Published in final edited form as:

J Autism Dev Disord. 2015 December ; 45(12): 4074–4083. doi:10.1007/s10803-015-2522-6.

Age and Adaptive Functioning in Children and Adolescents with ASD: The Effects of Intellectual Functioning and ASD Symptom Severity

Trenesha L. Hill¹, Sarah A. O. Gray¹, Jodi L. Kamps², and R. Enrique Varela³

¹ Department of Psychology, Tulane University, 2007 Percival Stern Hall, 6400 Freret St., New Orleans, LA 70118-5636, USA

² Children's Hospital, New Orleans, 200 Henry Clay Ave., New Orleans, LA 70118, USA

³ Department of Psychological Sciences, Loyola University New Orleans, Box 194, 6363 St. Charles Ave., New Orleans, LA 70118, USA

Abstract

The present study examined the moderating effects of intellectual functioning and ASD symptom severity on the relation between age and adaptive functioning in 220 youth with autism spectrum disorder (ASD). Regression analysis indicated that intellectual functioning and ASD symptom severity moderated the relation between age and adaptive functioning. For younger children with lower intellectual functioning, higher ASD symptom severity was associated with better adaptive functioning than that of those with lower ASD symptom severity. Similarly, for older children with higher intellectual functioning, higher ASD symptom severity was associated with better adaptive functioning than that of those with lower ASD symptom severity. Analyses by subscales suggest that this pattern is driven by the Conceptual subscale. Clinical and research implications are discussed.

Keywords

Autism spectrum disorder; Adaptive functioning; Age; ASD symptom severity; Intellectual functioning

Introduction

Autism spectrum disorder (ASD) is characterized by impairments in social communication and social interaction, and the presence of repetitive, restricted, patterns of behavior and interests (American Psychiatric Association 2013). Given the defining symptoms of ASD, it is not surprising that individuals with ASD exhibit significant deficits in their adaptive functioning (Tomanik et al. 2007). Adaptive behavior is “the collection of conceptual, social,

---

Sarah A. O. Gray sgray4@tulane.edu.

Author contributions TH and EV conceived of the study, participated in its design and coordination, and drafting of the manuscript; SG participated in drafting of manuscript and interpretation of the data; JK participated in the collection and coordination of data collection.

and practical skills that have been learned by people in order to function in everyday lives” (Luckasson et al. 2002: p. 73). Adaptive functioning skills are an important determinant of prognosis in autism, including the level of independence that an individual can obtain in adulthood (Paul et al. 2004). Considering the costs to society associated with non-independent living (e.g., housing, healthcare, job training), understanding factors that contribute to adaptive functioning in youth with ASD is critical.

Gains in adaptive functioning from early childhood to adulthood support the achievement of independence in adulthood, and in typically developing individuals, increases in age coincide with increases in adaptive skill attainment (Sparrow et al. 2005). In youth with ASD as well, there is an association between age and the acquisition of adaptive skills (Gillespie-Lynch et al. 2012), although when standard scores of adaptive functioning are used, this relation is not always observed (e.g., Lopata et al. 2012), suggesting that individuals with ASD may not acquire adaptive skills at the same rate as their typically-developing peers. It is likely that other variables, such as IQ and ASD symptom severity, are influencing adaptive functioning over time and that such variables may have differential effects on the adaptive functioning of youth with ASD depending on the youth’s age. In this study, we examined co-contribution of intellectual functioning and ASD severity to adaptive functioning in youth with ASD at different ages.

Adaptive Functioning and Age

The Vineland Adaptive Behavior Scales (Vineland; Sparrow et al. 1984) is the most commonly used measure of adaptive functioning in the extant ASD literature. The Vineland is used to assess adaptive functioning in four domains: Socialization, Communication, Daily Living, and Motor Skills (for children ages 6 and under). Studies that have investigated the relation between age and adaptive functioning in individuals with ASD have yielded somewhat inconsistent findings. Studies using raw scores indicating skill attainment have shown that, as expected, children on average gain adaptive skills across the childhood period. For example, Gillespie-Lynch et al. (2012) found that children with Autistic Disorder showed improvements in Vineland raw scores of daily living and communication skills from early childhood to adulthood, though no changes were noted in the children’s social skills from middle childhood to adolescence. However, in cross-sectional analyses, age has been negatively associated with adaptive functioning standard scores on the Vineland (Kanne et al. 2011; Klin et al. 2007). Consistent with this cross-sectional pattern, longitudinal analyses with Vineland standard scores indicate that the *rate* of acquisition of adaptive skills is more attenuated among individuals with ASD than in their typically-developing peers (Fisch et al. 2002; Gabriels et al. 2007); in these studies, the children’s standard scores on the Vineland *decreased* over time. For example, Gabriels et al. (2007) found that the average Vineland adaptive behavior composite score of children with ASD decreased from 67.71 (± 23.46) at initial testing to 50.36 (± 24.32) five years later.

