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Post–High School Daily Living Skills in Autism Spectrum Disorder

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Post-High School Daily Living Skills Outcomes in Autism Spectrum Disorder

RH = Post-High School DLS Outcomes in ASD

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Abstract

Objective: Daily living skills are a predictor of positive outcomes in individuals with autism spectrum disorder (ASD), yet little is known about trajectories of daily living skills in adults with ASD. This study investigated the impact of high school exit on participants' trajectories of daily living skills age equivalent (DLS-AE) scores from ages 2-26 and the relationship between DLS-AE trajectories and employment and education outcomes.

Method: 98 adults with ASD were drawn from an ongoing longitudinal study. The Vineland Adaptive Behavior Scales were administered 8 times from ages 2-26. Employment and education data were compiled from parent-report demographic forms.

Results: DLS-AE trajectories modestly increased with age prior to exiting school, at which point DLS-AE trajectories plateaued, then declined. A significant ($p < .01$) decrease occurred in the slope of DLS-AE trajectories following school exit. High DLS-AE scores predicted participation in post-secondary education (X^2 (5, n = 73) = 27.83, $p < .001$). Autism symptom severity predicted participation in employment (X^2 (5, n = 58) = 27.54, $p < .001$).

Conclusion: These findings provide evidence that DLS declines in adults with ASD, specifically after school exit, and highlight the importance of DLS in normative adult outcomes. Future work should examine the trajectories of DLS in middle and later adulthood and consider intervention targets for bolstering DLS following school exit.

Key words: autism spectrum disorder, adaptive function, daily living skills, adulthood, developmental trajectories

INTRODUCTION

Young adults with autism often share the same goals as their typical peers of achieving independence, establishing positive relationships and finding employment or fulfilling daily activities. However, many struggle to attain these ambitions [1-3]. Though many skill sets can contribute to a successful transition to adulthood, one commonality necessary to achieving all these goals is strong adaptive functioning.

Deficits in adaptive behavior—or communication, social, and daily living skills (DLS) abilities that promote independent functioning—are common amongst individuals with ASD [4,5]. DLS include proficiencies necessary for transitioning to adulthood, including personal care, time and money management, and chores [6,7]. Strong DLS are positively correlated with better outcomes amongst individuals with ASD [8-10]. Daily living skills are not solely determined by IQ. Individuals with ASD and average intelligence can show impairments in DLS [5,11]. Conversely, DLS may be comparatively less impaired in individuals with ASD and intellectual disability (ID) than IQ or social-communicative ability [12,13]. In addition, daily living skills can be taught and systematically supported in individuals with autism across a range of abilities [14,15]. Given 1) the positive correlation between DLS and better outcomes in ASD and 2) the accessibility of DLS to individuals of varying intellectual ability, an in-depth understanding of DLS developmental trajectories could shed light on strategies for improving adult outcomes in ASD [9,16].

Longitudinal research on DLS in ASD is relatively rare. The current literature suggests DLS age equivalents, though not necessarily standard scores [8, 17], tend to increase throughout childhood, but the DLS of children with ASD are lower and increase more slowly than in typical children and children with ID [5,18]. Moreover, DLS age equivalents of individuals with ASD may increase at an even slower rate in adolescence than childhood, resulting in lower standard scores

[16,20]. It has been suggested that DLS age equivalents may begin to decline as individuals with autism enter their mid- to late-twenties [9] though evidence for this is inconclusive [19]. Given the relationship between higher DLS and positive outcomes, this is troubling. This study reports DLS scores collected longitudinally from early childhood well into adulthood (e.g., age 26) and so allows us to observe these possible changes.

Post-High School Outcomes

Within the United States, individuals with ASD lose access to an array of school-based services in the years immediately preceding and following high school exit, with the majority of adults with autism receiving no vocational or life skills services after school exit [21,22]. This abrupt change has been linked to slowed rates of improvement in autism symptomatology in early adulthood [23]. It has been suggested that DLS in adults with autism may decrease, precipitated by school exit [9,19]; however, this has not been explicitly tested. The current study seeks to rectify this by comparing the slope of DLS trajectories in our sample before and after school exit.

Following high school exit, many young people with ASD are unprepared for independence in adulthood [23]. There is evidence to suggest that participation in employment decreases as adults with ASD age [10]. Higher DLS may be a protective factor for positive adult outcomes, including employment and post-secondary education. A prior study in a separate longitudinal sample of adults with ASD found that stronger adaptive behaviors were associated with more independent vocational and educational activities over a ten-year period [10]. The current study expands these findings by testing whether DLS trajectory can predict participation in employment and education immediately following and several years after high school exit. This study also extends previous work in this sample [19] by specifically testing the rate of change of DLS trajectories before and after school exit.

Work conceptualizing adult outcome typologies [2,24] and comparing the comparing the outcomes of ASD and non-ASD individuals [25] in this sample has been recently published. This study complements this recent work, but differs in its specific focus on DLS trajectories, as well as how these trajectories change as a function of school exit and map on to normative employment and education outcomes.

Study Aims

Our first aim was to characterize our sample's DLS trajectories from 2-26. Previous results in this sample from 2-21 suggested that DLS was beginning to plateau as participants moved through adolescence [19], with two diverging trajectories generally related to ability level. We expected to replicate these trajectories and to see evidence of a downward trend in trajectories at age 26.

