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Understanding the gap between cognitive abilities and daily living skills in adolescents with autism spectrum disorders with average intelligence

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Abstract

Daily living skills standard scores on the Vineland Adaptive Behavior Scales–2nd edition were examined in 417 adolescents from the Simons Simplex Collection. All participants had at least average intelligence and a diagnosis of autism spectrum disorder. Descriptive statistics and binary logistic regressions were used to examine the prevalence and predictors of a "daily living skills deficit," defined as below average daily living skills in the context of average intelligence quotient. Approximately half of the adolescents were identified as having a daily living skills deficit. Autism symptomatology, intelligence quotient, maternal education, age, and sex accounted for only 10% of the variance in predicting a daily living skills deficit. Identifying factors associated with better or worse daily living skills may help shed light on the variability in adult outcome in individuals with autism spectrum disorder with average intelligence.

Keywords

adaptive behavior; adolescence; autism spectrum disorder; cognitive abilities; daily living skills

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Autism spectrum disorders (ASDs) are considered to be lifelong, but the majority of individuals with ASD exhibit improvements in ASD-related symptoms and behaviors by the time they reach adolescence or young adulthood (Seltzer et al., 2004; Shattuck et al., 2007). Thus, particularly for some individuals with ASD, such as those with higher intelligence quotient (IQ) and/or milder ASD symptoms, the hope is that they will achieve positive adult outcomes, including residential independence, postsecondary education, employment, social interaction with peers, and community participation. Unfortunately, longitudinal investigations have indicated that adult outcomes are generally quite poor for individuals diagnosed with ASD during childhood (Eaves and Ho, 2008; Farley et al., 2009; Howlin et al., 2004).

Cognitive ability has been found to be the best prognostic indicator of outcome in adulthood (Eaves and Ho, 2008; Farley et al., 2009; Lord and Bailey, 2002). However, even among

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those with IQs over 70, there is still substantial variability in rates of adult "success." For example, Howlin et al. (2004) reported that only 32% of adults with nonverbal IQs over 70 had a "Good" or "Very Good" outcome as measured by their functioning in the areas of friendship, employment, and independent living. Thus, while cognitive ability affects the overall likelihood of a positive adult outcome for individuals with ASD, having a higher IQ does not necessarily ensure a better outcome. This finding is especially discouraging when considering individuals with ASD with average or above average intelligence because there is no cognitive impairment impeding their ability to lead independent adult lives. Furthermore, "intellectually able" individuals with ASD are often only eligible for a limited number of interventions and services after leaving high school (Taylor and Seltzer, 2010), which places the responsibility for adult care entirely on their families should they fail to achieve independence.

As more and more adolescents with ASD make the transition to adulthood, it is critical to identify the factors that promote a more successful adult outcome. Given that IQ is clearly not the only determinant of adult success among individuals with higher IQs, more research is needed to understand the observed gap between these individuals' "potential" for success (e.g. as measured by IQ) and their actual rates of independence in adulthood.

Poor adaptive behavior is one potential explanation for the worse than expected outcomes observed in adults with ASD with average or above average intelligence. It has been well established that individuals with ASD demonstrate impaired adaptive behavior skills relative to their cognitive abilities. Previous researchers have described the "autism profile" as being characterized by significant deficits in socialization, lesser deficits in communication, and a relative strength in daily living skills (DLS) (Carter et al., 1998; Klin et al., 2007; Volkmar et al., 1987). Interestingly, deficits in adaptive behavior appear to be more pronounced in individuals with ASD with higher IQs; those with lower IQs are more likely to exhibit adaptive behavior skills that are commensurate with their cognitive abilities (Kanne et al., 2011; Klin et al., 2007; Perry et al., 2009).

Despite the fact that children and adolescents with ASD exhibit a relative adaptive behavior strength in the area of DLS, they have poorer DLS than children with other developmental disorders or typically developing children (Gillham et al., 2000; Kenworthy et al., 2009; Klin et al., 2007; Liss et al., 2001). As is the case with overall adaptive behavior skills, some research suggests that deficits in DLS are more pronounced in children with ASD with higher IQs. Liss et al. (2001) reported that children with higher IQs exhibited relatively greater impairments in DLS compared to those with lower IQs. Additionally, Klin et al. (2007) found a negative relationship between age and DLS in intellectually able individuals with ASD, suggesting that deficits in DLS may worsen with age for these individuals because they are not acquiring skills at the same rate as their typically developing peers (see also Kanne et al., 2011).