Other researchers, however, have failed to observe an association between adaptive functioning standard scores and age in youth with ASD. For example, Kenworthy et al. (2010) did not find a correlation between age and adaptive functioning standard scores in a group of high functioning individuals (12–21 years old) with ASD. Another study

investigated the correlates of adaptive behavior in children ages 7–12 with high functioning ASD (Lopata et al. 2012). Consistent with previous findings, the results indicated that the children had significant deficits in their adaptive functioning. Similar to the Kenworthy et al. (2010) study, the researchers did not find an association between age and adaptive functioning. It is important to note that the Kenworthy et al. (2010) and the Lopata et al. (2012) studies assessed adaptive functioning using the Adaptive Behavior Assessment System—Second Edition (ABAS-II; Harrison and Oakland 2003), which has demonstrated moderate to strong correlations with the Vineland and other measures of adaptive functioning (Harrison and Oakland 2003).

Adaptive Functioning and Intellectual Functioning

One factor that may explain the inconsistent findings on the relation between adaptive functioning and age is intellectual functioning. Individuals with ASD present with a range of intellectual abilities. A recent study found that 55 % of their sample of children with ASD had an intellectual disability (i.e., $IQ < 70$), 17 % had below average intellectual functioning (i.e., $85 > IQ > 70$), 28 % had average intellectual functioning, and 3 % had above average intellectual functioning (Charman et al. 2011). Given that intellectual disability and ASD often co-occur, studies have compared the adaptive functioning of individuals with ASD and comorbid intellectual disability to those who have intellectual disability only.

Several studies have found a positive correlation between intellectual functioning (typically measured as Verbal IQ, Performance IQ, or Full Scale IQ) and adaptive functioning among children with ASD (Kanne et al. 2011). Schatz and Hamdan-Allen (1995) found a positive correlation between adaptive functioning (measured with the Vineland) and age and intellectual functioning in children and adolescents (mean age 8.20) with Autistic Disorder. Another study found that standard scores on the second edition of the Vineland were positively correlated with intellectual abilities and that age and intellectual functioning significantly predicted adaptive functioning in their sample of toddlers (ages 23–39 months) with ASD (Ray-Subramanian et al. 2011).

Additional studies also indicated that intellectual functioning may *interact* with age to predict adaptive functioning among individuals with autism. Just as increasing age has been associated with attenuated adaptive behavior scores among individuals with ASD, similar patterns have been observed among individuals with intellectual disability (Matson et al. 2009); it may be that these deficits are co-contributing to decrements in growth of adaptive skills. Freeman et al. (1999) investigated developmental trajectories of standard scores on the Vineland, demonstrating growth in communication, daily living, and social skills over time; critically, gains in communication and daily living skills were also related to IQ, with children with higher Performance IQs demonstrating faster growth rates in these areas. In a study by Fisch et al. (2002), children who were initially tested before the age of 6 showed significant declines in their intellectual functioning (from an initial mean IQ of 52.3 to a retest mean IQ of 43.0). The older children (i.e., those initially tested at or after the age of 6) did not show significant changes in intellectual functioning. Thus, for the older children, intellectual functioning remained relatively stable but adaptive functioning declined, suggesting that age and IQ interact to predict adaptive functioning over time.

It is likely that individuals with higher intellectual functioning are better able to learn adaptive behaviors than those with lower intellectual functioning (Liss et al. 2001), particularly the younger children whose gains in adaptive skills are closely linked to basic cognitive functions. For instance, learning names, self-grooming behaviors, and rudimentary social skills (e.g., sharing, not hitting) are largely a function of more fundamental cognitive processes such as rote memory, perceptual abilities, and effortful control. These cognitive abilities are tied to the development of more primitive areas of the brain which are still maturing in the first years of life (Gazzaniga et al. 2013). Thus, higher intellectual functioning in the early years may be responsible for gains in behavior that are considered adaptive. As children age, particularly into the preteen and adolescent years, environmental expectations increase and adaptive behaviors become more complex (Harrison and Boney 2002). At these later ages, the level of intellectual functioning required for successfully learning how to navigate environmental demands is much higher than many youth with ASD actually attain. More complex adaptive behaviors, particularly in the social domain, require higher-order cognitive functioning for successful learning including better executive functioning (e.g., planning, attentional and inhibitory control, and goal directed thought and behavior) and higher integration of cognitive systems including visuospatial, sensory, language, and attentional systems (Lewkowicz and Ghazanfar 2009). Thus, as intellectual functioning increases in older children with ASD, it may not be positively related to adaptive functioning because the increases in intellectual functioning are not commensurate with what is necessary to learn adaptive skills in an increasingly demanding environment.