Our second aim was to examine the impact of high school exit on the slope of daily living skills in the identified trajectories. We hypothesized that DLS would increase with age preceding school exit but would decline following school exit [9,23].

Our third aim was to investigate the relationship between DLS trajectories and post-high school employment and education outcomes. We anticipated that controlling for IQ and autism symptom severity, stronger DLS would be associated with increased likelihood of finding employment and attending post-secondary education.

Method

Participants

213 consecutive referrals under 37 months old at clinics in North Carolina and Chicago were initially enrolled in a longitudinal study of ASD. 192 participants were referred for autism and 21 participants were referred for non-spectrum developmental delays. 40 children of similar

age and diagnostic characteristics from Michigan joined the study at about age 9 and were seen at the same times thereafter, resulting in 253 participants total. In-person assessments were completed at ages 2, 3, 5, 9, 18, 21, and 26. Additional parent-interviews were completed at age 14. This sample has been described extensively in previous work [19,24,26].

The current analyses include 492 assessments of 98 individuals with at least three Vineland assessments, at least one of which was completed after high school exit. Due to our specific focus on how school exit impacts DLS trajectories, we chose to only include individuals with at least one DLS data point following school exit. Participants in this subset did not significantly differ from participants lost due to missing data or attrition by gender $X^2(1, 253) = .18$, $p = .75$, ethnicity = $X^2(1, 250) = 2.03$, $p = .27$, caregiver education $X^2(1, 253) = 2.02$, $p = .18$, recruitment site $X^2(1, 253) = 1.792$, $p = .41$, ever/never having ASD $X^2(1, 253) = 2.46$, $p = .13$, or IQ $t(122) = .745$, $p = .45$. However, excluded participants were more likely to be African American than included participants $X^2(4,98) = 11.46$, $p = .02$. Descriptive characteristics of the subsample and total sample are displayed in Table S1, available online.

Procedures

Questionnaires and direct testing, including the Autism Diagnostic Observation Schedule, Second Edition (ADOS-2) [27], IQ tests chosen from a standard hierarchy [24] and parent interviews conducted by a trained research assistant, specifically the Vineland Adaptive Behavior Scales, Second Edition (VABS-II) [6], the Autism Diagnostic Interview-Revised (ADI-R) [28] and the Social Emotional Functioning Interview (SEF-S and SEF-I) [29], were completed at participants' homes. Parents and participants over 18 who were their own legal guardians gave written consent as required by the relevant institutional review board(s) prior to visits.

Measures

Daily Living Skills. The VABS (Vineland Adaptive Behavior Scales 2nd edition) [6,7] was used to assess daily living skills (DLS) during in-person visits and a phone interview at age 14. The VABS is a caregiver-interview assessment of adaptive behavior composed of three domains: communication, daily living skills, and socialization. DLS is divided into three subdomains—personal, domestic, and community—which each produce an age equivalent (AE) score approximating the chronological age of typical development which matches an individual's abilities. For this study, subdomain AEs were averaged into an overall DLS age equivalent (DLS-AE) [19].

IQ. The Mullen Scales of Early Learning [30] were administered at age 2. Later cognitive assessments were chosen from a standard hierarchy including the Weschler Intelligence Scale for Children (WISC) [31], Wechsler Abbreviated Scale of Intelligence (WASI) [32], Differential Abilities Scale (DAS) [33], and Mullen [26,34]. Ratio IQs were calculated when raw scores fell outside deviation score ranges. See Table 1 for IQs in adulthood.

Diagnosis. Clinicians made best-estimate diagnoses of ASD, other developmental disabilities, or typical development at each in-person visit, except age 3. 17 individuals in the current subset never received a diagnosis of autism despite numerous assessments. These individuals did not differ from participants with ASD in IQ ($t(1, 76) = 0.41$, $p = .68$), post-school education ($X^2(1, 97) = 0.12$, $p = .73$) or employment outcomes ($X^2(1, 79) = 1.52$, $p = .22$). Given considerable overlap in challenges faced during young adulthood and the importance of DLS for individuals with autism and other developmental disabilities, these 17 participants were analyzed in conjunction with ASD participants [25]. Diagnoses were stable throughout childhood, though there was variability in a subset of participants which has been discussed elsewhere [26, 35]. Participants' most recent ADOS calibrated severity scores (CSS) are displayed in Table 1.

Education and Employment Status. Data from parent-report demographic forms completed at ages 18, 21, and 26-years were used to determine participants' education and employment status at two timepoints, 1) the first data collection timepoint after high school exit (M = 19.06 years, SD = 1.68) and 2) the most recent data collection timepoint at which the participant had been seen (M = 25.77 years, SD = 2.40). Employment was defined as current full- or part-time work, including employment with supports, but *not* including placement in vocational habilitation settings. Education was defined as current full-or part-time attendance of a four-year institution, a two-year institution, or a vocational education/certification program. Participant education and employment outcomes were coded as 1 or 0, for present or absent.

Data Analysis

To examine DLS and to extend previous findings in this sample [19], group-based trajectory modeling was performed using the traj plugin in Stata 16 [36-38]. Group based trajectory modeling estimates developmental trajectories via maximum likelihood estimation using a general quasi-Newton procedure. Missing data are handled by estimating the model using all available information. The best fitting model (linear, quadratic, etc.) and number of trajectory groups were determined using Bayesian Information Criteria (BIC).

