

Adaptive Functioning in Autism Spectrum Disorder During the Transition to Adulthood

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Abstract There is a dearth of research regarding adaptive functioning during the transition to adulthood in autism spectrum disorder (ASD). Profiles on the Vineland Adaptive Behavior Scales, Second Edition were examined by age and intellectual ability in 75 participants with ASD (16–58 years). Results extend previous reports of a cognitive advantage over adaptive functioning in children by demonstrating a similar pattern in an older sample. Daily living skills were a relative strength compared to communication and socialization in adults, but not adolescents. In general, highest subdomain scores were observed in writing skills and lowest scores were observed in interpersonal skills. Regardless of cognitive ability, all standard scores were well below average, indicating a need for lifelong intervention that targets adaptive functioning.

Keywords Autism spectrum disorder · Adaptive functioning · Cognitive functioning · Vineland-II · Adolescence · Adulthood

Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by impairment in social communication and restricted or repetitive behaviors and interests (American Psychiatric Association 2013). A large volume of literature has characterized ASD during childhood. In contrast, research examining older adolescents and adults

remains limited (Edwards et al. 2012). Little is known about the adaptive functioning profiles of this population, but recent reports suggest that strong adaptive functioning skills are associated with optimal outcomes for adults with ASD (Farley et al. 2009). The current study aimed to examine profiles of adaptive functioning by age and cognitive ability among a well-characterized sample of older adolescents and adults with ASD.

Adaptive functioning is a multifaceted construct that includes skills necessary for age-appropriate independent living. The Vineland Adaptive Behavior Scales (VABS; Sparrow et al. 2005) is perhaps the most commonly used measure of adaptive functioning in clinical and research contexts; it quantifies abilities in the domains of communication, daily living skills (DLS), socialization, and motor skills. Most previous microanalyses of the VABS in ASD samples have been limited to children and adolescents, and they reveal mixed findings. Many report an “autism profile”, with highest scores in DLS and lowest scores in socialization (e.g., Carter et al. 1998). However, this profile is not always replicated, and appears to differ depending on whether standard scores or age equivalent scores are examined (Fenton et al. 2003; Perry et al. 2009). For example, Perry et al. (2009) observed the purported autism profile when examining age equivalent scores, but not when examining standard scores in the same sample. Even when examining age equivalent scores, the effect was observed to be modest when controlling for participant age. Despite reports of a relative strength in DLS, individuals with ASD demonstrate impairment in this domain relative to typically developing peers. The DLS domain has been identified as important for optimal outcomes and is an area in need of evidence-based intervention (Duncan and Bishop 2013; Farley et al. 2009).

A negative correlation between age and adaptive functioning has been documented in ASD (Kanne et al. 2011; Klin

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et al. 2007). Cross-sectional studies suggest a cognitive functioning advantage over adaptive functioning that widens with age, and this pattern seems to be unique to ASD (Kanne et al. 2011; Perry et al. 2009). Rather than a decline, the development of adaptive skills appears to stagnate in children with only mild or no cognitive impairment in comparison to typically developing peers. This is reflected by VABS standard scores that appear to decrease with age, which suggests that development of adaptive functioning is not keeping pace with cognitive development (Kanne et al. 2011). However, there is a lack of empirical research that examines profiles of cognitive functioning and specific adaptive skills among older adolescents and adults with ASD.

One recent examination of VABS profiles compared subgroups of adults with ASD and intellectual disability (ID; i.e., deficits in intellectual and adaptive functioning as defined by the DSM-IV-TR) to individuals with ID and no other diagnosis and individuals with ID and psychopathology (not including ASD). The ASD and ID group was composed of two subgroups: (1) ASD and ID only, and (2) ASD, ID, and an Axis I diagnosis. Findings indicated differences among ASD subgroups in each of the VABS domains, which illustrates the diversity of adaptive functioning profiles among adults with varying phenotypic expressions of ASD. Additionally, results revealed that individuals with ASD and ID, and especially those with other comorbid psychopathology, had significantly poorer adaptive functioning across domains compared to individuals with ID and no ASD or other psychopathology (Matson et al. 2009). This study did not examine VABS profiles (i.e., relative performance across domains and subdomains) within ASD subgroups. Also, raw scores were used rather than standard scores, which limits comparison of descriptive statistics within this sample and to other literature.

Another recent study reported on relative VABS domain scores among adults with ASD and no ID (i.e., IQs ≥ 70 ; Farley et al. 2009). Adults in this study had highest scores in the DLS domain and no difference was observed between the communication and socialization domains. Average standard scores for the Adaptive Behavior Composite, communication, and socialization domains were all below 70, despite an average composite IQ of 89. Although the average DLS score was above 70, it was still 13 points lower than average IQ. A nuanced examination of adaptive functioning profiles by age and cognitive ability was beyond the scope of the study. However, findings provide provisional evidence for both the “autism profile” of adaptive functioning in cognitively able adults with ASD, as well as a cognitive functioning advantage over adaptive functioning (Farley et al. 2009).