Together, these studies indicate that adaptive behavior deficits are highly prevalent in individuals with ASD and may be especially prominent in those with higher cognitive abilities. Impaired adaptive behavior skills likely contribute to overall poor outcomes in adults with ASD and may help explain the variability in outcomes among individuals with

ASD with higher IQs. For example, difficulties with everyday activities such as bathing, cooking, cleaning, and handling money could drastically reduce an individual's chance of achieving independence in adulthood. In fact, Farley et al. (2009) found that scores in the area of DLS was the variable most highly correlated with a positive outcome in 41 adults with ASD who had IQs of at least 70. The finding that better DLS may facilitate a positive adult outcome is very promising because unlike many other skills that are lacking in individuals with ASD, DLS tend to be relatively explicit and concrete and may therefore be more amenable to intervention (see Hume et al., 2009). Furthermore, many DLS (e.g. cooking from a recipe, taking a shower, and setting an alarm clock) that are critical to success in the adult world do not rely as heavily as other adaptive behavior skills on the social–communication abilities impaired in individuals with ASD.

A deeper understanding of DLS profiles in adolescents with ASD could lead to the development of supports and interventions that facilitate a more optimal adult outcome. Unfortunately, very little is known about what factors are related to DLS deficits in individuals with ASD. This information is needed to understand why some individuals with ASD with average intelligence exhibit age-appropriate DLS, and others perform at a level far below age expectations. A body of research has demonstrated that overall adaptive behavior in individuals with ASD is associated with age (Kanne et al., 2011; Klin et al., 2007) and IQ (Charman et al., 2011; Kanne et al., 2011; Klin et al., 2007; Liss et al., 2001; Perry et al., 2009), but studies on the relationship between adaptive behavior and autism symptomatology have been less conclusive (Charman et al., 2011; Kanne et al., 2011; Klin et al., 2007; Liss et al., 2001; Perry et al., 2009). For example, in a group of 9- to 14-year-olds with ASD, IQ, and lifetime social scores (i.e. retrospective parent reports of social symptoms when the child was between 4 and 5 years old) on the Autism Diagnostic Interview–Revised (ADI-R; Rutter et al., 2003) were the only significant predictors of overall adaptive behavior scores (Charman et al., 2011). Kanne et al. (2011) also found strong associations between adaptive behavior and lifetime ADI-R scores in a sample of children and adolescents with ASD from the Simons Simplex Collection (SSC) but found weak associations between adaptive behavior and concurrent clinician-observed symptoms on the Autism Diagnostic Observation Schedule (ADOS; Lord et al., 1999). Several studies have also found links between adaptive behavior and internalizing and externalizing symptoms. For example, Sikora et al. (2012) found that children with ASD who had clinically significant attention deficit hyperactivity disorder (ADHD) symptoms had significantly lower DLS as compared to children who had ASD alone. In another recent study, Drahota et al. (2011) found that the DLS of children with ASD increased after they participated in a cognitive behavioral intervention that targeted reducing anxiety symptoms. The authors hypothesized that this gain in DLS occurred because parents who participated in the intervention gained a new perspective on the skills their child could obtain and decreased their level of involvement in their child's specific self-care skills.

Given the potential association between adaptive behavior (especially DLS) and adult independence, it is critical to gain a clearer understanding of which factors are related to better or worse DLS in children and adolescents with ASD. The current study examined the prevalence and predictors of DLS deficits in a large sample of adolescents with ASD. We chose to focus on DLS because they have been linked to positive adult outcome, seem to be more amenable to intervention, and are not as confounded with the social–communication impairments that are core to the disorder. We focused specifically on pre-adolescents and adolescents because of the importance of DLS to individuals on the verge of the transition from middle school and high school to adulthood. In addition, we limited our examination to adolescents with average or above average intelligence, as they would be expected to be capable of achieving average DLS on the basis of their cognitive abilities.

Method

Participants

Participants were obtained from the SSC, a North American multisite, university-based research study that collected phenotypic and genetic information from over 2600 simplex families (see Fischbach and Lord, 2010, for additional information about the SSC). Prior to inclusion in the SSC, probands with ASD, who were between the ages of 4 and 18 years, were evaluated with a battery of measures to assess autism symptomatology, cognitive ability, adaptive behavior, and emotional and behavior problems. Participants who did not meet study diagnostic criteria for ASD based on the results of the ADI-R (Lord et al., 1994), ADOS (Lord et al., 1999), and/or expert clinical judgment were excluded. Participants who had a nonverbal mental age below 18 months, medically significant perinatal incidents, severe neurological deficits, birth trauma, or genetic disorders such as Fragile X or Down syndrome were also excluded (see www.sfari.org for detailed information about SSC eligibility criteria).

Because the current study was focused specifically on adaptive behavior in adolescence, only participants between the ages of 10 years, 0 months and 17 years, and 11 months were included. In addition, only participants with a norm-referenced full-scale IQ (FSIQ) score of 85 or above and a Vineland Adaptive Behavior Scales–2nd edition (Vineland-II; Sparrow et al., 2005) DLS standard score were included. This resulted in a final sample of 417 adolescents with ASD (sample characteristics are presented in Tables 1 and 2).