Adaptive Functioning and ASD Symptom Severity

Beyond intellectual functioning, the severity of ASD symptoms is also likely to have an impact on adaptive functioning. Some studies have found strong negative associations between adaptive functioning and ASD symptom severity. For example, one study found that ASD symptom severity, measured using the Childhood Autism Rating Scale (Schopler et al. 1988), was moderately to strongly negatively correlated with most Vineland standard scores of a large group of children (aged 22–71 months) with ASD (Perry et al. 2009). The researchers also found a strong positive correlation between intellectual functioning and adaptive functioning. Analyses indicated that children with moderate to profound MR had IQs that were significantly lower than their adaptive functioning. Intellectual functioning and adaptive functioning were not different for children with mild MR. However, children higher in intellectual functioning (i.e., in the average and borderline ranges) had IQs that were significantly greater than their overall adaptive functioning. Furthermore, adaptive functioning and age were moderately negatively correlated. Similarly, Kenworthy et al. (2010) found negative correlations between ASD communication and social deficits, measured using the Autism Diagnostic Interview—Revised (Lord et al. 1994), and adaptive functioning in a sample of high functioning youth and adults (12–22 years) with ASD. These results suggest that higher levels of ASD symptom severity may interfere with an individual's ability to learn adaptive skills. Furthermore, the effect of ASD symptom severity on adaptive functioning may be influenced by an individual's level of intellectual functioning, which is related to adaptive functioning (Gotham et al. 2009). For example, among younger children with higher intellectual functioning, high levels of ASD symptom

severity may negate the positive effects of higher intellectual functioning on adaptive functioning, resulting in poorer adaptive functioning than those with higher intellectual functioning and lower levels of ASD symptom severity.

Current Study

Considering the importance of adaptive functioning to overall quality of life and independent living, research that could help elucidate the development and course of adaptive functioning in ASD is critical. The present study examined two variables—intellectual functioning and ASD symptom severity—that may help explain inconsistent results to date. We propose that both intellectual functioning and ASD symptom severity act in concert to influence the adaptive functioning of youth with ASD differentially across different ages. We examined the possible interaction effects of age, intellectual functioning, and ASD symptom severity in a large sample of youth with ASD with an age range of 4–16 years of age. We hypothesized that higher intellectual functioning and lower ASD symptom severity would be associated with increased adaptive functioning in younger children. However, as youth get older, we expect that higher intellectual functioning would not have a positive impact on adaptive functioning in the context of low or high ASD symptom severity. As children age, the skills that are considered adaptive change from more basic skills such as self-care to more complex skills such as detecting non-verbal cues in social interactions. Due to the shift in the complexity of adaptive skills and the greater need to successfully navigate the social environment, higher intellectual functioning in older children may not be positively associated with adaptive functioning.

Methods

Participants

Archival data from families seen at the Autism Center of Children's Hospital in a city in the Southeast United States between July 2006 and November 2013 were used for this study. The participants included 220 children and adolescents ages 4–16. The youth were evaluated by a licensed clinical psychologist and diagnosed as having an ASD. Our sample was composed of 193 males and 27 females. Of the 220 children and adolescents included in our sample, 21.8 % were African American, 69.1 % were Caucasian, 3.6 % were Hispanic, 4.1 % were Biracial, and 1.4 % identified as other. The diagnostic breakdown of our sample according to DSM-IV-TR criteria was as follows: 96 were diagnosed with Autistic Disorder, 86 were diagnosed with PDD-NOS, 31 were diagnosed with Asperger's Disorder; 7 were diagnosed using the fifth edition of the Diagnostic and Statistical Manual (DSM-5: American Psychiatric Association 2013).

Procedure

Prior to the evaluation, caregivers completed an intake form that asks caregivers background information and the parent report form of the Adaptive Behavior Assessment System—Second Edition (ABAS-II; Harrison and Oakland 2003). On the day of the evaluation, a doctoral level psychologist administered the Autism Diagnostic Interview, Revised (ADI-R; Lord et al. 1994) to the caregivers. Youth were administered a measure of intellectual

functioning by a psychometrist and completed the Autism Diagnostic Observation Schedule (ADOS; Lord et al. 2000) in the presence of the psychologist and a psychometrist. ASD diagnoses were made by the psychologist based on scores obtained on the ADI-R and the ADOS, as well as intellectual testing, behavioral observations, and intake information.

Measures

ASD Symptom Severity—The ADOS (Lord et al. 2000) is a semi-structured, standardized, observation-based assessment that is used to inform diagnosis of an ASD. Individuals suspected of having an ASD are administered one of four modules based the individual's age and verbal ability. The participants in our sample were administered either module 1, module 2, or module 3 of the ADOS. In each module, individuals are presented with various activities that allow the observer to assess behaviors that are directly related to ASD (i.e., deficits in reciprocal social interaction and communication and stereotyped behaviors and restricted interests). Items are coded on a three point scale ranging from 0 (no evidence of abnormal behavior) to 3 (markedly abnormal behavior). Each module includes a diagnostic algorithm that is composed of specific items that are summed. The diagnostic algorithm of the ADOS has separate cutoff scores for autism and non-autism ASD (i.e., Asperger's disorder and PDD-NOS). The ADOS has good inter-rater reliability (most modules have a kappa above .60), internal consistency, and test-retest reliability (Lord et al. 2000).

