HHS Public Access

Author manuscript

J Autism Dev Disord. Author manuscript; available in PMC 2016 June 01.

Published in final edited form as:

J Autism Dev Disord. 2015 June ; 45(6): 1579–1587. doi:10.1007/s10803-014-2309-1.

Increasing Adaptive Behavior Skill Deficits From Childhood to Adolescence in Autism Spectrum Disorder: Role of Executive Function

Cara E. Pugliese[1], **Laura Anthony**[1], **John F. Strang**[1], **Katerina Dudley**[1], **Gregory L. Wallace**[2], and **Lauren Kenworthy**[1]

[1]Children's National Medical Center, Rockville, Maryland [2]George Washington University, Washington, DC

Abstract

Almost half of all children with autism spectrum disorder have average cognitive abilities, yet outcome remains poor. Because outcome in HFASD is more related to adaptive behavior skills than cognitive level it is important to identify predictors of adaptive behavior. This study examines cognitive and demographic factors related to adaptive behavior, with specific attention to the role of executive function (EF) in youth with HFASD aged 4–23. There was a negative relationship between age and adaptive behavior and the discrepancy between IQ and adaptive behavior increased with age. EF problems contributed to lower adaptive behavior scores across domains. As such, it is important to target adaptive skills, and the EF problems that may contribute to them, in youth with HFASD.

Keywords

autism spectrum disorder; adaptive behavior; executive function; cognitive ability

Of the increasing number of children identified with an Autism Spectrum Disorder (ASD), the fastest growing sub-group is those without co-occurring intellectual disability (ID), termed 'high functioning' (i.e., HFASD) (Baio, 2014). There is an expectation of positive outcome for these individuals based on relatively higher cognitive and language abilities, however, longitudinal studies indicate these factors do not necessarily predict better outcome (Howlin, 2003). Evidence suggests adaptive behavior is more closely related to social functioning and independent living than intellectual ability or ASD symptomatology (Farley et al., 2009; Kanne et al., 2011). To date, many of the adaptive behavior findings

Correspondence concerning this article should be addressed to Cara Pugliese, Division of Neuropsychology, Center for Autism Spectrum Disorders, 15245 Shady Grove Road #350, Rockville, MD 20850. CPuglies@ChildrensNational.org Phone: 1.301.765.5430.

Cara E. Pugliese, Center for Autism Spectrum Disorders, Children's Research Institute, Washington, DC; Laura Anthony, Center for Autism Spectrum Disorders, Children's Research Institute, Washington, DC; John Strang, Center for Autism Spectrum Disorders, Children's Research Institute, Washington, DC; Katerina Dudley, Center for Autism Spectrum Disorders, Children's Research Institute, Washington, DC; Gregory L. Wallace, Department of Speech and Hearing Sciences, George Washington University, Washington, DC; Lauren Kenworthy, Center for Autism Spectrum Disorders, Children's Research Institute, Washington, DC.

related to ASD have come from studies utilizing heterogeneous samples, with far fewer studies focusing on individuals with HFASD (Lopata et al., 2013).

Well-developed adaptive behavior skills are essential to independent functioning. Adaptive behavior describes the typical performance of daily activities and represents the ability to translate cognitive potential into real-world skills (Sparrow & Cicchetti, 1984). Adaptive behaviors encompass everyday skills that are independently initiated, such as effectively communicating with others, participating in community activities, and developing meaningful relationships (Klin et al., 2007). The most frequently used measure of adaptive behavior is the Vineland Adaptive Behavior Scales (VABS, Sparrow et al., 1984; VABS-II, Sparrow et al., 2005), which emphasizes three domains: communication, socialization, and daily living skills. In general, individuals with HFASD demonstrate greatest weakness in adaptive socialization skills, while adaptive communication skills, though still impaired, are a relative strength (Perry, Flanagan, Geier & Freeman, 2009; Kenworthy, Case, Harms, Martin & Wallace, 2010; Liss et al., 2001). It is important to determine the impact of developmental course (e.g., age-related changes) and individual factors (e.g., intellectual capacity) on adaptive behavior in order to develop more effective interventions aimed at increasing functional independence.