In light of the growing population of children with ASD who will eventually become adults, increased understanding of adaptive functioning during the transition to

adulthood is of importance; especially if adaptive functioning truly stagnates with age. Although the theory of emerging adulthood (Arnett 2007) was conceptualized in reference to typically developing populations, this time period may also be qualitatively distinct in individuals with ASD. Emerging adulthood occurs roughly between the ages of 18 and 25 years and is characterized by heterogeneous developmental pathways. Essentially, the concept of emerging adulthood suggests that this time period is qualitatively different from both adolescence and adulthood (Arnett 2007). The transition out of secondary educational settings marks a loss of services for individuals with ASD (Taylor and Seltzer 2011). For many, the young adult years may be characterized by adjustment to new settings and roles. Difficulty adjusting to change and transitions is a hallmark impairment of ASD. Thus, it is reasonable to expect differences in profiles of adaptive functioning between young adults and adults.

The current study examined relative performance on VABS domains and subdomains by age and cognitive ability during the transition to adulthood. Whereas previous research on adaptive functioning in adults with ASD has focused on individuals with ID (Matson et al. 2009) or individuals with average cognitive abilities (Farley et al. 2009), this study included individuals with and without ID, and is thus more representative of recent reports that this population is characterized by a wide range of cognitive abilities (e.g., Chakrabarti and Fombonne 2005). Given previous mixed results in younger samples, no prediction was made regarding relative scores in the communication, DLS, and socialization domains. Consistent with previous literature, a negative relationship between age and adaptive functioning across VABS domains was predicted. A cognitive functioning advantage over adaptive functioning was hypothesized to be larger among older participants than younger participants. Last, exploratory analyses examined relative functioning on VABS subdomains by age and cognitive ability groups.

Methods

Participants

Participants were 75 adolescents and adults (age $M = 24.22$, $SD = 8.98$, range 16.08–58.17; 61 male) with a clinical DSM-IV diagnosis of Autism Disorder, Asperger’s Syndrome, or Pervasive Developmental Disorder—Not Otherwise Specified. All participants met criteria for Autism or Autism Spectrum on the Autism Diagnostic Observation Schedule (ADOS; Lord et al. 1999, 2012). The Autism Diagnostic Interview—Revised (ADI-R; Rutter et al. 2003) was completed for 42 participants; all met ADI-R criteria for Autism or Borderline Autism. Borderline Autism on the ADI-

R is characterized by meeting onset criteria, having scores above cutoff criteria on two of three behavioral domains, and being below cutoff criteria in third domain by no more than one point (Buxbaum et al. 2001). Participants were split into three age groups for the current analyses: adolescents ($n = 28$; 16–18 years), young adults ($n = 25$; 19–24 years), and adults ($n = 22$; 25+ years). In the current study, 18-year-olds were included in the adolescent age group due to the likelihood of 18-year-olds still being enrolled in high school. Twenty-four years of age was chosen as the maximum age for the young adult group to maintain consistency with census style. Additionally, demarcating age groups in this way resulted in relatively even group sizes, which is desirable for parametric statistical analyses. Ultimately, though, the young adult group was theoretically motivated by the concept of emerging adulthood. Demographic and diagnostic information for the full sample and age subgroups is reported in Table 1.

Procedure

Retrospective chart review was conducted using de-identified data from four standard assessments administered for clinical purposes and/or IRB-approved research projects at an autism center in the Southwestern United States. Thus, this research was exempt from the U.S. Department of Health and Human Services Human Subjects Research policy 45 CFR 46 and satisfied criteria for the American Psychological Association's ethical standard 8.05: Dispensing with Informed Consent for Research. All participants in the autism center's database who met the following criteria were included in the current analyses: (1) a clinical diagnosis of ASD; (2) 16 years of age and older, and (3) complete data on the ADOS (Lord et al. 1999, 2012), the Kaufman Brief Intelligence Test, Second Edition (KBIT-2; Kaufman and Kaufman 2004), and VABS, Second Edition (VABS-II; Sparrow et al. 2005). The ADI-R (Rutter et al. 2003) was not completed for all participants; results from this assessment are reported for descriptive purposes. The ADOS and ADI-R were administered by research reliable raters, who also administered the KBIT-2 and VABS-II.

The ADOS (Lord et al. 1999, 2012) and ADI-R (Rutter et al. 2003) are the gold standard assessments used to diagnose ASD. Both have well-established, acceptable psychometric properties that are discussed in detail in their respective manuals. The ADOS is a semi-structured, standardized measure that uses direct observation during social presses to quantify behaviors associated with ASD. The ADI-R is a semi-structured, standardized interview with an informant familiar with the participant's developmental history. The interview probes for information regarding current and previous communication, social interactions, and restricted/repetitive behaviors and interests. Both the

ADOS and ADI-R have defined cutoff scores which are widely used and well-documented for distinguishing between individuals with and without ASD (Lord et al. 1999, 2012; Rutter et al. 2003; Buxbaum et al. 2001).