The ADOS modules were not designed to directly compare raw scores across modules. Furthermore, ADOS raw scores are affected by age and language abilities (Gotham et al. 2009). In order to reduce these effects, each participant's ADOS raw totals were transformed into a calibrated severity score or CSS (Gotham et al. 2009). The CSS allows one to gauge ASD severity with less influence from participants' age and verbal IQ.

Non-Verbal Intellectual Functioning—Due to varying ages and abilities, several measures were used to assess the children's intellectual functioning. Based on the children's age and abilities, they were administered either the Leiter International Performance Scale—Revised (Leiter-R; Roid and Miller 1997), the Wechsler Nonverbal Scale of Ability (WNV; Wechsler and Naglieri 2006), the Wechsler Preschool and Primary Scale of Intelligence—Third Edition (WPPSI-III; Wechsler 2002), the Wechsler Intelligence Scale for Children—Fourth Edition (WISC-IV; Wechsler 2003), or the Wechsler Abbreviated Scale of Intelligence (WASI; Psychological Corporation 1999) as a part of their assessment. Because our measure of ASD symptom severity includes communication impairments, we used the nonverbal IQ obtained on these measures as an indicator of intellectual functioning in order to prevent overpenalizing for deficits in verbal functioning. Although normed on different samples, all measures have a standard score mean of 100 and a standard deviation of 15.

Adaptive Functioning—The Parent/Primary Caregiver Form and the Parent Form of the ABAS-II were used to assess children's adaptive functioning. The ABAS-II is designed to measure the adaptive functioning of individuals from birth to 89 years. The Parent/Primary Caregiver Form is used for individuals ages birth to 5 years and includes 241 items The Parent Form is used for individuals ages 5–21 and includes 232 items. Items are rated using

the following scale: 0 (is not able), 1 (never when needed), 2 (sometimes when needed), and 3 (always when needed). The ABAS-II measures 10 skill areas and yields four composite scores: Conceptual, Social, Practical, and General Adaptive. The General Adaptive Composite is an overall standard score that summarizes an individual's adaptive functioning across all skill areas except the Work skill area. Preschool aged children with PDD-NOS and Autistic Disorder, and an older group of individuals with Autistic Disorder (ages 5–18) were included in the standardization samples of the ABAS-II.

Results

The range of Full Scale IQs in our sample was 36–133. The mean Full Scale IQ for our sample was 77.88 (SD = 16.53). Of the 220 children and adolescents in our sample, 74.5 % had a Full Scale IQ at or above 70. The mean ABAS General Adaptive Composite (GAC) score was 60.07, with a range of 40–109.

Zero-order correlations among the main variables and demographic variables are presented in Table 1. The correlation analyses indicated that age was negatively correlated with ABAS standard GAC scores and positively correlated with calibrated severity scores. Intellectual functioning was positively correlated with ABAS GAC scores.

Independent samples *t* tests were conducted to test for sex differences in the main variables (see Table 2). The results revealed that there was a significant sex difference in intellectual functioning, with males demonstrating significantly higher intellectual functioning than females in this sample. No sex differences were found in age, adaptive functioning scores, or calibrated severity scores.

A hierarchical regression was conducted to test the hypothesis that intellectual functioning and ASD symptom severity would moderate the relation between age and adaptive functioning. In the regression, sex was entered into the first step as a co-variate. In the second step, age, intellectual functioning, and calibrated severity scores, all of which were centered around their respective means, were entered. In the third step, the two-way interactions between age, intellectual functioning, and calibrated severity scores (age $\times$ IQ, age $\times$ CSS, IQ $\times$ CSS) were entered. The three-way interaction term (age $\times$ IQ $\times$ CSS) was entered in the fourth step. A summary of this analysis is presented in Table 3.

The results of the regression indicated that age, intellectual functioning, and the three-way interaction term (i.e., age $\times$ IQ $\times$ CSS) significantly predicted adaptive functioning. The graph (see Fig. 1) of the three-way interaction between age, intellectual functioning, and ASD symptom severity indicated that the association between ASD symptom severity and adaptive functioning was strong for younger children with lower intellectual functioning. For younger children with lower intellectual functioning, greater ASD symptom severity was associated with better adaptive functioning than that of those with lower ASD symptom severity. On the other hand, the effect of ASD symptom severity on adaptive functioning did not vary for younger children with higher intellectual functioning. Among younger children with lower ASD symptom severity, higher intellectual functioning was associated with better adaptive functioning than that of those with lower intellectual functioning. Among older

children, the effect of ASD symptom severity on adaptive functioning was weak at lower levels of intellectual functioning. However, contrary to expectations, among older children, the effect of ASD symptom severity on adaptive functioning was strong at higher levels of intellectual functioning. Specifically, for older children with higher intellectual functioning, greater ASD symptom severity was associated with *better* adaptive functioning than that of those with a lower level of ASD symptom severity. As we hypothesized, higher intellectual functioning and less ASD symptom severity was associated with greater adaptive functioning in younger children.