In typically developing individuals, adaptive behavior skills are commensurate with intellectual ability (Sparrow, Cicchetti, & Balla, 2005), and in individuals with both ASD and intellectual disability (ID), adaptive behavior has been found to be commensurate with, or greater than, intellectual ability (e.g., Fenton et al., 2003; Perry et al., 2009; Kanne et al., 2011). There is a wide gap between IQ and adaptive behavior in HFASD, however, with ratings of adaptive behavior falling one to two standard deviations below the population mean, despite average intelligence (Lee & Park, 2007). Thus, when compared to typically developing peers matched on intellectual ability, those with HFASD demonstrate significantly lower adaptive behavior scores (Kanne et al, 2011).

IQ also appears to be a relatively weak predictor of adaptive behavior in HFASD. In a sample of predominantly HFASD, Klin and colleagues (2007) found that adaptive communication skills, which include reading, writing and structural language skills were linked to IQ scores but socialization skills were not. In the only sample comprised exclusively of individuals with HFASD studied to date, IQ predicted a deficit in daily living skills scores on the VABS, but only accounted for 10% of the variance of scores in conjunction with symptom severity, maternal education, age, and sex (Duncan & Bishop, 2013). Other aspects of adaptive behavior, such as socialization and communication skills were not addressed in this study.

Another variable that has been examined in relation to adaptive behavior is age. Several cross-sectional studies have reported age-related declines in adaptive communication and socialization skills, but not daily living skills. Kanne and colleagues (2011) indicated 37% of the variability in total adaptive scores was predicted by age, though age was not significantly correlated with daily living skills. Duncan and Bishop (2013) indicated age demonstrated relatively weak predictive ability for daily living skills deficits, while Klin and colleagues (2007) reported strong negative correlations between age and adaptive behaviors in the areas of communication and socialization skills. To date there are no published studies of which we are aware that investigate the relationship between age, IQ and adaptive behavior across all three adaptive behavior domains (Communication, Daily Living and Socialization) in a sample composed exclusively of individuals with ASD without ID. It is important to confirm and build upon previous findings by examining domain-specific age-related changes throughout childhood and adolescence in ASD without ID.

In addition to IQ and age, executive functioning (EF) is a plausible correlate of adaptive behavior. EF refers to cognitive skills that serve independent, purposive, goal-directed, and self-serving behavior (Lezak et al., 2012). Ozonoff and colleagues (1991) more specifically describe the skills that comprise EF as “behaviors such as planning, impulse control, inhibition of prepotent but irrelevant responses, set maintenance, organized search, and flexibility of thought and action (p. 1083).” EF problems are frequently documented in ASD and play a role in the observed social and cognitive deficits in this population (Hill, 2004; Kenworthy, Yerys, Anthony & Wallace, 2008). Behavioral manifestation of EF difficulties has been linked to difficulty with adaptive functioning in a small sample of youth with HFASD (Gilotty, Kenworthy, Sirian, Black & Wagner, 2002). This investigation found that metacognition (e.g., initiating activities, working memory, planning, organization, and self-monitoring) significantly predicted adaptive communication and socialization skills above and beyond IQ and autism symptomatology. Specifically, initiation and working memory abilities were significantly correlated with communication and socialization skills. It is notable that neither IQ nor autism symptomatology were significant predictors of adaptive function in this sample. Given age-related increases in EF problems in ASD compared to typically developing populations (Rosenthal et al., 2013), it is important to account for EF when predicting adaptive abilities across development.

Current Study

The present study examines cognitive and demographic factors related to adaptive behavior in HFASD, with specific attention to everyday EF. We hypothesized the sample as a whole would demonstrate global adaptive deficits, with greater impairment in the socialization and daily living skills domains compared to communication. We also expected the discrepancy between cognitive abilities and adaptive behavior to increase with age. Additionally, we hypothesized age would negatively predict adaptive behavior scores. We expected IQ to have a *small* positive relationship to adaptive behavior in this exclusively high functioning sample (Duncan & Bishop, 2013) and we hypothesized better everyday EF would also predict higher levels of adaptive behavior.