Measures

Autism symptomatology.—Autism symptoms in probands were measured using the ADI-R and ADOS. The ADI-R is a well-established, semistructured parent interview that assesses both current and past symptoms in the areas of communication, reciprocal social interaction, and restricted and repetitive behaviors. Multiple studies have established the validity and reliability of the ADI-R (Lecavalier et al., 2006; Lord et al., 1997). Current scores from the ADI-R were used because of our interest in examining the relationship between current autism symptoms and DLS. Three ADI-R current total scores were calculated for each participant. A social–communication symptom total was created by summing current scores from items in the Reciprocal Social Interaction and the Communication–Verbal Subjects Only domains of the ADI-R algorithm for individuals 10 years and older. The combined social–communication total was used in place of separate totals to be consistent with proposed *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; *DSM-5)* criteria which collapse social and communication symptoms into a single domain (American Psychiatric Association, 2011). Two repetitive behavior symptom totals were also calculated: a Repetitive Sensory Motor (RSM) total and an Insistence on Sameness (IS) total (see Bishop et al., 2013). Consistent with ADI-R algorithm scoring conventions, item scores of 3 were converted to 2 prior to being included in the total scores. Higher total scores indicate greater impairment.

The ADOS is a semistructured, clinician-administered instrument that assesses social–communication impairments and repetitive behaviors. The ADOS consists of four modules that are administered to individuals based on language and developmental level. In 2007, revised diagnostic algorithms were published that have been shown to be reliable and valid in differentiating children with ASD from those with non-ASD diagnoses (Gotham et al., 2007). Revised algorithm raw score totals can be used to derive a Calibrated Severity Score (CSS) based on an individual's age and level of language (Gotham et al., 2009). The CSS ranges from 1 to 10, with higher scores indicating greater symptom severity. The ADOS authors recommend that the CSS be used as a measure of autism severity instead of raw totals because the CSS is less heavily influenced by age or IQ. Because revised algorithms and CSS are only currently available for Modules 1–3, the CSS could not be calculated for participants who completed Module 4 of the ADOS (n = 51).

Cognitive abilities.—FSIQ scores were derived from either the *Wechsler Abbreviated Scale of Intelligence (WASI*; Wechsler, 1999), *Wechsler Intelligence Scale for Children* (4th ed., *WISC-IV*; Wechsler, 2003a), or the *Differential Abilities Scales* (2nd ed., *DAS-II*; Elliot, 2007). Most participants were administered the *DAS-II* (n = 350), followed by the *WASI* (n = 47), and the *WISC-IV* (n = 20). For all participants, the manual-derived, norm-referenced standard score was used as a measure of FSIQ. All of these cognitive measures have been validated and are commonly used in studies of children and adolescents with ASD (Minshew et al., 2005; Ozonoff et al., 2005, for a review). Convergent validity has been established between the *DAS-II* and the *WISC-IV* (Elliot, 2007) and between the *WISC-IV* and the *WASI* (Wechsler, 2003b). There were no significant differences in mean FSIQ scores between participants who received the three different cognitive tests ($p = 0.92$).

Adaptive behavior.—The Vineland-II (Sparrow et al., 2005) is a clinician-administered parent interview that is commonly used as a measure of adaptive behavior for children and adolescents with ASD (Carter et al., 1998; Kanne et al., 2011; Klin et al., 2007). All items are rated on a 3-point scale (i.e. 0 = never, 1 = sometimes or partially, and 2 = usually). For individuals over the age of 7 years, separate standard scores are provided for the communication, socialization, and DLS domains, as well as for the overall adaptive behavior composite. The DLS domain standard score was used as a measure of current DLS.

Emotional and behavioral problems.—The Child Behavior Checklist (CBCL; Achenbach and Rescorla, 2001) form for children 6–18 years yields T-scores for the Internalizing Problems scale, which includes the syndrome scales of Anxious/Depressed, Withdrawn/Depressed, and Somatic Complaints and the Externalizing Problems scale, which includes the syndrome scales of Rule-Breaking Behavior and Aggressive Behavior. The CBCL 6–18 form has been shown to be a valid measure of emotional and behavioral disorders in individuals with ASD (Pandolfi et al., 2011). All items are rated on a 3-point scale (i.e. 0 = not true, 1 = somewhat or sometimes true, and 2 = very true or often true). For the current study, T-scores from the Internalizing Problems and Externalizing Problems were used to measure internalizing and externalizing symptoms. T-scores of 65–69 are in the borderline range and T-scores above 69 are in the clinical range (higher scores indicate more symptoms).

Calculation of a DLS Deficit.—All participants were categorized as having either a *DLS Deficit* or *No DLS Deficit* based on their FSIQ and Vineland-II DLS scores. The presence of a *DLS Deficit* was determined differently for participants with FSIQs between 85 and 99 than for participants with FSIQs ≥100 (see below).