To test whether the relationship between adaptive functioning and ASD symptom severity was different for the four groups of children, differences in simple slopes were calculated. These analyses indicated that the slope of the line representing younger children with higher intellectual functioning was significantly different from the slope of the line representing older children with higher intellectual functioning ($t = 3.46, p = 0.001$), and younger children with lower intellectual functioning ($t = -2.66, p = 0.008$). The slope of the line representing younger children with higher intellectual functioning was not significantly different from the slope of the line representing older children with lower intellectual functioning ($t = -0.98, p = 0.33$). The slope of the line representing older children with higher intellectual functioning was not significantly different from the slope of the line representing older children with lower intellectual functioning ($t = 1.66, p = 0.10$). The slope of the line representing younger children with lower intellectual functioning was not significantly different from the line representing older children with lower intellectual functioning ($t = -1.35, p = 0.18$) or older children with higher intellectual functioning ($t = 0.413, p = 0.68$). A test of simple slopes revealed a significant positive association between adaptive functioning and ASD symptom severity among younger children with lower intellectual functioning ($t = 2.09, p = 0.04$). Similarly, there was a significant positive association between adaptive functioning and ASD symptom severity among older children with higher intellectual functioning ($t = 2.45, p = 0.01$). The association between adaptive functioning and ASD symptom severity was not significant among younger children with higher intellectual functioning or older children with lower intellectual functioning.

In order to further understand the clinical implications of this pattern, we conducted additional, exploratory analyses within the three subscales of the ABAS-II—Conceptual, Social, and Practical—to determine which domain of adaptive functioning is driving the overall pattern. The three-way interaction was not significant for the Practical subscale ($\beta = 0.10, p = 0.16$). While the overall interaction was significant for the Social subscale ($\beta = 0.14, p = 0.05$), simple slopes and slopes difference tests indicated that there was no significant difference between the lines, nor were any lines different from zero ($ps < 0$). For the Conceptual subscale, however, there was both a significant three-way interaction ($\beta = 0.14, p = 0.04$) and a significant simple slope as well as differences in slopes (see Table 4 and Fig. 2). Specifically, there was a significant positive association between conceptual skills and ASD symptom severity among younger children with lower intellectual functioning ($t = 2.21, p = 0.03$). Furthermore, the slope of the line representing younger children with higher intellectual functioning was significantly different from the slope of the line representing older children with higher intellectual functioning ($t = 2.35, p = 0.02$) and the slope of the line representing younger children with lower intellectual functioning ($t =$

–2.21, $p = 0.03$). The slope of the line representing older children with lower intellectual functioning was significantly different from the slope of the line representing younger children with lower intellectual functioning ($t = -2.08$, $p = 0.04$). These results suggest that the interaction observed in the ABAS-II composite score was driven by differences across age, IQ, and ASD symptom severity in the Conceptual subscale.

Discussion

The present study examined the effects of intellectual functioning and ASD symptom severity on the relation between age and adaptive functioning. Previous studies have found associations between intellectual functioning and adaptive functioning and between ASD symptom severity and adaptive functioning. However, it was unclear how age, intellectual functioning, and ASD symptom severity interact with one another to affect adaptive functioning. Our results indicated that the three-way interaction between age, intellectual functioning, and ASD symptom severity significantly predicted adaptive functioning in youth with ASD. Specifically, our results indicated that for younger children with higher intellectual functioning, lower levels of ASD symptom severity was associated with *better* adaptive functioning than that of younger children with greater ASD symptom severity. On the other hand, for older children with higher intellectual functioning, greater ASD symptom severity was associated with better adaptive functioning than that of older children with lower levels of ASD symptom severity. The association between ASD symptom severity and adaptive functioning was weak for younger children with higher intellectual functioning and older children with lower intellectual functioning. That is, for younger children with higher intellectual functioning and older children with lower intellectual functioning, changes in level of ASD symptom severity did not result in significant changes in adaptive functioning. Exploratory analyses by subscale indicated that this pattern of results was driven by the Conceptual domain, which captures children's functional communication, academics, and self-direction skills.

Surprisingly, there was a significant positive association between adaptive functioning and ASD symptom severity among younger children with lower intellectual functioning and older children with higher intellectual functioning. The positive association between adaptive functioning and ASD symptom severity in younger children with lower intellectual functioning may be due to the expectations that caregivers place on younger children with lower intellectual functioning, particularly within the areas that compose the Conceptual subscale, which includes children's functional communication skills, their functional academic skills, and their self-directions skills required for independent functioning, such as following directions or starting and finishing tasks. The items on the ABAS-II are rated using the scale, "not able, never when needed, sometimes when needed, and always or almost always when needed." Caregivers of younger children with lower intellectual functioning may have lower expectations of when their child "needs" to engage in a particular behavior. Thus, when caregivers complete the ABAS-II, they may respond that their child sometimes or almost always engages in a given behavior at a needed time because their perception of when the child actually needs to engage in the behavior is less frequent than among caregivers of younger children with higher intellectual functioning. For example, a caregiver may respond that their child almost always writes his/her first and last