Eight timepoints of VABS assessment were used as independent variables to analyze the latent grouping of individuals in their DLS-AE trajectories. Unconditional 2, 3, and 4 class models were compared using Bayesian Information Criterion (BIC) and the smallest group membership percentage (Figure 1). After classes were determined, higher order effects were tested to establish whether cubic, quadratic, linear, or intercept modeling best explained variation over time. To aid in model selection, the average posterior probabilities were evaluated to determine adequate model fit (above 0.70) [39]. We then compared the composition of classes by

diagnosis (Ever or Never ASD), gender, race, caregiver education, ADOS CSS scores, and education and employment statuses with chi square analyses (Table 2). The mixed procedure in Stata 16 was used to investigate rates of change in DLS-AE trajectories. The cut-off age for receipt of school-based services varies by state, individuals with ASD and other developmental disabilities exit school at different ages. In this sample, the average age of school exit was 20.01 (SD = 2.07, range 17-26). Multilevel modeling flexibly accounts for discrepancies in age while capturing individual variability. Binary logistic regressions were used to test the effect of DLS-AE trajectory on employment and education statuses, controlling for IQ, ADOS CSS, and race.

Results

Trajectories of DLS

A two-group model (Figure 1) was determined to be the best fit, based on the percentage of variance explained. The first trajectory group, Low DLS-AE, comprised 46.3% of the sample and was characterized by a linear increase in DLS, and the second group, Higher DLS-AE, comprised 53.7% of the sample and was characterized by a quadratic increase in DLS (Figure 1). Prior work by Bal and colleagues (2015) using the same longitudinal cohort up to age 21 found a Low DLS-AE trajectory comprising 66.2% of the sample, and a Higher DLS-AE trajectory comprising 33.8% of the sample. As shown in Figure 1, the DLS-AE of the higher and lower trajectories were similar in early childhood but diverged with increasing age [19]. In the present analyses, the Lower DLS-AE group's linear trajectory was characterized by slow gains from ages 2-21, with a small dip in DLS-AE at age 26. The higher-DLS group's quadratic trajectory was characterized by an increase in DLS-AE from ages 2-18, followed by a marginal increase in DLS-AE at age 21 and a decrease in DLS-AE at age 26.

Rate of Change in DLS by Trajectory Group Before and After HS Exit

Multilevel modeling was used to investigate whether the slopes of the DLS-AE trajectory groups varied as a function of high school exit. The data were fit using a crossed-effects model with random slopes and intercepts for age, with race, IQ, ADOS CSS, and caregiver education as covariates. The model indicated that there was a significant effect of age ($p < .001$) on DLS-AE and a significant effect of high school exit ($p = .002$) on DLS-AE (Table 4). There was also a significant interaction between age and high school exit, indicating that participants in the higher DLS-AE trajectory finished high school at younger ages than participants in the low DLS-AE trajectory ($p = .008$). IQ ($p < .001$). Race ($p = .01$) also significantly contributed to the model. Prior to school exit, participants' DLS trajectories increased with age. Upon school exit, the slope of participants' DLS trajectories significantly declined ($p < .01$), suggesting participants' growth in DLS diminishes after school exit. In the low trajectory group, DLS-AE scores continued to increase through the mean age of high school exit ($M = 21.15$, $SD = 1.97$), but declined by age 26. In the higher trajectory group, after high school exit ($M = 19.09$, $SD = 1.59$), absolute DLS-AE scores continued to increase slightly, but with a marked decrease associated after school exit, from 0.95 points gain per year between ages 14-18, to 0.11 points gain per year between ages 18-21, with continued declines at age 26 (Table 3).

DLS Trajectories and Adult Outcomes

Chi-square analyses indicated participants in the Higher DLS-AE trajectory were significantly more likely to be in post-secondary education at the first timepoint after school exit ($X^2 = 21.89$, p <.001) and significantly more likely to be employed at the most recent timepoint ($X^2 = 15.18$, p <.001) than the Lower DLS-AE trajectory (Table S2, available online). Binary logistic regressions were subsequently performed to assess the impact of DLS trajectory group on post-high school education and employment outcomes while controlling for covariates. In all

regression models, IQ, DLS trajectory group and an IQ*DLS trajectory interaction term were entered in the first block. To account for the fact that participants not included in these analyses because of attrition or missing data were significantly more likely to be African American (p = .02) and participants in the higher DLS trajectory group had significantly lower ADOS CSS scores than participants in the low DLS trajectory, ADOS CSS and race were entered in the second block. These regression models are summarized in Table S3, available online.

The first block of the post-secondary education model was significant (X^2 (3, n = 73) = 24.47, p < .001). The model correctly classified 75.3% of cases. DLS trajectory group was a significant predictor of participation in post-secondary education at the first timepoint after high school exit (p = .017) and IQ was a marginally significant predictor (p = .071). The interaction between IQ and DLS trajectory was not significant (p = .311). The inclusion of race and ADOS CSS in the second block did not significantly contribute to the model (p = .187).

The overall model of employment at the most recent contact was also significant (X^2 (5, n = 58) = 27.54, p < .001). The model correctly classified 77.6% of cases. ADOS CSS was a significant predictor of employment at the most recent timepoint (p = .02). DLS trajectory group (p = .48), IQ (p = .98), IQ*DLS trajectory interaction (p = .41, and race (p = .56) were not significant predictors. Lower ADOS CSS predicted employment several years following high school exit.