For participants with FSIQs between 85 and 99, a FSIQ-DLS difference score was first calculated by subtracting the Vineland-II DLS domain standard score from the FSIQ. It was determined that a difference score greater than 15 (i.e. at least 1 standard deviation) indicated (1) a significant difference according to the Vineland-II manual guidelines (Sparrow et al., 2005) and (2) DLS below what would be expected based on cognitive ability. For example, an individual with an FSIQ of 90 and a DLS domain score of 72 would be classified as having a *DLS Deficit*, whereas an individual with an FSIQ of 90 and a DLS domain score of 78 would be classified as having *No DLS Deficit*.

For participants with FSIQs ≥ 100, the presence of a *DLS Deficit* was determined differently so as not to "over-penalize" participants with above average cognitive abilities. In other words, we did not want to classify an adolescent with an FSIQ in the above average range and a DLS domain score in the adequate range as having a *DLS Deficit* just because his or her DLS score was significantly lower than his or her FSIQ score (e.g. an FSIQ of 130 and a DLS score of 110). Therefore, it was determined that a reasonable expectation would be for adolescents with IQs over 100 to have a DLS domain score that fell in at least the adequate range (i.e. 85 or above), as this indicates DLS that are commensurate with chronological age expectations (even if still lower than cognitive abilities). In summary, participants with an FSIQ > 100 were classified as having a *DLS Deficit* if their DLS domain score fell below the adequate range (i.e., <85). They were classified as having *No DLS Deficit* if their DLS domain score fell in or above the adequate range.

Design and analysis

All analyses were conducted using SPSS Version 17 (2008). Correlations were run to examine the relationship between FSIQ and the DLS standard score on the Vineland-II. To examine the prevalence of DLS deficits, frequencies were run for individuals classified as having a *DLS Deficit* or *No DLS Deficit*. Frequencies were also run to examine the prevalence of specific Vineland-II DLS classifications (e.g. adequate and moderately low). For illustrative purposes, frequencies are presented separately across three FSIQ groups (FSIQ > 114, FSIQ 100–114, and FSIQ 85–99).

Group comparisons were examined between those classified as having a *DLS Deficit* versus *No DLS Deficit* on measures of FSIQ, autism symptomatology, externalizing and internalizing symptoms, age, and gender. Due to the large sample size, statistical significance was set at $p < 0.01$.

Binary logistic regressions were conducted to identify which factors were most predictive of a *DLS Deficit*. In the first model, only participants with an ADOS CSS (n = 358) were included. The dependent variable was the presence of a *DLS Deficit* and the independent variables entered were age, gender, maternal education, FSIQ, current social–communication symptoms on the ADI-R, current RSM symptoms on the ADI-R, current IS symptoms on the ADIR, ADOS CSS, and internalizing and externalizing symptoms on the CBCL. In the second model, all participants were included and the ADOS CSS was removed as an independent variable. Race was not included in either model because the vast majority of the sample was Caucasian (n = 352), and there were very few participants in other racial categories (see Table 1).

Results

Relationship between FSIQ and DLS

Results revealed that there was a significant correlation between FSIQ and the DLS standard score on the Vineland-II for the entire sample, r (417) = 0.17, $p < 0.001$. Within the three FSIQ groups, there was only a significant correlation between FSIQ and DLS for the FSIQ 85–99 group, r(168) = 0.16, $p = 0.03$; and there was not a significant correlation for the FSIQ 100–114 group ($p = 0.58$) or the FSIQ > 114 group ($p = 0.95$).

Prevalence of DLS Deficits across IQ groups

Approximately 56.4% (n = 235) of participants were classified as having a *DLS Deficit*, whereas 43.6% (n = 182) of participants were classified as having *No D LS Deficit* (see Table 3). Figure 1 illustrates the Vineland-II DLS classification scores for participants in the three FSIQ groups. Despite all participants having FSIQs in at least the average range, 17.0%−26.2% of individuals across the three FSIQ groups had DLS that fell within the range of mild to moderate deficit according to the Vineland-II manual (i.e. standard scores ranging from 40 to 69). There was a significant difference in Vineland-II DLS standard scores among the three FSIQ groups, F(2, 414) = 6.30, $p = 0.002$ (see Figure 2). Specifically, post hoc t-tests revealed that individuals in the FSIQ > 114 group did have significantly higher Vineland-II DLS scores as compared to the FSIQ 85–99 group (p = .001). There were no statistically significant differences in Vineland-II DLS scores between the FSIQ > 114 group and the FSIQ 100–114 group ($p = 0.15$), and the FSIQ 85–99 group and the FSIQ 100–114 group (p = 0.34).