Methods

Procedure

This project used archival data and was conducted in compliance with standards established by the institution’s IRB including procedures for informed consent. Participants were evaluated for clinical or research purposes in the autism center of a children’s hospital.

Participants

Participants were 447 children (374 males) with ASD between 4 and 23 years of age (*M*=9.72, *SD*=3.27). A subset of 354 children (301 males) in the same age range (*M*=10.31, *SD*=3.00) had complete data available for EF analyses. Trained and experienced clinicians diagnosed all participants with ASD using DSM-IV-TR criteria (APA, 2000). All participants met criteria established by the NICHD/NIDCD Collaborative Programs for Excellence in Autism (Lainhart et al., 2006) using the Autism Diagnostic Interview (ADI) or Autism Diagnostic Interview–Revised (ADI-R; LeCouteur et al., 1989; Lord et al., 1994) and/or the first or second edition of the Autism Diagnostic Observation Schedule (ADOS; Lord et al., 2000 ADOS-2; Lord et al., 2012). All participants had Full Scale IQ scores (FSIQ) at or above 70 (*M*=102.57, *SD*=18.56 in the larger sample; *M*=104.38, *SD*=18.67 in the smaller sample) measured by the Wechsler Abbreviated Scale of Intelligence-four subtest version (Wechsler, 2011; *n*=204), Wechsler Preschool and Primary Scale of Intelligence-III (Wechsler, 2002; *n*=17), Wechsler Intelligence Scale for Children-III (Wechsler, 1991; *n*=22), Wechsler Intelligence Scale for Children-IV (Wechsler, 2003; *n*=147), Wechsler Adult Intelligence Scale-III (Wechsler, 1997; *n*=9), Wechsler Adult Intelligence Scale-IV (Wechsler, 2008; *n*=7), or the Differential Ability Scales-II (Elliot, 2007; *n*=40). Participants with co-morbid genetic conditions, traumatic brain injury, and neurological disorders that may affect cognitive functioning were excluded. Informed assent and consent were obtained from all participants and/or their parent/guardian when appropriate. Table 1 provides information on characterization measures in the sample.

Measures

ASD diagnoses were confirmed with the ADI/ADI-R and/or the ADOS/ADOS-2. The ADOS is a semi-structured, observational assessment that scores a participant's response to social presses for communication, reciprocal social behavior, and repetitive behaviors and stereotyped interest patterns. The ADI is a structured parent interview about the child's developmental history with an emphasis on communication, social development, and repetitive and restricted behaviors. Scores on both the ADOS and ADI are aggregated into symptom clusters that correspond with a DSM-IV diagnosis of Autistic Disorder.

Behavior Rating Inventory of Executive Function, Parent Form (BRIEF; Gioia, Isquith, Guy & Kenworthy, 2000)—The BRIEF is a parent questionnaire assessing behavioral manifestation of EF abilities in children. Scores are divided into two main indices, behavioral regulation (BRI) and metacognition (MCI). The BRI is further divided into three scales (initiate, emotional control, shift) and the MCI is divided into five scales (inhibit, organize/plan, organization of materials, working memory, monitor). Higher scores indicate poorer EF, with T-scores above 65 indicating clinically significant ratings. The BRIEF has good reliability, and convergent and discriminant validity (Gioia et al., 2000).

The Vineland Adaptive Behavior Scales, First and Second Editions (VABS, VABS-II; Sparrow, Balla & Cicchetti, 1984; Sparrow, Cicchetti & Balla, 2005)—The VABS is a standardized, structured parent/caregiver interview of adaptive skills. The current study used the Communication, Daily Living, and Socialization domain standard scores. The VABS has demonstrated strong reliability and validity (Sparrow et al., 2005).

Data Analysis

Demographic and Cognitive Variable Analyses—Analyses were conducted using IBM SPSS Statistics, version 22. Paired samples t-tests were used to test for relatively lower Socialization and Daily Living Scores compared to Communication scores on the VABS. Participants were divided into 6 age groups (4–5, 6–7, 8–9, 10–11, 12–13, 14–23 years) to examine age-related differences in VABS domain scores. Effort was made to space age groups equally, but participants aged 14 and above were collapsed into one group due to the small sample. One-way ANOVAs with linear contrasts were used to test for age-related decreases in adaptive scores. To examine whether discrepancies in cognitive and adaptive abilities differed across age groups, difference scores were calculated between IQ and adaptive behavior. Then, one-way ANOVAs with contrasts were used to test for linear increases in discrepancy scores across age groups.