Discussion

The present study illustrates important changes in daily living skills that occur as individuals with autism enter adulthood. Replicating and extending prior work in this sample [19], we found participants' DLS-AE trajectories increased with age prior to leaving the school system, at which point DLS-AE appeared to decline in the low trajectory group, and plateau, then decline

in the higher trajectory group. On average, DLS-AE scores increased in the years preceding school exit and increased at a slower rate or declined following school exit. Additionally, even when controlling for IQ, higher DLS-AE scores predicted participation in post-secondary education, whereas ADOS CSS predicted employment after school exit. The gains in daily living skills individuals with autism make in childhood appear to lessen in adulthood, however, strong daily living skills remain a predictor of post-secondary education.

The trajectories of DLS-AE seen here extend Bal et al.'s (2015) previous work in this sample. Other work has further shown that the DLS trajectories of adults with ASD in this sample fall below those of similarly followed IQ-equivalent adults with a history of neurodevelopmental disorders but not autism [25]. However, more information on later timepoints in adulthood is needed to confirm whether this change in DLS trajectories is a true decline rather than a temporary blip. The current findings are similar to Smith et al.'s (2012) results in a separate longitudinal sample indicating DLS trajectories decline in adulthood in individuals with ASD, with evidence of a trend that extended into middle adulthood. Smith et al. (2012) saw a steeper decline in DLS than seen in the current sample. This difference might be attributable to the wider age range of Smith et al.'s sample or our use of the Vineland Adaptive Behavior Scales [6], rather than the more concise Waisman Activities of Daily Living Scale (W-ADL) [40]. Despite these differences in sampling and measurement, results of the present study and that of Smith and colleagues (2012) are similar.

The DLS-AE slopes of both trajectory groups significantly decreased following school exit. By specifically testing the rate of change (i.e. slope) of DLS trajectories before and after school exit, this finding supports previous work suggesting DLS-AE trajectories decline in young adulthood [9,19]. Previous work in adults with ASD found a significant slowing of

improvements in autism symptom severity and internalizing problems following school exit [22]. This appears similar to the changes in DLS-AE seen in our sample between ages 18 and 21. Before declining at age 26, means in both DLS-AE trajectory groups increased from ages 18-21, but at a significantly slower rate than at earlier ages. Considered together with the current findings, this suggests school exit is associated with changes in a constellation of characteristics in adults with ASD, perhaps in part due to a loss of school-based services [20,21]. However, more information is needed to determine individual factors that promote or inhibit growth during this developmental period.

Higher DLS-AE increased the likelihood of post-secondary education in our sample. Strong DLS, such as personal care, time management, and financial planning, are important to success in post-secondary education, and may serve as a protective factor for students with ASD. However, contrary to our hypotheses, less severe symptoms during the ADOS were a stronger predictor of employment than higher DLS-AE. One explanation is that the social-communicative deficits associated with ASD exacerbate hurdles associated with obtaining and maintaining employment. Thus, social-communicative abilities may play a stronger role in helping adults with ASD find or maintain employment than DLS. In a separate analysis of the same longitudinal cohort, Pickles et al. (2020) found ADOS CSS and verbal and nonverbal IQ at age 2 significantly predicted adult outcome typology, including employment, but DLS at age 2 did not. In fact, DLS scores at age 2 were similar for the higher- and lower-DLS trajectory groups, despite considerable divergence in later in development (Figure 1). Meaningful variations in DLS amongst individuals with ASD may not become apparent until later childhood.

This sample was drawn from a longitudinal cohort first evaluated nearly thirty years ago, and thus represents a unique group of adults with ASD. Further, the sample described here is

relatively small. Attrition has reduced the number of African American participants in the longitudinal cohort.

Though the subsample of individuals without ASD included in this study is heterogenous, their adult outcomes appear more similar than different from those of individuals with ASD [25, 41]. Both groups experience considerable difficulty transitioning to adulthood. Future work should continue examining similarities and differences in the adult outcomes of individuals with ASD and other neurodevelopmental disorders.

To determine the extent of the decline in DLS after high school exit—and if this decline continues into adulthood—future work on DLS should include individuals in middle and later adulthood [41]. At present, relatively little is known about adulthood in autism, and still less is known about middle and older adulthood autism [42]. Though some prior studies have included a subset of older adults with ASD [9,10], work using a well-characterized cohort of individuals is needed to understand DLS-AE trajectories in middle and later adulthood. As increasing numbers of individuals with ASD enter adulthood each year [43], understanding the presentation of ASD in later stages of the life course should become a research priority.

DLS is one of many factors that can contribute to the adult outcomes of individuals with ASD. In our sample, autism severity as measured by ADOS CSS was a stronger predictor of employment in adulthood than DLS-AE trajectory. Other characteristics, including IQ [24,26], internalizing and externalizing symptoms [23,44], and executive functioning [45], both separately and in combination, likely also play a role in determining the adult outcomes of individuals with ASD, and should be examined further. Examinations of directionality in the relationship between DLS and adult involvement in employment and education are needed as well.

There are many ways to conceptualize "good" adult outcomes in ASD [2]. Education and employment were examined here as normative outcomes for young adults, however, these outcomes may not be appropriate nor desirable for all adults with autism [46,47]. The measures reported here do not touch upon subjective well-being and other important markers of quality of life [2, 24]. Given the heterogeneity of abilities and needs amongst individuals with ASD, future research should strive for broader, developmental conceptualizations of "good" outcomes [2, 48, 49].

