

Brief Report: Adaptive Behavior and Cognitive Skills for Toddlers on the Autism Spectrum

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Abstract This study examined adaptive behavior and cognitive skills for 125 toddlers on the autism spectrum using the recently updated Vineland-II and Bayley-III. Delays in adaptive skills were apparent at 2 years of age. As a group, toddlers on the autism spectrum had a profile of Vineland-II standard scores in which Motor Skills > Daily Living Skills > Socialization > Communication. Vineland-II scores were significantly correlated with Bayley-III Cognitive scores. Performance on the ADOS was significantly negatively correlated with Bayley-III Cognitive standard scores and standard scores in the Daily Living Skills and Communication domains of the Vineland-II. However, calibrated ADOS scores did not contribute significant variance to Vineland-II scores beyond that predicted by age and Bayley-III scores.

Keywords Autism · Adaptive behavior · Vineland · Cognitive skills · Bayley

Introduction

The assessment of adaptive skills is an important component in comprehensive autism diagnostic evaluations, treatment planning, progress monitoring, and program evaluation (Bishop et al. 2008; Carter et al. 1998; Sparrow et al. 2005). The Vineland Adaptive Behavior Scales (VABS; Sparrow et al. 1984) have been widely used in clinical and research settings with individuals on the autism spectrum. Previous research has demonstrated that children on the autism spectrum tend to have impairment in their

adaptive behaviors, compared with age- and IQ- or mental age-matched children without autism (e.g., Carter et al. 1998; Loveland and Kelley 1991).

Recently, Perry et al. (2009) conducted a study in which they (a) examined VABS score profiles across cognitive levels among young children on the autism spectrum, (b) compared VABS scores between young children with autism and chronological age- and mental age-matched, non-spectrum children with intellectual disabilities, and (c) investigated the relationships among VABS scores, cognitive skills, age, and performance on the Childhood Autism Rating Scale (CARS; Schopler et al. 1988). In general, Perry et al. found that a relatively consistent VABS profile was evident for most cognitive levels, except for those with the highest scores, when age equivalents were used. This profile (in which Motor Skills > Daily Living Skills > Communication > Socialization) did not emerge, however, when standard scores were examined. When standard scores were used, Socialization scores tended to be higher than Daily Living Skills and Communication standard scores for most cognitive levels. Compared to chronological age- and mental age-matched, non-spectrum children with intellectual disabilities, children with autism had significantly lower Communication and Socialization standard scores and age equivalent scores. There were no significant differences between the two groups for Motor Skills or Daily Living Skills. Finally, Perry et al. conducted hierarchical regression analyses to examine the incremental variance in VABS scores accounted for by CARS scores in addition to chronological age and cognitive level. CARS scores contributed an additional 6% of the variance in Socialization standard scores beyond the variance predicted by cognitive level and age. The CARS added a smaller amount of incremental variance for the Daily Living Skills and Communication domains.

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The study by Perry et al. (2009) built on previous research that has identified profiles in adaptive scores for individuals on the autism spectrum as a group (e.g., Carter et al. 1998; Fenton et al. 2003; Loveland and Kelley 1991). The age-related differences in adaptive behavior profiles found in this area of research highlight the importance of examining adaptive behavior using samples of individuals with a relatively narrow age range.

Although there is a growing body of literature examining adaptive behavior among individuals on the autism spectrum, much of this published research to date has been based on the original 1984 version of the Vineland. The Vineland Adaptive Behavior Scales, Second Edition (Vineland-II; Sparrow et al. 2005) is a revision and update of the VABS. Revisions and additions were included to better measure adaptive skills in very young children and to capture qualitative differences in communication and social interaction for individuals on the autism spectrum (Sparrow et al. 2005). Furthermore, existing research has not examined the relation between the Vineland-II scales and the Cognitive scale of the recently updated Bayley Scales of Infant and Toddler Development-Third Edition (Bayley-III; Bayley 2006) for very young children on the autism spectrum.

The current study examined adaptive and cognitive skills among toddlers on the autism spectrum. Our research questions were: (1) what is the profile of performance across the domains of the Vineland-II for toddlers on the autism spectrum?; (2) are Vineland-II, Bayley-III and calibrated ADOS (Gotham et al. 2009) scores significantly correlated with each other?; and (3) to what extent do cognitive scores, age, and calibrated ADOS scores contribute to the variance in Vineland-II scores? The unique contributions of this study include (a) the use of the updated Vineland-II and updated Bayley-III, as well as calibrated ADOS scores and (b) a younger sample, with a narrower age range, than previous research in this area.