A series of hierarchical multiple regressions were then conducted with VABS domain scores serving as the dependent variables (see Table 2). Demographic predictors were evaluated first (age, IQ, gender, and years of maternal education). Gender and years of maternal education were not significant predictors and were omitted from further analyses.

Executive Function Analyses—To explore contribution of EF to adaptive behavior skills above and beyond age and IQ, hierarchical regressions were run with age and IQ entered in the first block, followed by the BRIEF MCI and BRI scores in the second block. To examine the contribution of specific EF domains, when the MCI and BRI indices were significant predictors, they were broken down into their component scales and used as predictors for a second set of regression analyses (see Table 3). All statistical assumptions for multiple regression were met. The statistical significance criterion was set a priori at $\alpha=.05$.

Results

Demographic and Cognitive Variable Analyses

Paired samples t-tests indicated the VABS Communication domain was significantly higher than the Socialization domain ($t_{446}=12.14$, $p<.001$) and the Daily Living Skills domain ($t_{446}=5.37$, $p<.001$). The Daily Living Skills domain was also significantly higher than the Socialization domain ($t_{446}=5.44$, $p<.001$).

Separate one-way ANOVAs demonstrated a significant difference across age groups in the VABS Communication ($F_{5,441}=11.52$, $p<.001$), Daily Living Skills ($F_{5,441}=4.78$, $p<.001$) and Socialization ($F_{5,441}=7.17$, $p<.001$) domains. Contrast tests indicated a linear decrease in Communication ($t_{441}=-6.81$, $p<.001$), Daily Living ($t_{441}=-3.35$, $p<.01$), and Socialization scores as age increased ($t_{441}=-5.06$, $p<.001$; see Figure 1).

There were also significant differences across age groups in the discrepancy between IQ and the Communication ($F_{5,441}=18.23$, $p<.001$), Daily Living Skills ($F_{5,441}=4.83$, $p<.001$), and Socialization ($F_{5,441}=8.58$, $p<.001$) domains with contrast tests indicating a linear increase from younger to older participants ($t_{441}=8.16$, $p<.001$; $t_{441}=4.23$, $p<.001$; and $t_{441}=5.60$, $p<.001$, respectively; see Figure 2).

Initial regression analyses investigating demographic variables revealed age was a significant negative predictor and IQ was a significant positive predictor of VABS Communication ($F_{2,444}$=89.94, p<.001, R^2=.28), Daily Living Skills ($F_{2,444}$=13.39, p<.001, R^2=.06), and Socialization domain scores ($F_{2,444}$=19.05, p<.001, R^2=.08; see Table 2).

Executive Function Analyses

Communication Domain—IQ was a significant positive predictor and age was a significant negative predictor of Communication scores, accounting for 27.6% of the variance, $F_{2,354}$=67.46, p < .001. IQ accounted for 12.3% of the variance and age accounted for 15.3% of the variance in this model. The model with BRIEF domain scores added accounted for an additional 3.8% of the variance, $F_{4,352}$=40.21, p<.001, though only the MCI was a significant predictor of Communication scores along with age and IQ. When the MCI was broken down into individual scales and entered alongside age and IQ, the resulting model was significant ($F_{7,349}$=24. 81, p<.001), accounting for 33.2% of the variance (EF variables independently accounted for 5.6% of variance). Higher IQ, younger age, fewer initiation problems, and fewer working memory problems were significant predictors of better communication skills.

Daily Living Skills Domain—Higher IQ and lower age predicted greater Daily Living Skills scores, accounting for 5.9% of the variance, $F_{2,354}$=11.17, p<.001. IQ accounted for 2.5% and age accounted for 3.4% of the variance in scores. When EF domain variables were included in the model, IQ, age, and MCI significantly predicted daily living skills, $F_{4,352}$=14.40, p<.001. EF variables accounted for an additional 8.1% of the variance. When the MCI was broken down into scales and entered in conjunction with age and IQ, the new model was significant ($F_{7,349}$=11.14, p<.001), explaining 18.3% of the variance in scores (EF variables independently accounted for 12.3%). Higher IQ, younger age, and fewer problems with initiation, organization of materials problems, and working memory difficulties were significant predictors of better Daily Living Skills scores.