Daily living skills are a predictor of positive outcomes in ASD, yet little is known about the course of daily living skills as individuals with ASD enter adulthood. The current study investigated the impact of high school exit on participants' trajectories of daily living skills. Extending prior work in this sample [19], we found participants' DLS-AE trajectories increased with age prior to leaving the school system, at which point DLS-AE trajectories appeared to plateau, then decline. We found evidence of a significant change in DLS-AE trajectories following school exit. Finally, we found that high DLS-AE scores predicted participation in post-secondary education, though ADOS CSS was a stronger predictor of obtaining employment after school exit. Future work is needed to examine the trajectories of DLS in middle and later adulthood and to consider intervention targets for bolstering DLS following school exit, possibly through increasing community involvement and independence in domestic activities and personal care.

References

1. Howlin P, Magiati I. Autism spectrum disorder: outcomes in adulthood. *Curr Opin Psychiatry*. 2017;30(2):69-76. doi:10.1097/YCO.0000000000000308

2. McCauley JB, Pickles A, Huerta M, Lord C. Defining Positive Outcomes in More and Less Cognitively Able Autistic Adults. *Autism Res*. n/a(n/a). doi:10.1002/aur.2359

3. Orsmond GI, Shattuck PT, Cooper BP, Sterzing PR, Anderson KA. Social Participation Among Young Adults with an Autism Spectrum Disorder. *J Autism Dev Disord*. 2013;43(11):2710-2719. doi:10.1007/s10803-013-1833-8

4. Farmer C, Swineford L, Swedo SE, Thurm A. Classifying and characterizing the development of adaptive behavior in a naturalistic longitudinal study of young children with autism. *J Neurodev Disord*. 2018;10(1):1. doi:10.1186/s11689-017-9222-9

5. Kanne SM, Gerber AJ, Quirmbach LM, Sparrow SS, Cicchetti DV, Saulnier CA. The Role of Adaptive Behavior in Autism Spectrum Disorders: Implications for Functional Outcome. *J Autism Dev Disord*. 2011;41(8):1007-1018. doi:10.1007/s10803-010-1126-4

6. Sparrow SS, Cicchetti DV, Balla DA. *Vineland Adaptive Behavior Scales*. 2nd ed. American Guidance Service Inc; 2005.

7. Sparrow SS, Cicchetti DV. Diagnostic uses of the vineland adaptive behavior scales. *J Pediatr Psychol*. 1985;10(2):215-225. doi:10.1093/jpepsy/10.2.215

8. Di Rezze B, Duku E, Szatmari P, et al. Examining Trajectories of Daily Living Skills over the Preschool Years for Children with Autism Spectrum Disorder. *J Autism Dev Disord*. 2019;49(11):4390-4399. doi:10.1007/s10803-019-04150-6

9. Smith LE, Maenner MJ, Seltzer MM. Developmental Trajectories in Adolescents and Adults With Autism: The Case of Daily Living Skills. *J Am Acad Child Adolesc Psychiatry*. 2012;51(6):622-631. doi:10.1016/j.jaac.2012.03.001

10. Taylor JL, Center VK, Mailick MR. A Longitudinal Examination of 10-year Change in Vocational and Educational Activities for Adults with Autism Spectrum Disorders. *Dev Psychol*. 2014;50(3):699-708. doi:10.1037/a0034297

11. Duncan AW, Bishop SL. Understanding the gap between cognitive abilities and daily living skills in adolescents with autism spectrum disorders with average intelligence. *Autism*. 2015;19(1):64-72. doi:10.1177/1362361313510068

12. Alvares GA, Bebbington K, Cleary D, et al. The misnomer of 'high functioning autism': Intelligence is an imprecise predictor of functional abilities at diagnosis. *Autism*. Published online June 19, 2019:136236131985283. doi:10.1177/1362361319852831

13. Matthews NL. Adaptive Functioning in Autism Spectrum Disorder During the Transition to Adulthood. *J Autism Dev Disord*. Published online 2015:12.

14. Bennett KD, Dukes C. A Systematic Review of Teaching Daily Living Skills to Adolescents and Adults with Autism Spectrum Disorder. *Rev J Autism Dev Disord*. 2014;1(1):2-10. doi:10.1007/s40489-013-0004-3

15. Wehman P, Schall C, McDonough J, et al. Competitive Employment for Transition-Aged Youth with Significant Impact from Autism: A Multi-site Randomized Clinical Trial. *J Autism Dev Disord*. Published online March 1, 2019. doi:10.1007/s10803-019-03940-2

16. Baghdadli A, Assouline B, Sonié S, et al. Developmental Trajectories of Adaptive Behaviors from Early Childhood to Adolescence in a Cohort of 152 Children with Autism Spectrum Disorders. *J Autism Dev Disord*. 2012;42(7):1314-1325. doi:10.1007/s10803-011-1357-z

17. Green SA, Carter AS. Predictors and course of daily living skills development in toddlers with autism spectrum disorders. *J Autism Dev Disord*. 2014;44(2):256-263. doi:10.1007/s10803-011-1275-0

18. Flanagan HE, Smith IM, Vaillancourt T, et al. Stability and Change in the Cognitive and Adaptive Behaviour Scores of Preschoolers with Autism Spectrum Disorder. *J Autism Dev Disord*. 2015;45(9):2691-2703. doi:10.1007/s10803-015-2433-6