Predicting DLS deficit

Correlations were run to determine whether there were any issues with multicollinearity between the variables included in the linear and binary logistic regressions. There were significant correlations between ADI-R RSM and ADI-R IS, r (416) = 0.36, $p < 0.001$; ADI-R RSM and ADI-R Social–Communication, r (410) = 0.30, $p < 0.001$; and ADI-R IS and ADI-R Social-Communication, r (409) = 0.31, $p < 0.001$. There were no other significant correlations above r = 0.30 between the variables included in the linear and binary logistic regressions. The results from the linear regression are summarized in Tables 4 and 5. In the first regression analysis that was restricted to participants with an ADOS CSS, the model was significant, $\chi^2 = 28.6$, df = 11, $p = 0.003$), but only accounted for 10.3% of the variance

(Nagelkerke R^2). Level of current social–communication symptoms on the ADI-R (higher score/more symptoms) was the only significant predictor. In the second regression analysis that included the entire sample and did not include ADOS CSS as a predictor, the model was significant, $\chi 2 = 31.8$, df = 10, $p < 0.001$, accounting for 10.1% of the variance (Nagelkerke R^2). Current social–communication symptoms on the ADI-R (higher score/more symptoms) and age (older) were the only significant predictors.

Discussion

The current study examined factors associated with the gap between cognitive abilities and DLS in adolescents with ASD with average or above average IQ. Given that DLS may be positively related to adult outcomes, identifying factors associated with a *DLS Deficit* has implications for interventions designed to promote independence (e.g. transition programs). Results indicated that among these adolescents, more than half had DLS that were significantly below what would be expected based on their FSIQ. Furthermore, approximately a quarter of the sample had DLS below 70. While past research has documented lower than expected scores in overall adaptive behavior in individuals with ASD, it is surprising that DLS were also found to be so deficient in these intellectually able adolescents. DLS are neither a core deficit of ASD nor as confounded with social–communication skills as other areas of adaptive behavior (i.e. communication and socialization), thus the high prevalence of DLS deficits in this group is a significant cause for concern.

Interestingly, the only significant predictors of a *DLS Deficit* identified in this study were older age and greater parent-reported social–communication symptoms, and the overall model only accounted for a very small percentage (10%) of the variance. Neither parent-reported restricted and repetitive behaviors nor clinician-observed ASD symptoms on the ADOS were associated with a higher likelihood of exhibiting a *DLS Deficit*. This suggests that, at least among adolescents with average or above average intelligence, DLS are not strongly related to autism severity (at least as measured by the ADI-R and ADOS). Thus, adolescents with ASD with average intelligence may have the potential to acquire age-appropriate DLS regardless of the severity of their autism symptoms. This is a particularly exciting finding given that improving DLS may increase the likelihood of achieving independence in adulthood.

The lack of a strong association between the presence of a *DLS Deficit* and factors such as ASD symptomatology offers the opportunity to explore other predictors. It is highly plausible that other factors may influence the development of DLS, including individual characteristics often associated with a diagnosis of ASD such as executive functioning or receptive language abilities; family variables such as number of siblings, socioeconomic status, race, and emotional well-being of caregivers; and environmental factors or resources, such as receiving services or accommodations at school, classroom placement, and involvement in extracurricular activities (see Anderson et al., 2009; Benson et al., 2008; Orsmond et al., 2004; Smith et al., 2008, for studies that have examined the effects of environmental factors in individuals with ASD). Future research needs to investigate how these variables play a role in the acquisition of DLS in adolescents with ASD so that interventions that target DLS can be designed with relevant factors in mind.

Regardless of the specific factors influencing the likelihood that an individual will exhibit a *DLS Deficit*, there is clearly a need to address the substantial gap between cognitive ability and actual performance in activities of daily living. Addressing these skills prior to the transition to adulthood is crucial if we expect young adults to have the necessary skills to live independently. To this point, there has been very little research on the development, implementation, and effectiveness of interventions targeting DLS in individuals with ASD—especially intellectually able adolescents with ASD. Yet there are numerous opportunities for implementing such interventions. For example, techniques such as video modeling, self-monitoring, and individual work systems may be beneficial for developing and maintaining DLS because they not only provide structure, use visual strategies, and proceed in a predictable and clear sequence, but they also promote increased independence and decreased reliance on adult support (Hume et al., 2009). Alternatively, in a recent study of school-aged children with ASD undergoing cognitive behavioral therapy to address symptoms of anxiety, results indicated that DLS significantly increased at post-treatment and follow-up (Drahota et al., 2011). Thus, aspects of cognitive behavioral therapy such as encouraging skill acquisition and self-sufficiency may lead to improvements in DLS, as well. In another study, a manualized parent training program that used behavioral techniques to decrease behavior problems and noncompliance and teach developmental skills was also found to be effective in increasing adaptive behavior skills in children and young adolescents with ASD (Research Units on Pediatric Psychopharmacology (RUPP), 2007). The school setting may be an ideal environment in which to target these skills, as specific goals can be outlined under the independent living section of the transition plan in the adolescent's Individualized Education Plan (IEP).