Socialization Domain—Younger age and higher IQ significantly predicted higher Socialization skills, accounting for approximately 9% of the variability in scores, $F_{2,354}$=18.18, p<.001. IQ accounted for 1.3% of this variance, while 8% was attributable to age. When EF domain variables were included in the model, all four predictors were significant, $F_{4,354}$=25.88, p<.001. Inclusion of EF domain variables accounted for an additional 13% of the variance in Socialization skills. When the BRI and MCI were broken down into subscales and entered in combination with age and IQ, the model remained significant ($F_{10,346}$=12.25, p<.001), and accounted for approximately 24% of the variance (EF variables contributed to 16.8% of this variance). Younger age and fewer initiation and shifting problems were associated with higher adaptive socialization abilities.

Discussion

The present investigation of 447 individuals with HFASD between the ages of 4 and 23 years replicates previous findings in several key areas, including: demonstrating the expected profile of adaptive skill domains with lower socialization and daily living skills compared to communication skills (Carter et al., 1998; Liss et al., 2001; Kanne et al., 2011); showing markedly lower adaptive skills than intellectual ability; and finding age-related declines in adaptive functioning scores. We also found that the gap between IQ and adaptive behavior generally increased with age (Kanne et al., 2011; Klin et al., 2007). This raises significant questions about how we characterize impairment in ASD. In its most recent revision, the DSM-5 has forgone relying on IQ for classifying ID severity in favor of utilizing adaptive functioning scores to specify level of impairment (American Psychiatric Association, 2013). Despite having high cognitive abilities, youth in this study demonstrated significant impairment in adaptive ability, and the discrepancy in scores was notably greater for older participants. This is particularly concerning as adaptive behaviors are not typically targeted in individuals with HFASD in school or other interventions.

Notably, IQ and age differentially predicted domain specific variability in adaptive scores consistent with findings from Klin and colleagues (2007). However, IQ did not predict unique variance in Socialization scores when EF variables were considered. IQ accounted for a significant portion of variance in Communication skills, which is unsurprising given the documented link between cognitive ability and language development. Overall, IQ accounted for substantially less of the variance in Daily Living skills (2.5%) and Socialization skills (1.3%), suggesting other important variables may demonstrate greater predictive validity. Similar to Duncan and Bishop (2013), we found a small but significant proportion of variance accounted for by age and IQ in Daily Living skills. Notably, Duncan and Bishop sought to predict daily living skills *deficits* (e.g., the discrepancy between daily living skills domain scores and IQ scores), rather than *abilities* (total daily living skills domain scores).

In accordance with previous results, we also found a robust negative effect of older age on adaptive behavior scores that was not driven by IQ. The magnitude of the effect was more similar to the only previous study of exclusively high functioning individuals (Duncan & Bishop, 2013) than to studies of individuals with a wider IQ range (Kanne et al., 2011). Greater age predicted lower adaptive behavior scores most strongly in Communication and Socialization abilities, and to a lesser degree, Daily Living Skills. Although we did not account for access to intervention, it is important to note the drop in Socialization scores at the age groups where children typically access social skills groups within the school or community. Thus, it is important to include measures of adaptive behavior when considering the success of an intervention. Lower scores in the oldest age group may indicate a cohort effect (e.g., lack of participation in quality intervention, limited access to resources) or a failure to make gains in adaptive behavior skills at a level commensurate with chronological growth. It will be important to conduct longitudinal studies to disentangle age effects on adaptive behavior, however, low scores indicate the need for adaptive skill instruction in older individuals with HFASD.

