**1.01**	**0.39**	**40**	**1.27**	**0.35**	**3.36**	**106**	**0.001**
Coping	68	1.08	0.35	40	1.18	0.41	1.33	106	NS
Motor skills	68	1.67	0.48	40	1.57	0.50	−1.06	106	NS
Gross motor	68	1.75	0.52	40	1.64	0.57	−0.96	106	NS
Fine motor	68	1.57	0.54	40	1.45	0.42	−1.19	106	NS
Composite AE	68	1.29	0.37	40	1.39	0.38	1.40	106	NS

*Domains or subdomains found to significantly differentiate the two groups at the $p < 0.01$ level are in bold

Table 4

The first 20 items of the Vineland socialization domain and median age by which skill is acquired according to the standardization data (Sparrow et al. 1984)

Item #	Vineland socialization domain item	Age of acquisition in years-months
1	Looks at face of caregiver	<0–2
2	Responds to voice of caregiver or another person	<0–2
3	Distinguishes caregiver from others	<0–2
4	Shows interest in novel objects or new people	<0–2
5	Expresses two or more recognizable emotions such as pleasure, sadness, fear or distress	<0–2
6	Shows anticipation of being picked up by caregiver	<0–2
7	Shows affection toward familiar people	0–4
8	Shows interest in children or peers other than siblings	0–4
9	Reaches for familiar person	0–5
10	Plays with toy or other object alone or with others	0–5
11	Plays very simple interaction games with others	0–6
12	Uses common household objects for play	0–7
13	Shows interest in activities of others	0–8
14	Imitates simple adult movements, such as clapping hands or waving good bye, in response to a model	0–7
15	Laughs or smiles appropriately in response to positive statements	0–11
16	Addresses at least two familiar people by name	0–11
17	Shows desire to please caregiver	1–3
18	Participates in at least one game or activity with others	1–7
19	Imitates a relatively complex task several hours after it was performed by another	1–6
20	Imitates adult phrases heard on previous occasions	1–11

Table 5

Fisher's exact tests for the first 20 Vineland socialization items—Toddlers with ASD and Non-ASD developmentally delayed Toddlers matched on nonverbal developmental age

Items	N+/N_{total} ASD	N+/N_{total} Non-ASD	MA "cut-off" Years-months	Fisher's Exact *p* =	ASD ~ Non-ASD comparison
01 (IR)◆	50/68	31/40	<0–2	0.413 NS	
02 (IR)	**44/68**	**37/40**	**<0–2**	**0.000** ***	**ASD < Non-ASD**
03 (IR)	62/68	39/40	<0–2	0.191 NS	
04 (PLT)◆	**42/68**	**35/40**	**<0–2**	**0.003** **	**ASD < Non-ASD**
05 (IR)	66/68	39/40	<0–2	0.691 NS	
06 (IR)	**46/68**	**37/40**	**<0–2**	**0.002** **	**ASD < Non-ASD**
07 (IR)	51/68	31/40	0–4	0.480 NS	
08 (PLT)	**22/68**	**22/39**	**0–4**	**0.013** *	**ASD < Non-ASD**
09 (IR)	**51/68**	**33/40**	**0–5**	**0.018** *	**ASD < Non-ASD**
10 (PLT)	63/68	37/40	0–5	0.666 NS	
11 (PLT)	55/68	32/40	0–6	0.646 NS	
12 (PLT)	**37/68**	**30/40**	**0–7**	**0.026** *	**ASD < Non-ASD**
13 (PLT)	**19/68**	**27/40**	**0–8**	**0.000** ***	**ASD < Non-ASD**
14 (IR)	**44/68**	**34/40**	**0–7**	**0.003** **	**ASD < Non-ASD**
15 (IR)	24/65	19/37	0–11	0.113 NS	
16 (IR)	20/65	16/37	0–11	0.930 NS	
17 (IR)	5/56	7/31	1–3	0.076 NS	
18 (PLT)	10/41	10/23	1–7	0.065 NS	
19 (IR)	**11/46**	**12/26**	**1–6**	**0.047** *	**ASD < Non-ASD**
20 (IR)	6/31	3/20	1–11	0.498 NS	

All items found to significantly differentiate the two groups are in bold

◆Socialization Subdomains: *IR* Interpersonal relationships, *PLT* Play & leisure time