The KBIT-2 (Kaufman and Kaufman 2004) is a brief (15–30-min) standardized assessment of verbal and nonverbal intelligence. It yields Verbal IQ, Nonverbal IQ, and Composite IQ standard scores. Standard scores are age-based, have a mean of 100 and a standard deviation of 15. Test–retest reliability ranges from good to excellent and scores have been demonstrated to be moderately-to-highly correlated with scores on other brief and full cognitive functioning assessments (Kaufman and Kaufman 2004). The KBIT-2 manual reports five descriptive categories based on standard scores. Based on these categories, 18.67 % of the current sample was characterized as *lower extreme* (i.e., 69 or less), 21.33 % was characterized as *below average* (i.e., 70–84), 52.00 % was characterized as *average* (i.e., 85–115), 5.33 % was characterized as *above average* (i.e., 116–130), and 2.67 % was characterized as *upper extreme* (i.e., 131+).

The VABS-II is a semi-structured interview about adaptive functioning with well-documented psychometrics (Sparrow et al. 2005). The VABS-II Survey Interview Form is designed to be completed with a parent or caregiver of individuals ranging in age from birth through 90 years. It takes approximately 20–60 min to complete, and yields standard scores for overall adaptive behavior (Adaptive Behavior Composite; ABC), communication, DLS, socialization, and motor skills. The motor skills domain is not routinely administered in adult samples and was excluded from current analyses. Domain standard scores are age-based, have a mean of 100, and a standard deviation of 15. VABS-II age equivalent scores are useful in communicating results to parents and other stakeholders who may not be familiar with the interpretation of standard scores. However, they have a number of limitations and are only available for subdomains. Thus, age equivalent scores were not examined.

Each VABS-II domain consists of three subdomains. The communication domain includes receptive, expressive, and written communication skills. The DLS domain includes personal, domestic, and community skills. The socialization domain includes interpersonal relationships, play and leisure time, and coping skills. Each subdomain yields a V-scale score, which is comparable across all VABS-II subdomains. V-scale scores are age-based, range from 1 to 24, have a mean of 15 and a standard deviation of 3 (Sparrow et al. 2005).

Data Analysis

Preliminary analyses included descriptive statistics, Pearson correlations, and one-way analyses of variance (ANOVA). Similar patterns of functioning were observed

Table 1 Descriptive statistics: demographic and diagnostic variables for the full sample and by age subgroup

	Full sample (<i>n</i> = 75)	Adolescents (<i>n</i> = 28)	Young adults (<i>n</i> = 25)	Adults (<i>n</i> = 22)
Chronological age (years)				
<i>M</i> (<i>SD</i>)	24.22 (8.98)	17.52 (0.85)	22.22 (1.65)	35.04 (9.62)
Range	16.08–58.17	16.08–18.92	19.17–24.67	25.17–58.17
Gender (% male)	81.33	89.29	80.00	72.72
ADOS				
Autism (<i>n</i>)	62	24	18	20
Autism spectrum (<i>n</i>)	13	4	7	2
ADI-R				
Autism (<i>n</i>)	40	11	16	13
Borderline autism (<i>n</i>)	2	0	1	1
Not assessed	33	17	8	8
KBIT-2				
Composite IQ	88.52 (23.04)	82.21 (21.87)	92.08 (19.28)	92.50 (27.32)
Verbal	86.29 (23.14)	78.29 (20.01)	90.84 (21.01)	91.32 (26.98)
Nonverbal IQ	92.68 (22.59)	89.71 (22.96)	94.08 (17.64)	94.86 (27.31)
Race/ethnicity				
% African American	4.00			
% American Indian	1.33			
% Asian	2.67			
% Caucasian	65.33			
% Hispanic	12.00			
% Other/did not report	14.67			

ADOS Autism Diagnostic Observation Schedule, ADI-R Autism Diagnostic Interview—Revised. KBIT-2 Kauffman Brief Intelligence Test, Second Edition

between male and female participants; thus, gender was not examined during the focal analyses. To examine cognitive ability and adaptive functioning by age group, a 3 (age group) \times 4 (measure: composite IQ, VABS domains) mixed analysis of covariance (ANCOVA) was conducted. This was followed by separate 3 (age group) \times 3 (VABS subdomains) mixed ANCOVAs for each VABS domain (i.e., communication, DLS, and socialization), which yielded a more fine-grained analysis of adaptive functioning by age group. Verbal IQ was included as a covariate to control for differences among age groups identified during preliminary analyses.

The use of the KBIT-2 descriptive categories to create cognitive ability groups resulted in small and unbalanced cell sizes. For the purpose of the focal analyses, the following groups were created: (1) Intellectual disability (i.e., 0–69; *n* = 14); (2) borderline IQ (i.e., 70–84; *n* = 16); (3) average IQ (i.e., 85–99; *n* = 18), and (4) high average/above average IQ (i.e., 100+; *n* = 27). With the exception of the high average/above average group, these groups are consistent with standard deviations on the KBIT composite IQ score. All models described below were run with and without the six cases in the high average/above average group with IQ scores greater than 115 to determine whether these cases were biasing the results.

Results did not differ substantively; thus, the reported results include these six cases. All participants in the intellectual disability group also had ABC scores of 69 or lower, indicating deficits in adaptive functioning consistent with DSM-5 criteria for intellectual disability. Differences in adaptive functioning profiles among cognitive ability groups were examined using a 4 (cognitive ability group) \times 3 (VABS domain) mixed ANCOVA. Last, separate 4 (cognitive ability group) \times 3 (VABS subdomains) mixed ANCOVAs were conducted for each VABS domain. Age was included as a covariate to control for age differences among cognitive ability groups identified during preliminary analyses. In all models, covariates were centered on their mean. A Huynh–Feldt correction was used when violations of the assumption of sphericity were observed (Huynh and Feldt 1970). *p* values from post hoc pairwise comparisons reflect a Bonferroni correction.