19. Bal VH, Kim S-H, Cheong D, Lord C. Daily living skills in individuals with autism spectrum disorder from 2 to 21 years of age. *Autism*. 2015;19(7):774-784. doi:10.1177/1362361315575840

20. Gabriels RL, Ivers BJ, Hill DE, Agnew JA, McNeill J. Stability of adaptive behaviors in middle-school children with autism spectrum disorders. *Res Autism Spectr Disord*. 2007;1(4):291-303. doi:10.1016/j.rasd.2006.11.004

21. Laxman DJ, Taylor JL, DaWalt LS, Greenberg JS, Mailick MR. Loss in services precedes high school exit for teens with autism spectrum disorder: A longitudinal study. *Autism Res Off J Int Soc Autism Res*. 2019;12(6):911-921. doi:10.1002/aur.2113

22. Shattuck PT, Wagner M, Narendorf S, Sterzing P, Hensley M. Post–high School service use among young adults with an autism spectrum disorder. *Arch Pediatr Adolesc Med*. 2011;165(2). doi:10.1001/archpediatrics.2010.279

23. Taylor JL, Seltzer MM. Changes in the Autism Behavioral Phenotype During the Transition to Adulthood. *J Autism Dev Disord*. Published online 2010:16.

24. Pickles A, McCauley JB, Pepa LA, Huerta M, Lord C. The adult outcome of children referred for autism: typology and prediction from childhood. *J Child Psychol Psychiatry*. Published online January 19, 2020:jcpp.13180. doi:10.1111/jcpp.13180

25. Lord C, McCauley JB, Pepa LA, Huerta M, Pickles A. Work, living, and the pursuit of happiness: vocational and psychosocial outcomes for young adults with autism. *Autism*. Published online May 20, 2020: doi: 10.1177/1362361320919246

26. Anderson DK, Liang JW, Lord C. Predicting young adult outcome among more and less cognitively able individuals with autism spectrum disorders. *J Child Psychol Psychiatry*. 2014;55(5):485-494. doi:10.1111/jcpp.12178

27. Lord C, Rutter M, DiLavore PC, Risi S, Gotham K, Bishop S. *Autism Diagnostic Observation Schedule: ADOS-2*. Western Psychological Services Torrance; 2012.

28. Le Couteur A, Lord C, Rutter M. The autism diagnostic interview-revised (ADI-R). *Los Angel CA West Psychol Serv*. Published online 2003:659–685.

29. Rutter M, LeCouteur A, Lord C, Macdonald H, Rios P, & Folstein S. (1988). Diagnosis and subclassification of autism. In Schopler E, Mesibov G, ed. *Diagnosis and Assessment in Autism* New York, NY: Springer; 1988:239–259.

30. Mullen E. Mullen Scales of Early Learning. *Circle Pines, MN, American Guidance Service*. 1995.

31. Wechsler D. Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV). *San Antonio, TX, PsychCorp.* 2003.

32. Wechsler D. Wechsler Abbreviated Scale of Intelligence. *San Antonio, TX, PsychCorp*. 1999.

33. Elliott CD. Differential ability scales, 2nd edition. *San Antonio, TX, Harcourt Assessment*. 2007.

34. Risi S, Lord C, Gotham K, et al. Combining information from multiple sources in the diagnosis of autism spectrum disorders. *J Am Acad Child Adolesc Psychiatry*. 2006;45(9):1094-1103. doi:10.1097/01.CHI.0000227880.42780.0E

35. Lord C, Risi S, DiLavore P, Shulman C, Thurm A, Pickles A. Autism from 2 to 9 years of age. *Arch Gen Psychiatry.* 2006;63(6):694-701. doi:10.1001/archpsyc.63.6.694

36. Jones B, Nagin D. Advances in group-based trajectory modeling and an SAS procedure for estimating them. *Sociol Methodol.* 2007;35(4):542-571. doi:10.1177/0049124106292364

37. Jones B, Nagin D. A note on a Stata plugin for estimating group-based trajectory models. *Sociol Methodol.* 2013;42(4):608-613. doi:10.1177/0049124113503141

38. Jones B, Nagin D, Roeder K. A SAS procedure based on mixture models for estimating developmental trajectories. *Sociol Methodol.* 2001;29(3):374-393. doi:10.1177/0049124101029003005

39. Nagin D. *Group-based modeling of development.* Boston, MA: Harvard University Press; 2005.

40. Maenner MJ, Smith LE, Hong J, Makuch R, Greenberg JS, Mailick MR. Evaluation of an activities of daily living scale for adolescents and adults with developmental disabilities. *Disabil Health J*. 2013;6(1):8-17. doi:10.1016/j.dhjo.2012.08.005

41. Mawhood L, Howlin P, Rutter M. Autism and developmental receptive lagnuage disorder--a comparative follow-up in early adult life. I: Cognitive and language outcomes. *J Child Psychol Psychiatry.* 2000;41(5):547-559.