This study provides further support of a negative relationship between EF problems and adaptive behavior in youth with HFASD. EF indices contributed to adaptive behavior scores above and beyond demographic variables and IQ in all domains. Notably, metacognition abilities, rather than behavior regulation skills, drove this finding in all domains but socialization. While EF problems accounted for only 4% of the variance in Communication skills, the pattern was much different for other domain scores. EF problems accounted for 12.3% of the variance in Daily Living Skills, and 13% of the variance in Socialization skills, which was considerably *more* than age and IQ. These results clearly indicate deficits in metacognitive and behavioral regulation aspects of EF are important contributors to adaptive impairments in youth with HFASD.

When the metacognition and behavior regulation indices were broken down further into specific domains, between 5.6% (Communication) and 16.8% (Socialization) of the variance was explained in adaptive behavior. Parent reported problems with initiation was a robust predictor of lower adaptive skill across domains, and working memory problems were specifically associated with Communication and Daily Living Skills. These results suggest that these abilities may be aspects of metacognition that are most closely related to impairments in adaptive skills in this population. This finding is consistent with our previous investigation of EF and adaptive behavior in HFASD, in which working memory and initiation skills stood out as related to adaptive behavior in a small sample (Gilotty et al., 2002). The behavioral manifestation of working memory assessed by the BRIEF involves the capacity to hold information in mind for the purpose of completing a task, encoding information, or generating goals. This type of working memory is critical to carrying out multistep activities and following complex instructions. It is plausible that difficulty sustaining working memory has significant impact on the ability to hold a conversation, plan an outing with a friend, or complete chores and homework. Closely related are initiation abilities, or "self-starting" skills that are necessary to begin these tasks. Notably, initiation abilities on the BRIEF also reflect problems with generativity, such as coming up with new ideas or activities during free time or complaining about having "nothing to do." This finding is in line with results from lab-based tests indicating impaired generativity in ASD (Hill, 2004; Kenworthy et al., 2009).

In addition to initiation and working memory problems, difficulty with organization of materials predicted lower Daily Living Skills scores. Gilotty et al., (2002) also reported negative correlations between these measures, though estimates did not reach significance. The Organization of Materials scale on the BRIEF represents the ability to organize, keep track of, and clean up their belongings. These skills directly relate to daily living skills (i.e., cooking, cleaning, handling money, using community transportation). For example, paying for items can be difficult if one cannot properly keep track of money.

Within the Socialization domain, poorer shifting abilities also predicted lower scores. The Shift scale on the BRIEF represents the ability to transition to a new situation or activity, tolerate change, problem-solve flexibly, and change from one topic to another. Youth with HFASD are often described as being rigid and inflexible, and these difficulties may significantly impact their ability to socialize with others. For example, refusing to compromise with a peer due to a lack of flexible thinking can cause strain on social relationships, and resisting new situations, such as a school club or sports activity, can prevent a child from making friends. Indeed, previous research has documented EFs are associated with social communication symptoms, (McEvoy, Rogers & Pennington, 1993; Kenworthy et al., 2009); enhance social reasoning (Fisher & Happé, 2005); and may predict variation in social communication abilities (Pellicano, 2007) in children with HFASD.

Furthermore, gains in social skills and adaptive classroom behaviors were observed in children with HFASD who participated in an EF intervention compared to a social skills intervention during a randomized controlled trial (Kenworthy et al., 2013). Such findings support the notion that EFs are important to real world behavioral outcomes.

Limitations

The current study has several limitations, and suggests areas for future direction. Participants' performance was assessed via parent-report measures, an indirect measurement of abilities, which may have led to an incomplete or biased understanding of the participant. Utilization of lab-based measures of EF and other-informant report (i.e., teacher) would strengthen the conclusions made by this study. Due to our use of archival data, the oldest age group investigated spanned 9 years (from 14–23 years of age), representing a wide range of developmental abilities. It will be important for future research to determine whether differences in adaptive behavior exist within this age range. We also must note that, based on the education level of the participants' mothers in this study, our sample had a higher that expected social economic status. Although maternal education was not a significant predictor of adaptive behavior in this study, it is still the case that this sample may have had more access to treatment than is typical, making the findings of declining adaptive behavior even more concerning. We focused specifically on EF and key cognitive and demographic variables to predict outcomes in adaptive behavior. Future research should consider other variables such as comorbid psychopathology, intervention, and family factors. Additionally, reliance on cross-sectional data precludes causal interpretation of the findings. Longitudinal studies are needed to more clearly understand the links between adaptive behavior, EF, and adult outcome, as well as to explore when age-related progress in adaptive skills begins to slow to determine optimal developmental periods for intervention.