Results

Preliminary and Descriptive Analyses

Age was significantly and positively correlated with composite IQ ($r = .34$, $p = .003$), verbal IQ ($r = .38$,

$p < .001$) and nonverbal IQ ($r = .24, p = .04$) in the full sample. Within age groups, age was only correlated with IQ scores in the adult group ($r_s = .47-.61, p_s = .002-.03$). There were no significant differences in composite IQ [$F(2, 72) = 1.71, p = .19, \eta^2 = .05$] or nonverbal IQ [$F(2, 72) = 0.39, p = .68, \eta^2 = .01$] among the age groups (see Table 1). However, there was a marginal effect of age group on verbal IQ [$F(2, 72) = 2.81, p = .07, \eta^2 = .07$], such that adolescents had a significantly lower average verbal IQ than young adults and adults (both $p_s = .05$). There was a significant main effect of cognitive ability group on age [$F(3, 71) = 4.41, p = .01, \eta^2 = .16$]. Post-hoc pairwise comparisons indicated that the above average IQ group was significantly older than the intellectual disability group ($p = .01$), the borderline IQ group ($p = .01$), and the average IQ group ($p = .004$).

Regarding overall adaptive functioning, 86.67 % of the current sample had ABC scores that correspond to a low adaptive level, 10.67 % had ABC scores that correspond to a moderately low adaptive level, and 2.67 % had ABC scores that correspond to an adequate adaptive level. No participants in the current sample were functioning at moderately high or high adaptive levels (Sparrow et al. 2005).

Adaptive Functioning Among Adolescents, Young Adults, and Adults

Results of a 3 (age group) \times 4 (measure: composite IQ, VABS domains) mixed ANCOVA revealed significant main effects of age group and measure and a significant interaction between age group and measure (see Table 2; Fig. 1). Post-hoc pairwise comparisons indicated that adolescents had significantly and marginally higher average composite IQ and VABS domain standard scores than young adults and adults, respectively. There was no significant difference between young adults and adults. Within the full sample, composite IQ was significantly higher than communication, DLS, and socialization scores. Communication and socialization scores were significantly lower than DLS scores, but there was no difference between communication and socialization scores. Tests of simple effects confirmed this general pattern among young adults. In contrast, DLS scores did not differ significantly from communication scores and were only marginally higher than socialization scores among adolescents. Socialization scores were significantly lower than communication scores among adolescents and adults (see Table 2; Fig. 1).

To examine subdomain profiles by age group, separate ANCOVAs were conducted. Starting with the communication domain, results of a 3 (age group) \times 3 (receptive, expressive, and written) ANCOVA revealed significant main effects of age group and subdomain; there was no significant interaction between the two variables (see

Table 3; Fig. 1). Post-hoc pairwise comparisons indicated that young adults had marginally and significantly lower average communication V-scale scores than adolescents and adults, respectively. There was no significant difference in average communication V-scale scores between adolescents and adults. Collapsing across groups, there was no significant difference between receptive and expressive scores. Writing scores were significantly higher than both receptive and expressive scores.

Within the DLS domain, results of a 3 (age group) \times 3 (personal, domestic, and community) ANCOVA indicated no significant main effect of age group; however, there was a main effect of subdomain. The interaction between age group and subdomain was not significant (see Table 3; Fig. 1). Within the full sample, post hoc pairwise comparisons indicated no significant difference between the personal and domestic V-scale scores. Community V-scale scores were significantly lower than both the personal and domestic V-scale scores.

Regarding the socialization domain, results of a 3 (age group) \times 3 (interpersonal relationships, play and leisure time, and coping skills) ANCOVA indicated that the main effect of age group was not significant. There was a significant main effect of subdomain and a significant interaction between age group and subdomain (see Table 3; Fig. 1). Within the full sample, post hoc pairwise comparisons revealed that interpersonal relationships scores were significantly lower than play and leisure time and coping skills scores. Tests of simple effects indicated that interpersonal scores were significantly lower than play and leisure time and coping skills scores in young adults and adults. Whereas interpersonal scores were significantly lower than coping skills scores in adolescents, there was no significant difference between interpersonal and play and leisure time scores in this group.

Adaptive Functioning Among Composite IQ Groups

For illustrative purposes, VABS domain scores were plotted for each of the KBIT composite IQ descriptive categories (see “Methods” and Fig. 2). Visual inspection indicated that in the lower extreme category, below average category, and average category, DLS standard scores appeared to be higher than average communication and socialization standard scores. Communication scores and socialization scores were similar within each of these groups. Of these three groups, the lower extreme group demonstrated the flattest profile such that score differences between average DLS and the other domains were smallest in this group. The above average category had a relatively flat profile, with lowest scores in the socialization domain. The upper extreme group had highest scores in the communication domain, followed closely by DLS, and then considerably lower scores in the socialization domain.