name. However, if the caregiver assists the child with writing his/her name and the child usually does not need to write his/her name, the child is not engaging in the behavior usually and consistently. Conversely, caregivers of younger children with higher intellectual functioning may respond that their child never or almost never writes his/her first and last name because these caregivers believe that their child is responsible for writing his/her name thus, the child needs to write his/her first and last name but does not do so usually and consistently. Therefore, the adaptive functioning of younger children with lower intellectual functioning as measured by the ABAS-II may be overestimated due to the exceptions of their caregivers. Further analysis of this relation using the Vineland, which asks not when behaviors are “needed” but rather whether they are consistently performed, may help to clarify this suggestion.

A possible explanation for the significant positive association between adaptive functioning and ASD symptom severity in older children with higher intellectual functioning is that over time, children with higher intellectual functioning develop compensatory strategies to alleviate some of the negative effects of greater ASD symptom severity on adaptive functioning. For example, older children with severe communication deficits may develop functional communication through pictures, which would allow them to meet some of their daily environmental demands. Therefore, the adaptive functioning of older children with higher intellectual functioning is not negatively impacted by greater ASD symptom severity.

Our results did not reveal a significant correlation between ASD symptom severity and adaptive behavior. Similarly, Kanne et al. (2011) failed to find a significant correlation between ASD symptom severity, as indicated by ADOS calibrated severity scores, and adaptive functioning in a large sample of 4–17 year olds. However, Perry et al. (2009) found moderate to strong negative correlations between ASD symptom severity and adaptive behavior in younger children (i.e., children ages 22–71 months). The opposite directional effects of ASD symptom severity among younger and older children could account for the lack of associations between ASD symptom severity and adaptive functioning in samples that contain younger and older children and adolescents. However, further research is needed to corroborate these patterns of findings, as our findings did not indicate that age moderated ASD symptom severity.

The results of this study should be considered in light of some limitations. First, our study utilized cross-sectional data. As such, our assumption that we are drawing from a similar population of children and adolescents across ages may not be valid. Given our hypotheses, it is imperative that future studies collect longitudinal data to obtain a better understanding of the relations between age, intellectual functioning, ASD symptom severity, and adaptive functioning. Second, as intellectual functioning decreases, the validity of standardized measures of intellectual functioning decreases; therefore, we may not have established a meaningful level of functioning for children with lower levels of intellectual functioning. Future research may examine whether the relationships found in this study are similar when the Vineland/Vineland-II is used as a measure of adaptive functioning, particularly given that in general, patterns of findings regarding age and adaptive functioning with the ABAS and the Vineland appear to be divergent (cf. Kenworthy et al. 2010; Gabriels et al. 2007).

This study contributes to the extant literature on adaptive functioning in ASD by further elucidating the relationship between age, intellectual functioning, ASD symptom severity, and adaptive functioning in a large sample of children and adolescents with ASD. The results of this study have several clinical implications. While our results did not reveal that greater ASD symptom severity may have a significantly negative impact on younger children with higher intellectual functioning, it would be beneficial to develop early interventions targeting adaptive functioning in addition to symptom-specific deficits. Additionally, although longitudinal studies are needed to determine whether an age effect truly exists, the negative association between age and adaptive functioning that was found in this study indicates that older children and adolescents with ASD are showing greater deficits in their adaptive functioning than younger children with ASD. As such, implementing effective interventions for older children and adolescents with the goal of improving functional independence is critical.

Acknowledgments

Funding This work was supported by a Flowerree Summer Research Award.

References

- American Psychiatric Association. Diagnostic and statistical manual of mental disorders. 5th. American Psychiatric Publishing; Arlington, VA: 2013.
- Charman T, Pickles A, Simonoff E, Chandler S, Loucas T, Baird G. IQ in children with autism spectrum disorders: Data from the Special Needs and Autism Project (SNAP). *Psychological Medicine*. 2011 doi:10.1017/S003329171000099.
- Fisch GS, Simensen RJ, Schroer RJ. Longitudinal changes in cognitive and adaptive behavior scores in children and adolescents with the Fragile X mutation or autism. *Journal of Autism and Developmental Disorders*. 2002 doi:10.1023/A: 101488505185.
- Freeman BJ, Del'Homme MM, Guthrie DD, Zhang FF. Vineland Adaptive Behavior Scale scores as a function of age and initial IQ in 210 autistic children. *Journal of Autism and Developmental Disorders*. 1999 doi:10.1023/A:1023078827457.
- Gabriels RL, Ivers B, Hill DE, Agnew JA, McNeill J. Stability of adaptive behaviors in middle-school children with autism spectrum disorders. *Research in Autism Spectrum Disorders*. 2007 doi: 10.1016/j.rasd.2006.11.004.
- Gazzaniga, MS.; Ivry, RB.; Mangun, GR. *Cognitive neuroscience: The biology of the mind*. 4th. W. W. Norton & Company; New York, NY: 2013.
- Gillespie-Lynch K, Sepeta L, Wang Y, Marshall S, Gomez L, Sigman M, Hutman T. Early childhood predictors of the social competence of adults with autism. *Journal of Autism and Developmental Disorders*. 2012 doi:10.1007/s10803-011-1222-0.
- Gotham K, Pickles A, Lord C. Standardizing ADOS scores for a measure of severity in autism spectrum disorders. *Journal of Autism and Developmental Disorders*. 2009 doi:10.1007/s10803-008-0674-3.
- Harrison, PL.; Boney, TL. Best practices in the assessment of adaptive behavior. In: Thomas, A.; Grimes, J., editors. *Best practices in school psychology IV*. Vol. 1, 2. National Association of School Psychologists; Washington, DC: 2002. p. 1167-1179.
- Harrison, PL.; Oakland, T. *Adaptive behavior assessment system*. 2nd. The Psychological Corporation; San Antonio, TX: 2003.
- Kanne SM, Gerber AJ, Quirnbach LM, Sparrow SS, Cicchetti DV, Saulnier CA. The role of adaptive behavior in autism spectrum disorders: Implications for functional outcome. *Journal of Autism and Developmental Disorders*. 2011 doi:10.1007/s10803-010-1126-4.