NS non-significant

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

Table 6

Fisher's exact tests for the first 20 Vineland socialization items—toddlers with ASD and Non-ASD developmentally delayed toddlers matched on verbal developmental age

Items	N+/N_{total} ASD	N+/N_{total} Non-ASD	MA "cut-off" Years-months	Fisher's Exact *p* =	ASD ~ Non-ASD comparison
01 (IR) *	48/66	32/40	<0–2	0.273 NS	
02 (IR)	**42/66**	**37/40**	**<0–2**	**0.000** ***	**ASD < Non-ASD**
03 (IR)	61/66	39/40	<0–2	0.186 NS	
04(PLT) *	**42/66**	**35/40**	**<0–2**	**0.001** ***	**ASD < Non-ASD**
05 (IR)	64/66	39/40	<0–2	0.681 NS	
06 (IR)	**46/66**	**37/40**	**<0–2**	**0.004** **	**ASD < Non-ASD**
07 (IR)	50/66	31/40	0–4	0.516 NS	
08 (PLT)	**22/66**	**23/39**	**0–4**	**0.000** ***	**ASD < Non-ASD**
09 (IR)	50/66	33/40	0–5	0.286 NS	
10 (PLT)	61/66	37/40	0–5	0.650 NS	
11 (PLT)	54/66	32/40	0–6	0.690 NS	
12 (PLT)	**37/66**	**30/40**	**0–7**	**0.038** *	**ASD < Non-ASD**
13 (PLT)	**18/66**	**28/40**	**0–8**	**0.000** ***	**ASD < Non-ASD**
14 (IR)	**44/66**	**34/40**	**0–7**	**0.030** *	**ASD < Non-ASD**
15 (IR)	23/64	19/37	0–11	0.096 NS	
16 (IR)	20/64	16/38	0–11	0.906 NS	
17 (IR)	5/56	7/31	1–3	0.076 NS	
18 (PLT)	**11/47**	**12/26**	**1–7**	**0.047** *	**ASD < Non-ASD**
19 (IR)	**11/47**	**12/26**	**1–6**	**0.047** *	**ASD < Non-ASD**
20 (IR)	6/27	2/15	1–11	0.395 NS	

All items found to significantly differentiate the two groups are in bold

◆Socialization Subdomains: *IR* Interpersonal relationships, *PLT* Play & leisure time

NS non-significant

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

Table 7

Comparison of item analyses in the non-verbally matched (NV) versus the verbally matched (V) groups

Items	Nonverbally-matched	Verbally-matched	NV-matched ASD ~ Non-ASD comparison	V-matched ASD ~ Non-ASD comparison
1	0.413 NS	0.273 NS		
2	**0.000** ***	**0.000** ***	**ASD < Non-ASD**	**ASD < Non-ASD**
3	0.191 NS	0.186 NS		
4	**0.003** **	**0.001** ***	**ASD < Non-ASD**	**ASD < Non-ASD**
5	0.691 NS	0.681 NS		
6	**0.002** **	**0.004** **	**ASD < Non-ASD**	**ASD < Non-ASD**
7	0.480 NS	0.516 NS		
8	0.013 *	0.000 ***	ASD < Non-ASD	ASD < Non-ASD
9	0.018 *	0.286	ASD < Non-ASD	
10	0.666 NS	0.650 NS		
11	0.646 NS	0.690 NS		
12	0.026 *	0.038 *	ASD < Non-ASD	ASD < Non-ASD
13	**0.000** ***	**0.000** ***	**ASD < Non-ASD**	**ASD < Non-ASD**
14	0.003 **	0.030 *	ASD < Non-ASD	ASD < Non-ASD
15	0.113 NS	0.096 NS		
16	0.930 NS	0.906 NS		
17	0.076 NS	0.076 NS		
18	0.065 NS	0.047 *		ASD < Non-ASD
19	0.047 *	0.047 *	ASD < Non-ASD	ASD < Non-ASD
20	0.498 NS	0.395 NS		

Only items found to significantly differentiate the ASD from the DD group at the $p \leq 0.01$ level in both nonverbally- and verbally-matched comparisons are in bold. Notable trends at $p < 0.05$ are listed but not bolded

NS non-significant

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$