Table 2 Cognitive and adaptive functioning by age and cognitive ability subgroups: standard scores mixed ANCOVA models

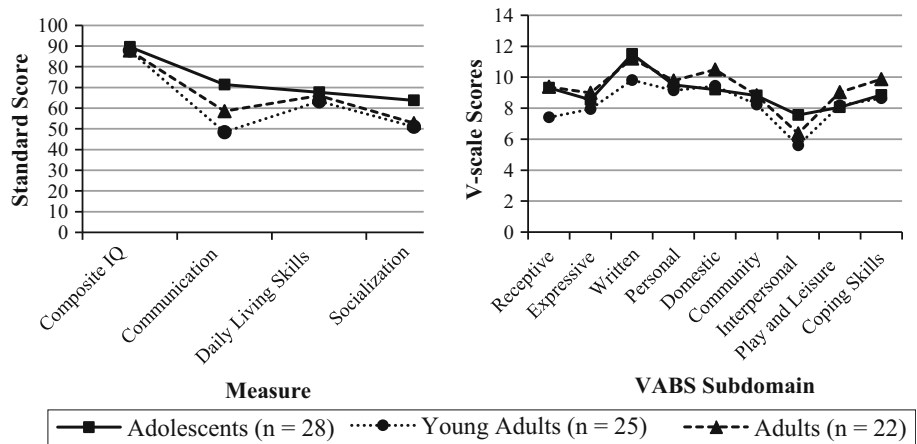
	<i>F</i>	<i>(df, df)</i>	<i>p</i>	η^2	Within-group variables				Avg. Measure <i>M (SE)</i>
					Composite IQ <i>M (SE)</i>	VABS Com <i>M (SE)</i>	VABS DLS <i>M (SE)</i>	VABS Soc <i>M (SE)</i>	
<i>Age group model</i>									
Main effects									
Age group	6.16	(2, 71)	.003	0.09					
Measure: FSIQ and VABS	94.87	(1.98, 142.69)	<.001	0.53					
Interaction									
Measure × age group	6.37	(3.96, 142.69)	<.001	0.07					
Post-hoc comparisons									
Age groups									
Adolescents					89.63 (1.78)	71.43 (3.73) ^b	67.72 (2.44) ^{bdf}	63.81 (3.12) ^{bc}	73.15 (2.08)
Young adults					87.87 (1.85)	48.40 (3.51) ^b	63.28 (2.54) ^{bcd}	51.03 (3.25) ^b	62.65 (2.16) ^a
Adults					87.85 (1.97)	58.55 (3.74) ^b	66.13 (2.71) ^{bcd}	52.75 (3.46) ^{bc}	66.32 (2.30) ^{a†}
Full sample					88.45 (1.07)	59.46 (2.02) ^b	65.71 (1.46) ^{bcd}	55.86 (1.87) ^b	
<i>Cognitive ability model</i>									
Main effects									
Cognitive ability subgroups	1.22	(3, 70)	.31	0.05					
VABS Domain	15.55	(2, 142)	<.001	0.18					
Interaction									
VABS Domain × subgroup	0.74	(6, 142)	.62	0.03					
Post-hoc comparisons									
Cognitive ability subgroups									
Intellectual disability						52.95 (5.54)	57.56 (3.46)	50.86 (4.66)	53.79 (4.09)
Borderline IQ						58.78 (5.15)	66.73 (3.22)	59.72 (4.34)	61.74 (3.81)
Average IQ						60.59 (4.90)	67.74 (3.06)	54.22 (4.12)	60.85 (3.62)
High/above average IQ						63.91 (4.17)	68.15 (2.61)	58.51 (3.51)	63.52 (3.08)
Full sample						59.06 (2.45)	65.05 (1.53) ^{cd}	55.83 (2.06)	

VABS Vineland Adaptive Behavior Scales, Com Communication, DLS Daily Living Skills, Soc Socialization

^a Significantly different from the adolescent age group. ^b Significantly different from FSIQ. ^c Significantly different from VABS Com. ^d Significantly different from VABS Soc. ^{a-d} $p < .05$.

[†] Difference indicated by lower case superscript is marginal ($p \leq .10$)

Fig. 1 Cognitive and adaptive functioning among adolescents, young adults, and adults



Due to small and unbalanced sample sizes, different subgroups (described in Data Analysis) were created for the focal analyses, which examined differences in adaptive functioning profiles among cognitive ability groups. Results of a 4 (cognitive ability group) × 3 (adaptive functioning domain) ANCOVA indicated no significant main effect of cognitive ability group when controlling for age. However, there was a significant main effect of adaptive functioning domain. The interaction between composite IQ group and adaptive functioning domain was not significant (see Table 2; Fig. 3). Within the full sample, post hoc comparisons indicated that average communication and socialization scores were significantly lower than DLS scores. No difference was observed between communication and socialization scores.