- Kenworthy L, Case L, Harms MB, Martin A, Wallace GL. Adaptive behavior ratings correlate with symptomatology and IQ among individuals with high-functioning autism spectrum disorders. *Journal of Autism and Developmental Disorders*. 2010 doi:10.1007/s10803-009-0911-4.
- Klin A, Saulnier C, Sparrow SS, Cicchetti DV, Volkmar FR, Lord C. Social and communication abilities and disabilities in higher functioning individuals with Autism: The Vineland and the ADOS. *Journal of Autism and Developmental Disorders*. 2007; 37:748–759. doi:10.1007/s10803-006-0229-4.
- Lewkowicz DJ, Ghazanfar AA. The emergence of multisensory systems through perceptual narrowing. *Trends in Cognitive Sciences*. 2009 doi:10.1016/j.tics.2009.08.004.
- Liss M, Harel B, Fein D, Allen D, Dunn M, Feinstein C, Rapin I. Predictors and correlates of adaptive functioning in children with developmental disorders. *Journal of Autism and Developmental Disorders*. 2001 doi:10.1023/A:1010707417274.
- Lopata C, Fox JD, Thomeer ML, Smith RA, Volker MA, Kessel CM, Lee GK. ABAS-II ratings and correlates of adaptive behavior in children with HFASDs. *Journal of Developmental and Physical Disabilities*. 2012 doi:10.1007/s10882-012-9277-1.
- Lord C, Risi S, Lambrecht L, Cook EHJ, Leventhal BL, DiLavore PC, Rutter M. The Autism Diagnostic Observation Schedule—Generic: A standard measure of social and communication deficits associated with the spectrum of autism. *Journal of Autism and Developmental Disorders*. 2000 doi:10.1023/A:1005592401947.
- Lord C, Rutter M, Le Couteur A. Autism diagnostic interview—revised: A revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. *Journal of Autism and Developmental Disorders*. 1994 doi:10.1007/BF02172145.
- Luckasson, R.; Borthwick-Duffy, S.; Buntinx, WHE.; Coulter, DL.; Craig, EM.; Reeve, A.; Tasse, MJ. *Mental retardation: Definition, classification, and systems of support*. 10th. American Association on Mental Retardation; Washington DC: 2002.
- Matson JL, Rivet TT, Fodstad JC, Dempsey T, Boisjoli JA. Examination of adaptive behavior differences in adults with autism spectrum disorders and intellectual disability. *Research in Developmental Disabilities*. 2009 doi:10.1016/j.ridd.2009.05.008.
- Paul R, Miles S, Cicchetti D, Sparrow S, Klin A, Volkmar F, Booker S. Adaptive behavior in autism and pervasive developmental disorder-not otherwise specified: Microanalysis of scores on the Vineland adaptive behavior scales. *Journal of Autism and Developmental Disorders*. 2004 doi:10.1023/B:JADD.0000022612.18116.46.
- Perry A, Flanagan HE, Geier J, Freeman NL. Brief report: The Vineland adaptive behavior scales in young children with autism spectrum disorders at different cognitive levels. *Journal of Autism and Developmental Disorders*. 2009 doi:10.1007/s10803-009-0704-9.
- Psychological Corporation. *Wechsler Abbreviated Scale of Intelligence*. Psychological Corporation; San Antonio, TX: 1999.
- Ray-Subramanian CE, Huai N, Weismer S. Brief report: Adaptive behavior and cognitive skills for toddlers on the autism spectrum. *Journal of Autism and Developmental Disorders*. 2011 doi:10.1007/s10803-010-1083-y.
- Roid, GH.; Miller, LJ. *Leiter International Performance Scale-Revised (Leiter-R) manual*. Stoelting; Wood Dale, IL: 1997.
- Schatz J, Hamdan-Allen G. Effects of age and IQ on adaptive behavior domains for children with autism. *Journal of Autism and Developmental Disorders*. 1995 doi:10.1007/BF02178167.
- Schopler, E.; Reichler, RJ.; Renner, BR. *The childhood autism rating scale (CARS)*. Western Psychological Services; Los Angeles, CA: 1988.
- Sparrow, SS.; Balla, DA.; Cicchetti, DV. *Vineland adaptive behavior scales*. American Guidance Service; Circle Pines, MN: 1984.
- Sparrow, SS.; Cicchetti, VD.; Balla, AD. *Vineland adaptive behavior scales*. 2nd. American Guidance Service; Circle Pines, MN: 2005.
- Tomanik SS, Pearson DA, Loveland KA, Lane DM, Shaw J. Improving the reliability of autism diagnoses: Examining the utility of adaptive behavior. *Journal of Autism and Developmental Disorders*. 2007 doi:10.1007/s10803-006-0227-6.