42. Piven J, Rabins P. Autism Spectrum Disorders in Older Adults: Toward Defining a Research Agenda. *J Am Geriatr Soc*. 2011;59(11):2151-2155. doi:10.1111/j.1532-5415.2011.03632.x

43. Roux AM, Shattuck PT, Cooper BP, Anderson KA, Wagner M, Narendorf SC. Postsecondary employment experiences among young adults with an autism spectrum disorder. *J Am Acad Child Adolesc Psychiatry*. 2013;52(9):931-939. doi:10.1016/J.JAAC.2013.05.019

44. Woodman AC, Mailick MR, Greenberg JS. Trajectories of internalizing and externalizing symptoms among adults with autism spectrum disorders. *Dev Psychopathol*. 2016;28(2):565-581. doi:10.1017/S095457941500108X

45. Wallace GL, Kenworthy L, Pugliese CE, et al. Real-World Executive Functions in Adults with Autism Spectrum Disorder: Profiles of Impairment and Associations with Adaptive Functioning and Co-morbid Anxiety and Depression. *J Autism Dev Disord*. 2016;46(3):1071-1083. doi:10.1007/s10803-015-2655-7

46. Black MH, Mahdi S, Milbourn B, et al. Perspectives of key stakeholders on employment of autistic adults across the united states, australia, and sweden. *Autism Res*. 2019;12(11):1648-1662. doi:10.1002/aur.2167

47. Scott M, Milbourn B, Falkmer M, et al. Factors impacting employment for people with autism spectrum disorder: A scoping review. *Autism*. 2019;23(4):869-901. doi:10.1177/1362361318787789

48. Bal VH, Hendren RL, Charman T, et al. Considerations from the 2017 IMFAR Preconference on Measuring Meaningful Outcomes from School-Age to Adulthood. *Autism Res*. 2018;11(11):1446-1454. doi:10.1002/aur.2034

49. Lounds Taylor J. When is a good outcome *actually* good? *Autism*. 2017;21(8):918-919. doi:10.1177/1362361317728821

Table 1. IQ and Autism Severity Scores by Daily Living Skills Age Equivalent (DLS-AE) Trajectory Groups

	Lower DLS-AE		**Higher DLS-AE**				
	n	m(SD)	*n*	m(SD)	***t***	**df**	***p***
Non-verbal IQ	35	42.49(36.03)	42	86.1(34.19)	5.44	75	<.001
Verbal IQ	35	41.86(39.21)	42	84.24(36.53)	4.87	75	<.001
Full-Scale IQ	37	41(36.63)	47	83.68(36.53)	5.17	82	<.001
ADOS CSS Score	37	7.35(1.81)	46	4.78(2.69)	4.96	81	<.001

Note: ADOS = Autism Diagnostic Observation Schedule; CSS = calibrated severity scores.

Table 2. Descriptive Characteristics by Daily Living Skills Age Equivalent (DLS-AE) Trajectory Groups

		Total	**Low DLS-AE**		**High DLS-AE**			
		N = 97	***n* = 42**		***n* = 55**			
		***n*(%)**	**ASD *n* = 35**	**Non-ASD *n* = 7**	**ASD *n* = 45**	**Non-ASD *n* =10**	**X^2 (df, N)**	***p***
Gender	Male	77 (78.6)	28	3	42	4	1.405(1,97)	0.31
	Female	21 (21.4)	7	4	3	6		
Ethnicity	Non-Hispanic/Latino	91 (92.9)	33	6	41	10	1.321(2,97)	0.52
	Hispanic/Latino	5 (5.1)	2	1	2	0		
	Prefer not to answer	2 (2.0)	1	0	1	0		
Race	White	79 (80.6)	28	6	37	8	0.012(1,97)	1.00
	Non-White	19 (19.3)	8	1	9	1		
Recruitment site	North Carolina	50 (51.0)	15	6	22	6	1.231(2,97)	0.54
	Illinois	35 (35.7)	17	0	17	1		
	Michigan	13 (13.3)	3	1	6	3		
Caregiver education	College degree or higher	19 (19.5)	5	3	8	3	.014(1.97)	1.00
	Some college or less	78 (80.4)	30	4	37	7		

Note: ASD = autism spectrum disorder.

Table 3. Pre- and Post-School Exit Mean Daily Living Skills Age Equivalent (DLS-AE) Domain Scores by Trajectory Group at Ages 2, 3, 5, 9, 14, 18, 21, and 26

Data collection time point		Participant age		Higher DLS-AE			Lower DLS-AE		
		n	m(SD)	Years since school exit	DLS-AE m(SD)	Average annual change	Years since school exit	DLS-AE m(SD)	Average annual change
Before school exit	T2	69	2.44 (0.38)	-17	1.70 (0.78)	N/A	-19	1.32 (0.48)	N/A
	T3	35	3.47 (0.37)	-16	2.09 (0.43)	0.39	-18	1.58 (0.67)	0.26
	T5	59	4.97 (0.93)	-13	4.31(2.57)	0.74	-15	1.92 (0.74)	0.17
	T9	83	9.87 (1.44)	-10	8.33 (2.80)	1.01	-11	4.07 (1.89)	0.54
	T14	78	14.14 (0.39)	-5	10.85 (2.85)	0.50	-7	5.34 (2.35)	0.25
	T18	78	18.94 (0.99)	-1	14.65 (3.51)	0.95	-3	5.98 (2.42)	0.16
After school exit	T21	28	21.89 (1.08)	2	15.00 (3.40)	0.11	0	6.73 (2.75)	0.25
	T26	52	25.91 (1.14)	7	14.28 (3.02)	-0.14	5	6.37 (2.50)	-0.10

Note: The dashed black line indicates high school exit in the higher DLS-AE (m = 19.09, SD = 1.59) and lower DLS-AE trajectory groups (m = 21.15, SD = 1.97).