To examine profiles *within* adaptive functioning domains (i.e., communication, DLS, and socialization) by cognitive ability, separate 4 (cognitive ability groups) × 3 (subdomain V-scale scores) ANCOVAs were conducted (see Table 4; Fig. 3). There was a main effect of cognitive ability group in the communication domain model, but not the DLS or socialization domain models. Specifically, the high average/above average IQ group had significantly higher average communication V-scale scores than the intellectual disability group. There were no other significant comparisons among the cognitive ability groups. There was a significant main effect of subdomain in all three domain models. Post-hoc pairwise comparisons revealed findings identical to those reported for the age group models (i.e., communication: writing skills > expressive and receptive; DLS: community < personal and domestic; socialization: interpersonal < play and leisure < coping). Significant interactions between cognitive ability groups and subdomain were not observed in any of the three models.

Discussion

Although not considered a defining characteristic of the disorder, adaptive functioning has been identified as an area of major impairment in most individuals with ASD (Kanne et al. 2011). In a sample with a wide range of cognitive abilities, the current study addressed the lack of published empirical data regarding VABS adaptive functioning profiles among older adolescents and adults with ASD. Consistent with previous studies of younger samples, composite IQ scores were significantly higher than all adaptive functioning domains in each age group. DLS were observed to be a relative strength in the young adult and adult groups. The adolescent group, which had the highest average adaptive functioning standard scores, demonstrated a relatively flat profile of adaptive functioning. Writing skills were observed to be a relative strength across all age and cognitive ability groups, whereas interpersonal relationship skills were observed to be an area of relative weakness. Significant differences in adaptive functioning were not observed among cognitive ability groups. Notably, some cognitive ability categories were collapsed to ensure sufficient cell sizes for the analyses, which may have obscured meaningful differences in adaptive functioning. Together, the current findings provide a preliminary picture of adaptive functioning in adults with ASD that, with replication, will prove useful to the development of intervention programs.

A cognitive functioning advantage over adaptive functioning in children and adolescents with ASD has been repeatedly documented (see Kanne et al. 2011). This pattern was replicated in the current sample of older adolescents and adults. Although the majority of the sample had composite IQs in the average to above average range, average VABS domain standard scores were below 70 in all

Table 3 VABS subdomains by age subgroups: mixed ANCOVA models

	<i>F</i>	<i>(df, df)</i>	<i>p</i>	η^2	Within-group variables			
					Receptive <i>M (SE)</i>	Expressive <i>M (SE)</i>	Written <i>M (SE)</i>	Average V-scale <i>M (SE)</i>
<i>Communication</i>								
Main effects								
Age group	3.94	(2, 70)	.02	0.07				
Subdomains	19.26	(2, 142)	<.001	0.21				
Interaction: subdomains × age group	0.59	(4, 142)	.67	0.01				
Post-hoc comparisons								
Adolescents					9.32 (0.65)	8.54 (0.57)	11.50 (0.51)	9.79 (0.41)
Young adults					7.41 (0.66)	7.94 (0.58)	9.81 (0.52)	8.39 (0.42) ^{a†}
Adults					9.38 (0.70)	8.99 (0.62)	11.20 (0.56)	9.86 (0.44) ^b
Full sample					8.70 (0.38)	8.49 (0.33)	10.84 (0.30) ^{cd}	
					Personal	Domestic	Community	
<i>Daily living skills</i>								
Main effects								
Age group	0.66	(2, 70)	.52	0.08				
Subdomains	6.51	(2, 142)	.002	0.02				
Interaction: subdomains × age group	0.38	(4, 142)	.82	0.01				
Post-hoc comparisons: full sample					9.48 (0.32)	9.71 (0.39)	8.63 (0.23) ^{ef}	
					Interpersonal	Play and leisure	Coping skills	Average V-scale
<i>Socialization</i>								
Main effects								
Age group	0.96	(2, 71)	.39	0.02				
Subdomains	35.97	(2, 144)	<.001	0.31				
Interaction: subdomains × age group	3.43	(4, 144)	.01	0.06				
Post-hoc comparisons								
Adolescents					7.56 (0.59)	8.06 (0.60)	8.85 (0.48) ^g	8.16 (0.47)
Young adults					5.60 (0.62)	8.18 (0.63) ^g	8.64 (0.50) ^g	7.48 (0.49)
Adults					6.37 (0.66)	9.03 (0.67) ^g	9.87 (0.54) ^g	8.43 (0.52)
Full sample					6.51 (0.35)	8.43 (0.36) ^g	9.12 (0.29) ^g	

VABS Vineland Adaptive Behavior Scales

^a Significantly different from the adolescent age group. ^b Significantly different from the young adult age group. ^c Significantly different from receptive. ^d Significantly different from expressive. ^e Significantly different from personal. ^f Significantly different from domestic. ^g Significantly different from interpersonal. ^{a–g} $p < .05$. [†] Difference indicated by lower case superscript is marginal ($p = .06$)

cognitive ability groups. Despite having similar composite IQ scores, the adolescent group had significantly higher average VABS domain scores than the young adult and adult groups. These findings support previous suggestions that the gap between cognitive and adaptive functioning skills continues into adulthood and increases with age (Kanne et al. 2011; Klin et al. 2007).