Conclusion

In a large sample of youth with HFASD, we found significant age-related differences in adaptive behavior after accounting for IQ. Moreover, EF variables accounted for additional variance in all domains of adaptive functioning. EF variables also accounted for variance attributed to cognitive ability in Socialization scores. Specifically, initiation, working memory, organization of materials and flexibility or shifting played significant roles in adaptive behavior scores. It will be important to target adaptive skills, and EFs that contribute to them, in individuals with HFASD across developmental periods from childhood through adolescence in order to improve outcomes.

Acknowledgments

This work was supported by an award from the Isadore and Bertha Gudelsky Family Foundation and grants by the National Institutes of Health (P30HD040677 and T32 HD046388-01A2).

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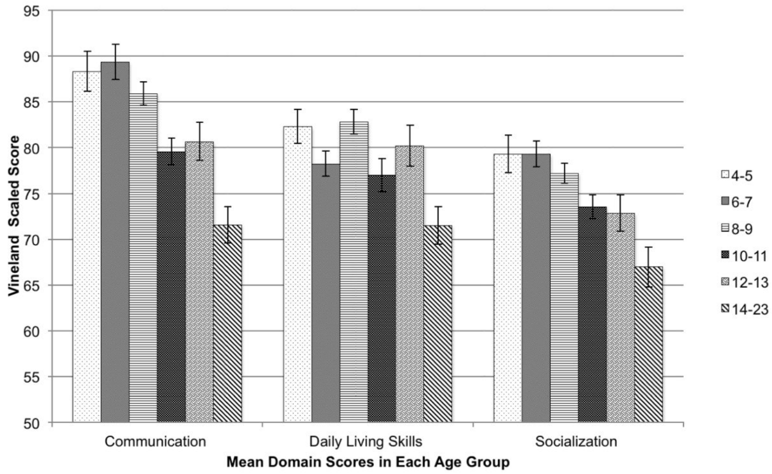

Figure 1.

Mean VABS scores across domains separated by age group. A negative linear relationship was found from younger to older participants in each domain. Sample sizes for age groups are as follows: 4–5 year-olds (*n*=53), 6–7 year-olds (*n*=80), 8–9 year-olds (*n*=125), 10–11 year-olds (*n*=89), 12–13 year-olds (*n*=55), 14–23 year-olds (*n*=45). Standard errors are represented by the error bars attached to each column.

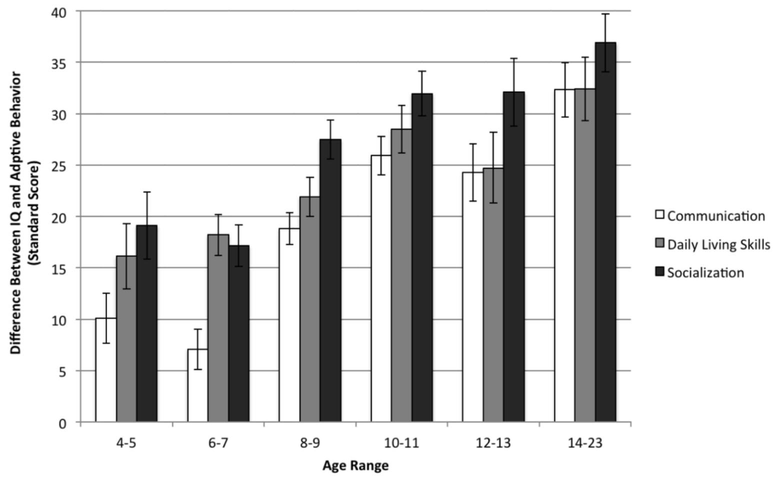

Figure 2.

Difference in IQ and VABS scores separated by age group. A positive linear relationship was found such that the discrepancy between IQ and adaptive behavior scores increased from younger (4–5 years) to older (14–23 years) participants. Standard error bars are attached to each column.