Methods

Participants

Participants included 125 children (mean age = 31 months, SD = 4.1 months, range = 23–39 months) who are part of an ongoing longitudinal study of early language development in children on the autism spectrum. Among the participants, there were 108 boys and 17 girls. More than 90% ($n = 114$) of the participants received a diagnosis of autism/autistic disorder and the remaining 11 participants received a diagnosis of PDD-NOS. Approximately 89% of the participants had received some amount of speech-language, occupational, and/or physical therapy through a

statewide Birth to 3 Program. Seven children were receiving private speech-language therapy and only two participants were receiving 10 or more hours of autism-specific behavioral therapy at the time of data collection.

Instruments

Vineland Adaptive Behavior Scales, Second Edition

The Survey Interview Form of the Vineland Adaptive Behavior Scales, Second Edition (Vineland-II) was used to measure participants' levels of adaptive skills. This semi-structured interview assesses an individual's adaptive behaviors, based on a caregiver's report, in four broad domains: Communication, Daily Living Skills, Socialization, and Motor Skills. The Vineland-II has been shown to have a high degree of test-retest reliability and the subdomains have demonstrated acceptable levels of internal consistency (Sparrow et al. 2005). Two types of norm-referenced scores are available on the Vineland-II: standard scores for each domain and v -scale scores for each subdomain. The v -scale scores have a mean of 15 and a standard deviation of 3 (possible range = 1–24). The written communication subdomain v -scale scores were not included in our analyses, as this subscale is only applicable for children 3 years of age and older (13% of our sample).

Bayley Scales of Infant and Toddler Development, Third Edition

The Cognitive scale of the Bayley Scales of Infant and Toddler Development, Third Edition (Bayley-III) was used to measure participants' cognitive skills. This scale includes items that assess various aspects of cognitive processing, including object relatedness and concept formation, and were designed to be less dependent on the child's receptive language skills compared to previous versions of the scale (Bayley 2006). The Cognitive scale has been shown to have sound evidence of validity and reliability (Bayley 2006).

Autism Diagnostic Observation Schedule

The Autism Diagnostic Observation Schedule (ADOS; Lord et al. 2002) is a semi-structured, standardized assessment of social communication skills and behaviors characteristic of autism. There are four modules, one of which is selected for a given individual based on his or her expressive language and developmental level. Recently, Gotham et al. (2009) developed calibrated ADOS scores for the purpose of comparing scores across modules and time. These calibrated scores, which range from 1 to 10, were used in the current study.

Procedure

As part of the larger study, children ages 24–36 months who were diagnosed or suspected to be on the autism spectrum were recruited from a variety of community sources including a statewide early intervention program for infants and toddlers exhibiting developmental delays (Birth to 3 Program), pediatricians, and a university-based developmental disabilities clinic. Comprehensive diagnostic evaluations were conducted at the participants’ initial visit that included a toddler research version of the Autism Diagnostic Interview-Revised (ADI-R; Rutter et al. 2003); Autism Diagnostic Observation Schedule (ADOS) or Autism Diagnostic Observation Schedule-Toddler Module (ADOS-T; Luyster et al. 2009); Cognitive Scale of the Bayley Scales of Infant and Toddler Development—Third Edition (Bayley-III); and the Vineland Adaptive Behavior Scales—Second Edition, Survey Interview Form (Vineland-II). Following the diagnostic evaluations, best estimate clinical DSM-IV diagnoses were made using all available information and assessment results. Best estimate clinical diagnoses using DSM-IV or ICD-10 criteria are commonly used by autism researchers (e.g., Chawarska et al. 2007; Lord et al. 2006) to categorize participants by diagnosis and have been shown to be reliable (Klin et al. 2000) and generally stable over time, even for children under 3 years of age at their initial diagnosis (Moore and Goodson 2003; Stone et al. 1999).