- Wechsler, D. Wechsler preschool and primary scale of intelligence. 3rd. Harcourt Assessment; San Antonio, TX: 2002.
- Wechsler, D. Wechsler intelligence scale for children. 4th. The Psychological Corporation; San Antonio, TX: 2003.
- Wechsler, D.; Naglieri, JA. Wechsler Nonverbal Scale of Ability (WNV). The Psychological Corporation; San Antonio, TX: 2006.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Fig. 1.

Graph of the three-way interaction between age, intellectual functioning, and ASD symptom severity predicting ABAS global composite scores. * Line has a significant *slope* Lines with different subscripts have significantly different slopes

Fig. 2.

Graph of the three-way interaction between age, intellectual functioning, and ASD symptom severity predicting ABAS conceptual scores. * Line has a significant *slope* Lines with different letter or number subscripts have significantly different slopes

Table 1

Summary of correlations between the main variables and demographic variables

Measure	1	2	3	4
1. Age	–	.067	–.179 *	.198 *
2. IQ		–	.252 **	–.015
3. ABAS GAC			–	.065
4. Calibrated severity score				–

IQ = nonverbal IQ on the Leiter-R, WNV, WPPSI-III, WISC-IV, or WASI; ABAS GAC = Global Adaptive Composite on the ABAS-II

*
 $p < .01$,

**
 $p < .001$

Table 2

Mean scores (+SD) for males and females

Variables	Sex	
	Females	Males
Age	8.36 (2.46)	8.24 (2.72)
Calibrated severity score	6.00 (1.71)	6.52 (1.84)
IQ	74.67 (16.39)	85.56 (17.85) ^a
ABAS GAC score	60.04 (12.45)	60.07 (13.08)

IQ = nonverbal IQ on the Leiter-R, WNV, WPPSI-III, WISC-IV, or WASI; ABAS GAC = Global Adaptive Composite on the ABAS-II

^a Means are significantly different at the .05 level

Table 3

Summary of hierarchical regression analysis predicting global adaptive functioning from age, IQ, and ASD symptom severity

Step 1	β (<i>SE B</i>)
Sex	.001 (2.673)
R ²	.000
F	$F(1, 218) = .000$
Step 2	
Age	-.223 (.316) **
IQ	.282 (.047) **
Calibrated severity score	.120 (.466)
R ²	.119
F	$F(3, 215) = 9.666$ **
Step 3	
Age $\times$ IQ	-.033 (.016)
Age $\times$ calibrated severity score	.051 (.189)
IQ $\times$ calibrated severity score	-.039 (.029)
R ²	.006
F	$F(3, 212) = .487$
Step 4	
Age $\times$ IQ $\times$ calibrated severity score	.156 (.011) *
R ²	.020
F	$F(1, 211) = 5.008$ *

Total statistics for model: $R^2 = .145$, $F(8, 211) = 4.479$, $p < .001$

* $p < .05$,

** $p < .01$

Table 4

Summary of hierarchical regression analysis predicting conceptual adaptive functioning from age, IQ, and ASD symptom severity

Step 1	β (<i>SE B</i>)
Sex	.056 (2.554)
R ²	.003
F	$F(1, 218) = .685$
Step 2	
Age	-.180 (.299) **
IQ	.337 (.045) **
Calibrated severity score	.112 (.442)
R ²	.135
F	$F(3, 215) = 11.185^{**}$
Step 3	
Age $\times$ IQ	-.066 (.015)
Age $\times$ calibrated severity score	-.009 (.179)
IQ $\times$ calibrated severity score	-.028 (.027)
R ²	.006
F	$F(3, 212) = .494$
Step 4	
Age $\times$ IQ $\times$ calibrated severity score	.144 (.011) *
R ²	.017
F	$F(1, 211) = 4.369^*$

Total statistics for model: $R^2 = .161$, $F(8, 211) = 5.064$, $p < .001$

* $p < .05$,

** $p < .01$