Consistent with a previous study examining adaptive functioning in adults with ASD and no ID (Farley et al. 2009), DLS standard scores were observed to be an area of

relative strength when compared to the communication and socialization standard scores in the full sample. In adolescents, however, DLS standard scores did not differ significantly from communication and socialization standard scores. Notably, the three age groups did not differ in DLS standard scores; instead, adolescents had higher communication and socialization standard scores than young adults and adults. Standard scores are age-based; they represent functioning relative to same-age peers. The current findings suggest that DLS continue to develop post-

Fig. 2 Adaptive functioning by KBIT-2 composite IQ categories

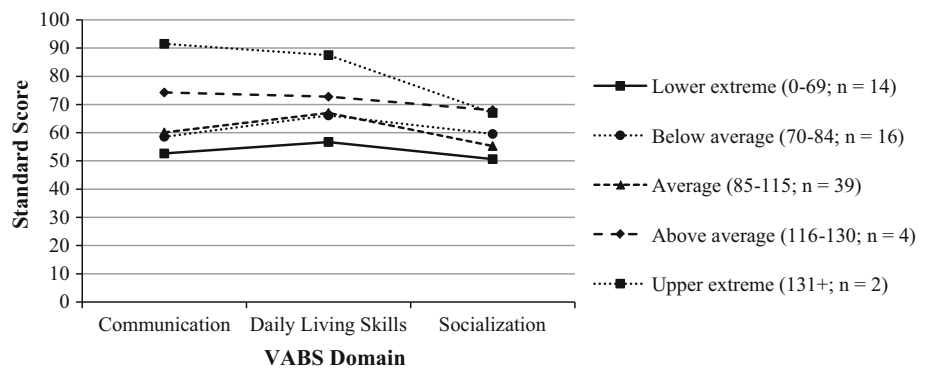
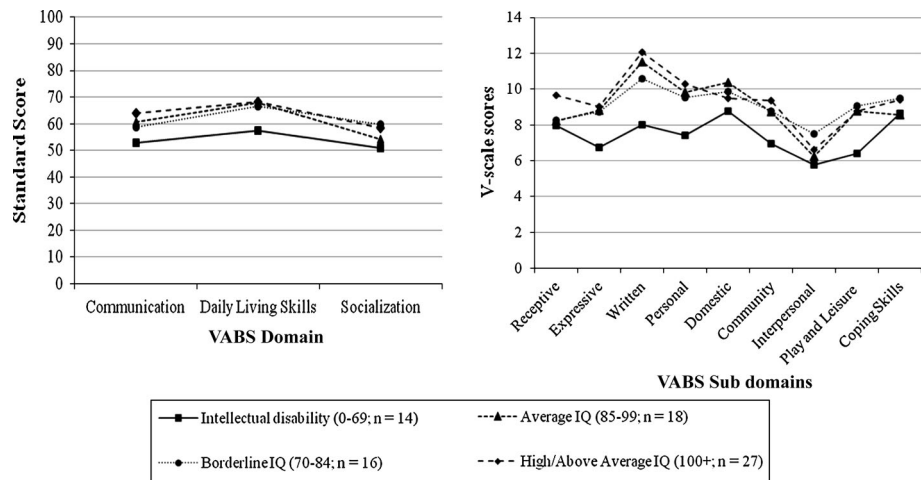


Fig. 3 Adaptive functioning among intellectual ability groups



adolescence in individuals with ASD, whereas the development of age-appropriate communication and socialization skills appears to slow with age. This is consistent with previous findings indicating that DLS continue to grow during the third decade of life (Smith et al. 2012) and that improvement in symptoms and behaviors related to ASD slows after exiting high school (Taylor and Seltzer 2011).

It is possible that this pattern of adaptive functioning across age groups reflects the reduction of clinical and educational support experienced by many individuals with ASD, especially those without ID, as they transition to adulthood (Taylor and Seltzer 2011). The reduction or loss of intensive behavioral intervention and/or stimulating educational settings may truncate the developmental trajectory of age-appropriate social communication skills in adults with ASD. Appropriate social skills for adults (e.g., understanding indirect cues in conversations) are nuanced and may be especially difficult to master in the absence of direct support. In contrast, the skills measured by the DLS domain may be more easily learned and maintained. For example, many adults with ASD may be capable of preparing basic food, especially if required to do so by caregivers. The dataset used for the current analyses did

not include histories of clinical and educational supports; thus, it was not possible to examine this hypothesis.

Alternatively, the hallmark impairments in social communication that characterize ASD may manifest in such a way that differences in functioning between affected and non-affected individuals increase with age. Differences in social communicative functioning between a teenager with ASD and his peers are likely to be of smaller magnitude than those between an adult with ASD and his peers. Specifically, typically developing adults demonstrate, on average, more sophisticated social communication skills than typically developing teenagers.

Although the DLS domain was observed to be an area of relative strength in young adults and adults, and across cognitive ability groups, average standard scores for all groups were below 70, indicating a low level of adaptive functioning. Together with other recent research (Duncan and Bishop 2013), these findings indicate that DLS should be considered an area of impairment in adolescents and adults with ASD. Increased independence for adults with ASD may be achieved through interventions that target DLS that start early in childhood and persist throughout the lifespan.