Results

Cognitive, Adaptive Behavior, and Calibrated ADOS Scores

Table 1 presents the mean scores, standard deviations, and minimum and maximum values for the Bayley-III Cognitive scale, the Vineland-II, and the calibrated ADOS scores. The mean developmental age (in months) on the Bayley-III Cognitive scale was approximately 7 months lower than the mean chronological age of the sample. Only 9% of participants had Bayley-III standard scores of 100 or greater. On the Vineland-II subdomains, the sample mean *v*-scale scores for receptive communication, expressive communication, personal skills, interpersonal relationships, and play and leisure time were at least 1.5 standard deviations below the mean of the standardization sample. Among the subdomains, receptive communication *v*-scale scores demonstrated the greatest variability. The mean calibrated ADOS score was 7.5 and 88% of participants had scores of 6 or higher, which corresponds to the cutoff for a classification of autism on the ADOS (Gotham et al. 2009). Two participants had calibrated ADOS scores below

Table 1 Mean Scores, Standard Deviations, and Minimum and Maximum Values for the ADOS, Bayley-III and Vineland-II

| Variable | Mean | SD | Min. | Max. |
|------------------------------------|------|------|------|------|
| ADOS calibrated scores | 7.5 | 1.9 | 1 | 10 |
| Bayley-III | | | | |
| Cognitive composite score | 85.0 | 12.0 | 60 | 140 |
| Cognitive developmental age | 23.9 | 5.4 | 9 | 45 |
| Vineland-II | | | | |
| Communication standard score | 73.8 | 12.1 | 38 | 102 |
| Receptive VS | 10.1 | 2.6 | 3 | 17 |
| Expressive VS | 9.9 | 2.1 | 6 | 16 |
| Daily living skills standard score | 80.1 | 9.8 | 50 | 104 |
| Personal VS | 10.0 | 2.0 | 4 | 15 |
| Domestic VS | 12.6 | 2.3 | 9 | 18 |
| Community VS | 12.1 | 1.9 | 9 | 17 |
| Socialization standard score | 77.6 | 6.8 | 61 | 98 |
| Interpersonal relationships VS | 10.5 | 1.6 | 7 | 15 |
| Play and leisure time VS | 10.3 | 1.3 | 8 | 14 |
| Coping skills VS | 12.2 | 1.4 | 9 | 16 |
| Motor skills standard score | 87.3 | 8.5 | 69 | 108 |
| Gross VS | 12.9 | 1.7 | 9 | 17 |
| Fine VS | 13.0 | 1.8 | 9 | 17 |

VS v-scale score

4, which corresponds to the cutoff for a classification of autism spectrum disorder, and were given best estimate diagnoses of PDD-NOS based on a comprehensive diagnostic evaluation that included a toddler research version of the ADI-R.

Vineland-II Standard Score Profile

Paired-sample *t*-tests were conducted to examine whether the mean Vineland-II domain standard scores were significantly different from one another. A profile of adaptive behavior emerged (in which Motor Skills > Daily Living Skills > Socialization > Communication) with statistically significant differences between each of the four mean domain standard scores, as shown in Table 2. Cohen’s *d* was used to calculate effect sizes, which ranged from small (0.20+) to large (0.80+; Cohen 1988).

Correlations among Bayley-III, Vineland-II, and Calibrated ADOS Scores

Correlations were calculated between Bayley-III Cognitive standard scores and Vineland-II domain standard scores and subdomain *v*-scale scores. All correlations were positive and were statistically significant at the 0.05 level. As can be seen in Table 3, calibrated ADOS scores were significantly negatively correlated with Vineland-II Communication and

Table 2 Comparison of mean standard scores on Vineland-II

| Vineland-II standard scores (Mean, SD) | Mean difference | <i>t</i> value (<i>df</i> = 124) | Effect size |
|--|-----------------|-----------------------------------|-------------|
| Communication (73.8, 12.1) | −6.33 | −7.34** | 0.66 |
| Daily Living Skills (80.1, 9.8) | | | |
| Communication | −3.85 | −4.55** | 0.41 |
| Socialization (77.6, 6.8) | | | |
| Communication | −13.49 | −13.18** | 1.18 |
| Motor Skills (87.3, 8.5) | | | |
| Daily Living Skills | 2.48 | 3.56* | 0.32 |
| Socialization | | | |
| Daily Living Skills | −7.16 | −9.70** | 0.89 |
| Motor Skills | | | |
| Socialization | −9.64 | −13.69** | 1.22 |
| Motor Skills | | | |