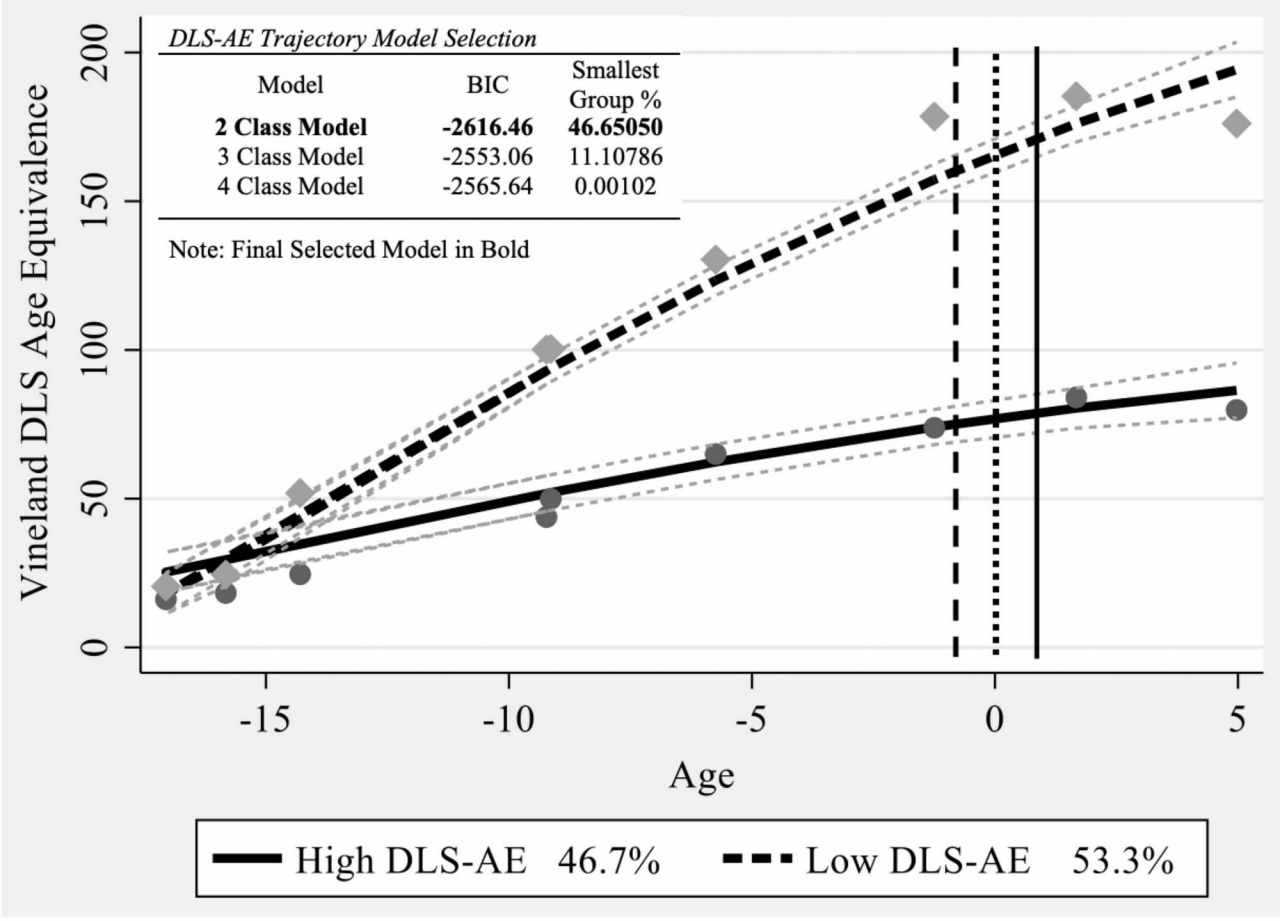
Table 4. Multilevel Model of Rates of Change Before and After High School Exit in Daily Living Skills Age Equivalent (DLS-AE)

Vineland DLS-AE (N = 91)	**Coefficient**	**SE**	**95% CI**	
High school exit	23.26**	7.34	8.86	37.66
Participant age	.48***	.03	.42	.54
Age x high school exit	-.98**	.37	-1.72	-.25
Race covariate	-.51*	.20	-.92	-.11
Adult IQ covariate	2.11***	.40	1.31	2.91
Caregiver education covariate	-.04	.34	-.72	.62
ADOS CSS covariate	-.09	.10	-.30	.10
DLS-AE Trajectory Group	.87	.96	.10	7.58

Note: ADOS = Autism Diagnostic Observation Schedule; CSS = calibrated severity scores.
* $p < .05$,;**$p < .01$; ***$p \leq .001$.

Figure 1. Trajectories of Daily Living Skills Age Equivalent (DLS-AE) From 2 to 26

Note: The dotted line indicates mean age of high school exit in our sample (m = 20.01, SD = 2.07). The dashed (m = 21.15, SD = 1.97) and solid (m = 19.09, SD = 1.59) lines indicate mean ages of high school exit in the Low DLS-AE and High DLS-AE groups, respectively.


DLS-AE Trajectory Model Selection
Model | BIC | Smallest Group %
2 Class Model | -2616.46 | 46.65050
3 Class Model | -2553.06 | 11.10786
4 Class Model | -2565.64 | 0.00102
Note: Final Selected Model in Bold
Vineland DLS Age Equivalence
0
50
100
150
200
-15
-10
-5
0
5
Age
High DLS-AE 46.7%
Low DLS-AE 53.3%