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Table 1

Means on Demographics, EF and Adaptive Behavior Measures

Scale	*M*	*SD*	*n*
ADOS Social + Communication Total	11.97	4.89	436
ADOS Restricted & Repetitive Behaviors	2.37	1.93	436
ADI Reciprocal Social Interaction	17.72	5.87	394
ADI Verbal Communication	14.65	4.80	394
ADI Restricted, Repetitive and Stereotyped Behaviors	5.74	2.79	394
BRIEF Behavior Regulation Index	66.48	12.00	358
Initiate	63.75	10.77	358
Emotional Control	61.84	12.08	358
Shift	69.17	12.58	358
BRIEF MCI	66.28	10.89	358
Inhibit	63.28	12.56	358
Organize/Plan	65.22	11.92	358
Organization of Materials	57.87	10.22	358
Working Memory	66.80	10.78	358
Monitor	65.22	11.08	358
VABS Communication	83.38	15.89	447
VABS Daily Living Skills	79.24	15.35	447
VABS Socialization	75.49	13.72	447

Note: BRIEF scores are reported as T scores (*M*=50, *SD*=10) and VABS scores are reported as standard scores (*M*=100, *SD*=15).

Table 2

VABS Domain Scores Regressed Onto Age and IQ (n=447)

Predictor	***B***	**SE *B***	***t***
Communication Skills			
IQ	0.35	0.04	10.10***
Age	−1.88	0.20	−9.50***
Daily Living Skills			
IQ	0.15	0.04	3.96***
Age	−0.86	0.22	−3.82***
Socialization			
IQ	0.10	0.03	2.84**
Age	−1.12	0.19	−5.81***

Note:

* $p < .05$,

** $p < .01$,

*** $p < .001$.

Table 3

VABS Domain Scores Regressed onto Age, IQ, and EF Domain and Subscale Scores (n=357)

Predictor	*B*	SE *B*	*t*	*B*	SE *B*	*t*	*B*	SE *B*	*t*
	Communication			Daily Living Skills			Socialization		
BRIEF Index Analyses									
Step 1									
FSIQ	0.32	0.04	**8.48*****	0.14	0.04	**3.40****	0.10	0.04	**2.76****
Age	−2.01	0.23	**−8.65*****	−0.94	0.26	**−3.57*****	−1.26	0.23	**−5.58*****
Step 2									
FSIQ	0.31	0.04	**8.48*****	0.13	0.04	**3.28****	0.09	0.03	**2.66****
Age	−1.90	0.23	**−8.32*****	−0.77	0.25	**−3.03****	−1.10	0.21	**−5.24*****
BRI	−0.07	0.07	−0.95	0.01	0.08	0.06	−0.22	0.07	**−3.48****
MCI	−0.22	0.08	**−2.84****	−0.40	0.09	**−4.63*****	−0.25	0.07	**−3.45****
BRIEF Subscale Analyses									
FSIQ	0.29	0.04	**7.59*****	0.12	0.04	**3.01****	0.06	0.03	1.84
Age	−1.87	0.23	**-−8.24*****	−0.77	0.25	**−3.08****	−1.08	0.21	**−5.21*****
Initiate	−0.22	0.09	**−2.35***	−0.30	0.10	**−2.93****	−0.29	0.09	**−3.34****
Organize/Plan	−0.10	0.10	−0.96	0.11	0.11	1.01	−0.01	0.09	−0.06
Organization of Materials	0.08	0.09	0.95	−0.19	0.09	**−2.00***	0.14	0.08	1.75
Working Memory	−0.21	0.10	**−2.15***	−0.34	0.11	**−3.12****	−0.18	0.09	−1.92
Monitor	0.16	0.09	1.80	0.17	0.10	1.67	0.06	0.09	0.61
Inhibit	---	---	---	---	---	---	−0.10	0.07	−1.41
Shift	---	---	---	---	---	---	−0.18	0.07	**−2.70****
Emotional Control	---	---	---	---	---	---	−0.01	0.07	−0.09

Note: BRI=Behavior Regulation Index; MCI=Metacognition Index, FSIQ=Full Scale IQ

$^{*}p < .05$,

** $p < .01$,

*** $p < .001$.