* $p < 0.01$, ** $p < 0.001$

Table 3 Vineland-II Correlations with Bayley-III and calibrated ADOS Scores

| Vineland-II | Bayley-III | ADOS |
|--------------------------------|------------|---------|
| Communication SS | 0.56** | −0.23* |
| Receptive VS | 0.53** | −0.27** |
| Expressive VS | 0.52** | −0.10 |
| Daily Living Skills SS | 0.47** | −0.22* |
| Personal VS | 0.43** | −0.26** |
| Domestic VS | 0.27** | −0.18* |
| Community VS | 0.40** | −0.03 |
| Socialization SS | 0.38** | −0.13 |
| Interpersonal Relationships VS | 0.36** | −0.15 |
| Play and Leisure Time VS | 0.32** | −0.03 |
| Coping Skills VS | 0.26** | −0.11 |
| Motor Skills SS | 0.41** | −0.03 |
| Gross VS | 0.19* | 0.04 |
| Fine VS | 0.46** | −0.09 |

SS standard score, VS *v*-scale score

* $p < 0.05$, ** $p < 0.01$

Daily Living Skills standard scores and with receptive communication, personal skills, and domestic skills *v*-scale scores. There were no statistically significant correlations between the calibrated ADOS scores and Vineland-II scores in the Socialization or Motor Skills domains. The calibrated ADOS scores were, however, significantly correlated with Bayley-III Cognitive standard scores ($r = -0.26$, $p < 0.01$).

Using Cicchetti and colleagues' (2010) effect size index for correlations (<0.10 = Trivial; 0.10 – 0.29 = Small; 0.30 – 0.49 = Medium; 0.50 – 0.69 = Large; ≥ 0.70 = Very Large), the correlation between Communication and Bayley-III Cognitive scores can be considered large. The

correlations between the Bayley-III and the Daily Living Skills, Socialization, and Motor Skills standard scores were medium in magnitude. The statistically significant correlations between the ADOS calibrated scores and the Communication and Daily Living Skills scores were small.

Hierarchical Regressions Predicting Vineland-II Scores from Bayley-III and ADOS

A series of hierarchical regression analyses revealed that calibrated ADOS scores did not contribute to the variance in Vineland-II standard scores beyond that explained by participants' age and Bayley-III Cognitive standard scores. The variance explained by age and cognitive skills ranged from 14% for Socialization to 32% for Communication. The multiple correlation coefficients indicate medium and large effect sizes (Cicchetti et al. 2010). The regression results are shown in Table 4.

Discussion

Our results indicate that delays in adaptive skills for young children on the autism spectrum can be observed as early as 2 years of age. Five of the ten Vineland-II *v*-scale sample means were at least 1.5 standard deviations below the standardization sample mean.

We found a group profile of Vineland-II standard scores in which Motor Skills > Daily Living Skills > Socialization > Communication for this sample of toddlers on the autism spectrum. Past research examining profiles of adaptive behavior for individuals on the autism spectrum has produced somewhat inconsistent results (e.g., Carter et al. 1998; Fenton et al. 2003; Perry et al. 2009), partially due to the use of samples of varying ages and cognitive levels. Varying amounts and types of intervention services received across samples could also contribute to the inconsistent results (e.g., the vast majority of our participants were not receiving an intensive amount of intervention at the time of data collection). However, prior research has shown that, as a group, children on the autism spectrum tend to demonstrate lower scores in the Socialization and Communication domains compared to age- and MA-matched, non-spectrum children with intellectual disabilities (e.g., Loveland and Kelley 1991; Perry et al. 2009). Although an individual's adaptive behavior score profile should not be used as a diagnostic heuristic, the presence of a characteristic group profile on the Vineland-II contributes to our understanding of the relative parent-reported strengths and weaknesses in adaptive skills found among toddlers on the autism spectrum. With a general emphasis being placed on early diagnosis, these findings may have