Limitations

Our analyses were restricted to variables included in the SSC, so there were many factors (particularly family and environmental factors) that we were not able to examine with respect to their relationship to DLS. Our sample was primarily Caucasian and relatively well educated, so more diverse samples will be needed to examine whether race/ethnicity and/or socioeconomic status affect the likelihood of exhibiting a *DLS Deficit*. Furthermore, the SSC had stringent inclusion criteria (i.e. only one child within a family can have a diagnosis of ASD, must meet criteria on both the ADOS and ADI-R), which may limit the generalizability of these findings. Another significant limitation of the study was its cross-sectional design. Longitudinal studies are needed to more clearly understand the links between DLS, other aspects of the ASD cognitive and behavioral phenotype, and adult outcome, as well as to explore the relationship between age and DLS and adult outcome, including when and how progress begins to slow as compared to same-aged peers and what DLS are most difficult to acquire. For example, a recent study by Smith et al. (2012) found that DLS improved in adolescents with ASD, plateaued in young adulthood and then declined in 30-year-olds with ASD.

Conclusion

Research suggests that better DLS are associated with increased independence in adulthood. In this sample of adolescents with average or above average IQ, half had DLS that were significantly below chronological age and IQ expectations, and a quarter had DLS in the low range of adaptive functioning (i.e. below 70). Future research should focus on identifying factors associated with the presence of a *DLS Deficit* and developing and evaluating interventions that target the acquisition of DLS in children and adolescents with ASD. Interventions that simultaneously consider individual, family, and environmental factors, as well as techniques that lead to skill acquisition in individuals with ASD, will likely be most successful in increasing DLS because the skills can be taught with a focus on the strengths and weaknesses of the family and implemented across environments (e.g. home, school, and in the community) to increase generalization. It will also be important to determine whether interventions that target DLS have spillover effects into areas such as relationships with peers and participation in community and school activities.

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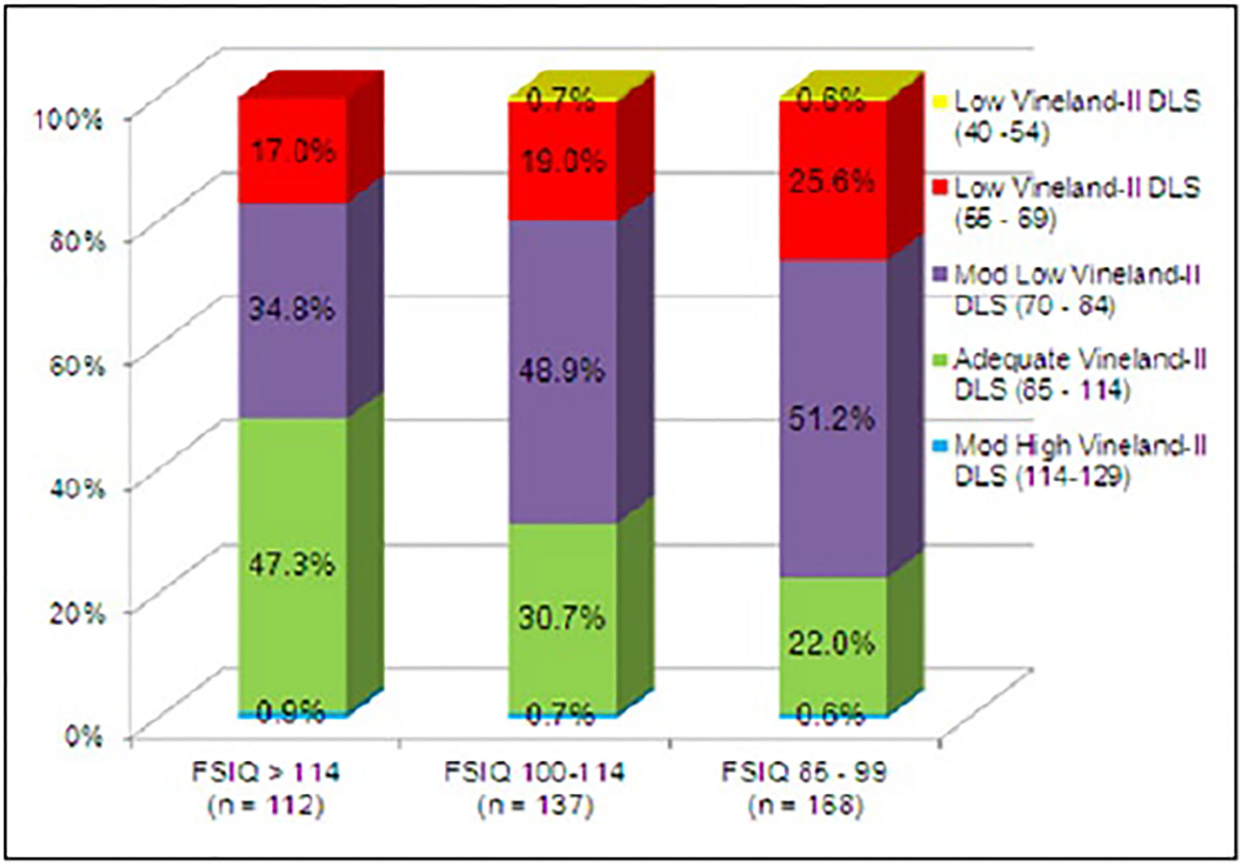

Figure 1. Vineland-II DLS classification across IQ classification in adolescents with ASD.