Table 4 VABS subdomains by cognitive ability subgroups: mixed ANCOVA models

	<i>F</i>	<i>(df, df)</i>	<i>p</i>	η^2	Within-group variables			
					Receptive <i>M (SE)</i>	Expressive <i>M (SE)</i>	Written <i>M (SE)</i>	Avg. V-Scale <i>M (SE)</i>
<i>Communication</i>								
Main effects								
Intellectual ability group	4.04	(3, 69)	.01	0.14				
Subdomains	16.77	(2, 140)	<.001	0.19				
Interaction: subdomains × group	1.30	(6, 140)	.26	0.04				
Post-hoc comparisons								
Intellectual disability					7.95 (0.94)	6.74 (0.78)	7.99 (0.72)	7.56 (0.61)
Borderline IQ					8.25 (0.88)	8.71 (0.73)	10.59 (0.67)	9.18 (0.57)
Average IQ					8.20 (0.86)	8.82 (0.71)	11.49 (0.66)	9.50 (0.55)
High/above average IQ					9.64 (0.71)	9.02 (0.59)	12.06 (0.54)	10.24 (0.46) ^a
Full sample					8.51 (0.42)	8.32 (0.35)	10.53 (0.32) ^{bc}	
					Personal	Domestic	Community	Avg. V-Scale
<i>Daily living skills</i>								
Main effects								
Intellectual ability group	2.70	(3, 69)	.06	0.10				
Subdomains	7.15	(2, 140)	.001	0.09				
Interaction: subdomains × group	1.19	(6, 140)	.32	0.04				
Post-hoc comparisons								
Intellectual disability					7.43 (0.74)	8.75 (0.90)	6.94 (0.53)	7.71 (0.61)
Borderline IQ					9.52 (0.69)	9.86 (0.84)	8.78 (0.49)	9.39 (0.57)
Average IQ					9.82 (0.65)	10.36 (0.80)	8.73 (0.47)	9.64 (0.54)
High/above average IQ					10.27 (0.56)	9.50 (0.69)	9.36 (0.40)	9.71 (0.46) ^{a†}
Full sample					9.26 (0.33)	9.62 (0.40)	8.45 (0.23) ^{de}	
					Interpersonal	Play and leisure	Coping skills	
<i>Socialization</i>								
Main effects								
Intellectual ability group	1.46	(3, 70)	.23	0.05				
Subdomains	28.83	(2, 142)	<.001	0.28				
Interaction: subdomains × group	1.47	(6, 142)	.19	0.04				
Post-hoc comparisons: full sample					6.53 (0.37)	8.25 (0.36) ^f	9.03 (0.29) ^{fg†}	

VABS Vineland Adaptive Behavior Scales

^a Significantly different from the intellectual disability group. ^b Significantly different from receptive. ^c Significantly different from expressive.

^d Significantly different from personal. ^e Significantly different from domestic. ^f Significantly different from interpersonal. ^g Significantly different from play and leisure. ^{a–g} $p < .05$. [†] Difference indicated by lower case superscript is marginal ($p < .10$)

Socialization standard scores were observed to be a relative weakness in adolescents and adults, but did not differ significantly from communication scores in young adults or when examined among the full sample. Previous examinations of the VABS in samples of children and adolescents with ASD have also reported a relative weakness in socialization compared to communication and DLS (Klin et al. 2007). This may be driven by the relative advantage in writing skills and relative weakness in

interpersonal relationships revealed by the examination of VABS subdomains. It could also be due, in part, to the preponderance of individuals with average to above average composite IQ in the current sample. Often individuals with ASD without ID have or develop age-appropriate verbal skills such as articulation, grammar, and semantics, despite atypical non-verbal communication (e.g., prosody), pragmatic language abilities, and social skills. Indeed, the difference between the communication and socialization

domain was smallest in the intellectual disability group in the current study, suggesting that the relative disadvantage in socialization is more pronounced in cognitively able individuals with ASD.

Limitations

Current results contribute to a more complete understanding of adaptive functioning profiles among older adolescents and adults with ASD. In line with previous work in younger samples, these findings suggest that cognitively able individuals with ASD demonstrate marked impairment in all domains of adaptive functioning. Limitations include an atypical distribution of cognitive abilities based on previous reports. Although the current sample represents a wide range of cognitive abilities, there was a preponderance of individuals with average to above average intelligence. This is likely a result of sampling bias, as the majority of participants were individuals living outside of an institutional setting during their adult years. Additionally, the current study was cross-sectional. There is a great need for longitudinal studies of adaptive functioning in individuals with ASD to determine whether reported associations between age and adaptive skills are due to age or cohort effects. Last, future research may consider whether verbal and nonverbal IQ scores are differentially associated with specific patterns of adaptive functioning, as the current study only considered composite IQ scores.

Conclusion

Taken together with a large literature on adaptive functioning in ASD during the first two decades of life, these findings suggest that interventions need to focus not only on social communicative skills, but also on the DLS necessary to live independent adult lives. Results of the current study contribute to a growing body of literature that demonstrates that ASD is a lifelong disorder that requires consistent, intensive intervention starting very early in childhood and lasting throughout the lifespan. The relative intensity of intervention for communication, socialization, and DLS during different periods of the lifespan is an important consideration. Communication is certainly an area of prime concern in early childhood given well-documented sensitive periods for language development (Bjorklund 1997). However, as children gain functional language skills, an appropriate portion of each individual's intervention hours should be allocated for social skills and DLS as dictated by societal demands.

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