Table 4 Hierarchical regression analyses predicting Vineland-II Standard Scores from Chronological Age (CA), Bayley-III Cognitive standard scores (Bayley-III), and Calibrated ADOS scores

| Vineland-II domain | Step 1 (CA & Bayley-III) | | | | | Step 2 (ADOS) | | | |
|---------------------|--------------------------|------|--------|------------|---------|---------------|------------|---------|--------------|
| | R^2 | R | B | SE (B) | β | B | SE (B) | β | ΔR^2 |
| Communication | 0.32 | 0.57 | 0.564 | 0.076 | 0.561** | -0.304 | 0.513 | -0.048 | 0.00 |
| Daily Living Skills | 0.22 | 0.47 | 0.379 | 0.066 | 0.468** | -0.469 | 0.442 | -0.091 | 0.01 |
| Socialization | 0.14 | 0.37 | 0.214 | 0.049 | 0.374** | -0.030 | 0.328 | -0.008 | 0.00 |
| Motor Skills | 0.24 | 0.49 | -0.278 | 0.057 | 0.390** | 0.048 | 0.385 | 0.011 | 0.00 |

For Step 1, R^2 reflects both CA and Bayley-III in the model and coefficients shown are for Bayley-III scores

** $p < 0.01$

utility in differential diagnoses as one piece of information in the context of a comprehensive diagnostic evaluation.

Our findings demonstrated that Vineland-II and Bayley-III Cognitive scores were significantly correlated for our sample using both domain standard scores and subdomain v -scale scores. As noted by Brassard and Boehm (2007), the Bayley-III Cognitive standard scores have an absolute floor of 55, which may limit score variability among toddlers with significant cognitive delays. Although none of our participants obtained a score of 55, it is possible that our sample mean Cognitive standard score of 85 may have been lower if the instrument had a lower floor.

Calibrated ADOS scores were significantly negatively correlated with Bayley-III Cognitive standard scores and with standard scores in the Daily Living Skills and Communication domains of the Vineland-II. For toddlers on the autism spectrum, the negative correlation between ADOS and Bayley-III scores may be influenced by the presence of restricted and repetitive behaviors that may interfere with performance on developmental testing or reduced engagement in some of the Bayley-III tasks that require imitation, demonstration of pretend play skills, and interaction with the examiner.

Interestingly, there was not a significant association between calibrated ADOS scores and Socialization scores on the Vineland-II. This may be due to the nature of the Socialization domain items for young children, which assess some skills that are not covered on the ADOS (e.g., play interactions with other children), or differences between parents' perceptions of their child's social skills and an examiner's observations during a specific, semi-structured assessment. As pointed out by one of the anonymous reviewers of this article, it may also be possible that parents or caregivers may not recognize and report the extent to which they modify the child's environment to minimize the impact of the child's impairments.

We did not find that calibrated ADOS scores contributed additional variance to Vineland-II scores beyond that predicted by age and Bayley-III Cognitive standard scores. This result was in contrast to the findings of Perry et al.

(2009), although their study used the CARS to measure characteristics of autism and the original VABS. Additionally, their sample included children up to 6 years of age. Replication studies will be necessary to determine whether calibrated ADOS scores generally contribute to the variance in adaptive behavior for young children on the autism spectrum. Our study examined adaptive behavior and cognitive skills for toddlers on the autism spectrum and, as such, the results should not be generalized to other age groups.

Limitations

A limitation of this study is that identifying group profiles on measures such as the Vineland-II does not reveal within-group variance. Although typical profiles can contribute to our general understanding of group characteristics, it is also important to acknowledge that a range of individual differences may be present within a group on a given measure.

Conclusions and Future Directions

This study demonstrated that delays in adaptive skills for toddlers on the autism spectrum are evident using the recently updated Vineland-II. A Vineland-II group profile was found which suggests a relative weakness in parent-reported social and communication skills for these young children. Calibrated ADOS scores also appear to be negatively correlated with performance on the Bayley-III, although their association with adaptive behavior is less clear.

Future research should examine Vineland-II adaptive behavior profiles for older children on the autism spectrum to identify possible age-related patterns on this recently updated instrument. Similarly, this revised measure can be used in comparison with cognitive measures other than the Bayley-III, such as those that offer full-scale IQ scores. There is also a need for further research replicating the work of Gotham et al. (2009) and examining relationships

between calibrated ADOS scores and other measures of functioning. Research examining predictors of growth in adaptive skill levels during early childhood could also be useful for clinical applications, such as intervention planning and progress monitoring.

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