Vineland-II: Vineland Adaptive Behavior Scales (2nd ed.); DLS: daily living skills; IQ: intelligence quotient; ASD: autism spectrum disorder.

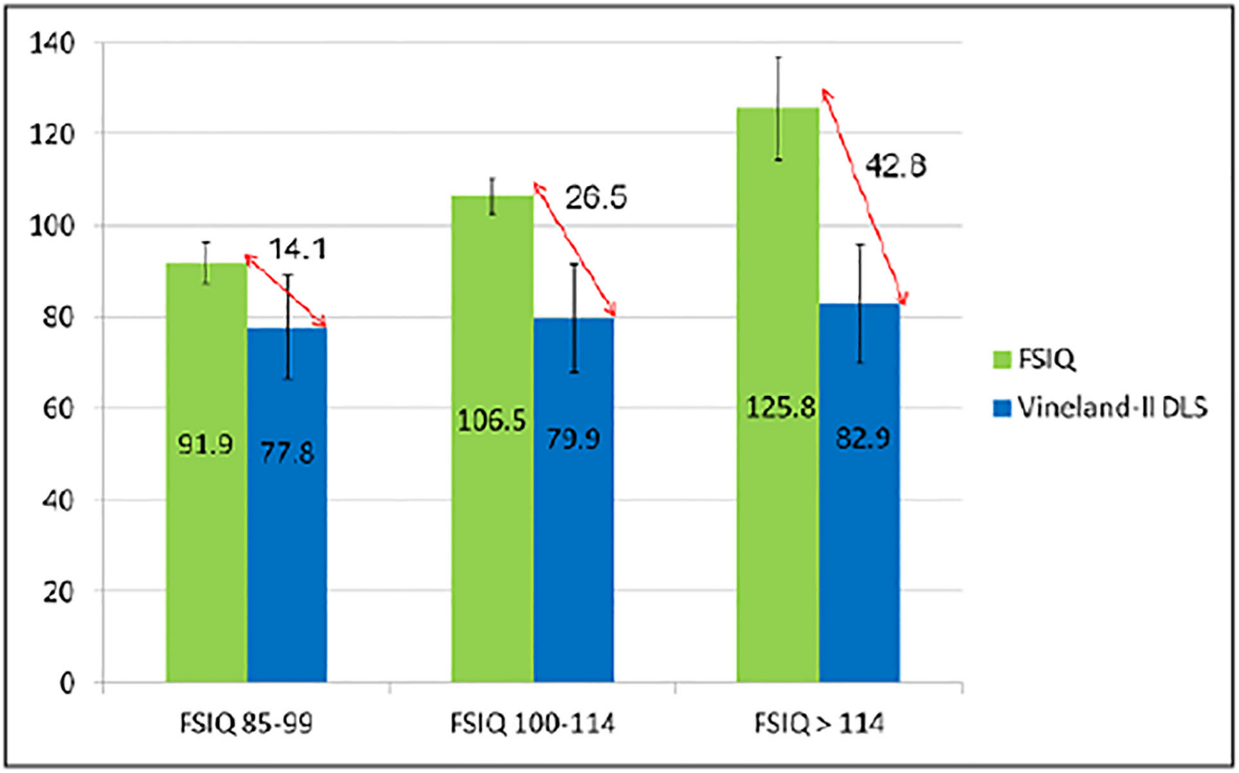

Figure 2. Mean FSIQ-DLS difference score across three FSIQ groups.
FSIQ: full-scale intelligence quotient; DLS: daily living skills.

Table 1.

Sample demographics (n = 417).

	Frequency	Percent
Sex		
Male	377	90.4
Female	40	9.6
Race		
White/Caucasian	352	84.4
African American	8	1.9
Other	57	13.7
Best-estimate diagnosis		
Autism	363	87.1
ASD	30	7.2
Asperger's disorder	24	5.7
Highest maternal education		
High school or less	41	9.9
Some college	124	29.8
Baccalaureate or graduate	251	60.3
IQ test		
DAS-II school age	350	83.9
WASI	*47*	11.3
WISC-IV	20	4.8

ASD: autism spectrum disorder; IQ: intelligence quotient; *DAS-II: Differential Abilities Scales* (2nd ed.); *WASI: Wechsler Abbreviated Scale of Intelligence; WISC-IV: Wechsler Intelligence Scale for Children* (4th ed.).

Table 2.

Sample characteristics (n = 417).

	Mean (SD)	Range
Age (months)	156.6 (26.5)	120–215
ADI-R RSM	2.5 (2.1)	0–10
ADI-R IS	4.0 (2.5)	0–10
ADI-R Social-Communication	12.3 (4.8)	1–26
ADOS CSS	6.9 (1.7)	4–10
Vineland-II daily living skills	79.9 (12.1)	52–119
Vineland-II communication	78.7 (9.8)	57–132
Vineland-II socialization	71.1 (10.7)	45–103
Vineland-II adaptive behavior composite	74.5 (8.7)	00165
CBCL Externalizing Problems	54.9 (11.2)	33–78
CBCL Internalizing Problems	63.3 (9.3)	34–86
Nonverbal IQ	105.2 (18.3)	75–161
Verbal IQ	105.9 (14.4)	51–167
Full-scale IQ	105.7 (15.3)	85–167

SD: standard deviation; ADI-R: Autism Diagnostic Interview-Revised; RSM: Repetitive Sensory Motor; IS: Insistence on Sameness; ADOS: Autism Diagnostic Observation Schedule; CSS: Calibrated Severity Score; CBCL: Child Behavior Checklist; IQ: intelligence quotient.

Table 3.

Group means and differences.

	Daily living skills deficit (n = 235)	No daily living skills deficit (n = 182)
Age (months)*	160.3 (27.7)	151.9 (24.3)
Sex (male:female ratio)	9.7:1	9.1:1
ADI-R RSM	2.7 (2.2)	2.3 (1.9)
ADI-R IS	4.1 (2.5)	4.0 (2.4)
ADI-R Social–Communication*	13.1 (4.8)	11.2 (4.7)
ADOS CSS	6.9 (1.7)	6.9 (1.7)
Full-scale IQ	106.5 (14.1)	104.8 (16.6)
CBCL Internalizing	63.8 (9.5)	62.8 (8.9)
CBCL Externalizing	55.1 (11.1)	54.6 (11.3)

ADI-R: Autism Diagnostic Interview-Revised; RSM: Repetitive Sensory Motor; IS: Insistence on Sameness; ADOS: Autism Diagnostic Observation Schedule; CSS: Calibrated Severity Score; CBCL: Child Behavior Checklist; IQ: intelligence quotient.

* $p < 0.001$.

Table 4.

Statistics for binary logistic regression assessing prediction of daily living skills deficit in adolescents with ASD with FSIQ ≥ 85 and who have an ADOS CSS score.

	B	SE	Wald	Odds ratio, Exp (B)
Constant	−2.82	1.52	3.44	0.06
Age	0.01	0.01	5.67	1.01
Sex	0.32	0.39	0.67	1.37
Maternal education				
High school or less and baccalaureate/graduate	0.26	0.39	0.43	1.29
Some college and baccalaureate/graduate	−0.27	0.25	1.10	0.77
FSIQ	0.001	.01	.03	1.00
ADI-R				
Social–Communication	0.08	0.03	10.10*	1.09
RSM	0.12	0.06	3.95	1.13
IS	−0.05	0.05	0.85	0.95
ADOS CSS	−0.11	0.07	2.54	0.90
CBCL Internalizing	0.01	0.02	0.49	1.01
CBCL Externalizing	−0.003	0.01	0.08	1.00

ASD: autism spectrum disorder; FSIQ: full-scale IQ; SE: standard error; ADI-R: Autism Diagnostic Interview-Revised; RSM: Repetitive Sensory Motor; IS: Insistence on Sameness; ADOS: Autism Diagnostic Observation Schedule; CSS: Calibrated Severity Score; CBCL: Child Behavior Checklist; IQ: intelligence quotient.

χ^2 (n = 357, df = 11) = 28.63, $p = 0.003$, Nagelkerke $R^2 = 0.103$.

* $p \geq 0.01$.

Table 5.

Statistics for binary logistic regression assessing prediction of daily living skills deficit in adolescents with ASD with FSIQ ≥ 85.

	B	SE	Wald	Odds ratio, Exp (B)
Constant	−3.87	1.30	8.81*	0.02
Age	0.01	0.004	9.86*	1.01
Sex	0.01	0.36	0.001	1.01
Maternal education				
High school or less and baccalaureate/graduate	0.25	0.37	0.45	1.29
Some college and baccalaureate/graduate	−0.22	0.24	0.82	0.81
FSIQ	0.01	0.01	1.37	1.01
ADI-R				
Social–Communication	0.08	0.03	10.04*	1.08
RSM	0.10	0.06	2.93	1.10
IS	−0.05	0.05	0.88	0.96
CBCL internalizing	0.01	0.01	0.31	1.01
CBCL externalizing	−0.004	0.01	0.16	1.00

ASD: autism spectrum disorder; FSIQ: full-scale IQ; SE: standard error; ADI-R: Autism Diagnostic Interview-Revised; RSM: Repetitive Sensory Motor; IS: Insistence on Sameness; ADOS: Autism Diagnostic Observation Schedule; CSS: Calibrated Severity Score; CBCL: Child Behavior Checklist; IQ: intelligence quotient.

χ^2 (n = 407, df = 10) = 31.78, $p < 0.001$, Nagelkerke $R^2 = 0.101$.

*$p \geq 0.01$.