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Utility of the Vineland Adaptive Behavior Scales in Predicting Future Cognitive Function in Children with Autism Spectrum disorders

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Abstract

Objective: Literature shows that cognitive function of a child with autism spectrum disorder (ASD) is positively associated with later outcomes. However, developmental and cognitive assessments have not been consistently completed at the time of diagnosis in many clinical settings. It is uncertain whether a standardized parent adaptive questionnaire will help predict later cognitive functioning. This study explored the utility of a standardized questionnaire in predicting future cognitive functioning in children with ASD.

Method: Children aged 24 to 59 months consecutively diagnosed with ASD from January 2011 to October 2013, and had a cognitive assessment completed at a later time point, were included in the study (N=113). Descriptive data on demographic characteristics, Autism Diagnostic Observation Schedule (ADOS) scores, Vineland Adaptive Behavior Scales-II (VABS-II) standard scores at the time of ASD diagnosis and later cognitive scores of the cohort were presented. VABS-II standard scores at the time of diagnosis were used to predict best estimate nonverbal cognitive scores using linear regression models, after controlling for gender, race, age at diagnosis, and ADOS scores.

Results: In this cohort, 88.5% were boys and the mean age of diagnosis was 48.4 months. The adaptive behaviour profile of the study population showed motor skills>communication>daily living>socialization skills, consistent with previous studies on verbal children with ASD. The VABS-II adaptive behaviour composite score and all the VABS-II domain scores at the time of diagnosis significantly predict later cognitive functioning. The adaptive behaviour composite score best predicts later nonverbal cognitive standard scores ($p<0.001$, $R^2=0.446$). The age at diagnosis and ADOS social score were also predictors of later nonverbal IQ scores.

Conclusion: In clinical settings where cognitive assessments cannot be completed at the time of diagnosis, there may be utility in using the VABS-II to better understand the cognitive functioning of children with ASD.

Keywords: Autism spectrum disorder; Adaptive skills; Cognitive function

Introduction

Autism spectrum disorder is a chronic and pervasive neurodevelopmental disorder characterized by impairments in social interaction, social communication and restricted and repetitive patterns of behaviour, interests and activities that arise in early childhood or when social demands exceed limited capacities [1]. Children with ASD present with a wide range of variability in symptom severity, cognitive ability, and adaptive behaviour. It is estimated that about 30-50% of children with ASD have co-occurring intellectual disability [2,3].

Cognitive testing is an important part of the evaluation of children with ASD and is helpful in planning educational and treatment programs. Emerging evidence shows that the cognitive status of toddlers with ASD closely predicts how they function as adults [4-6]. Additionally, childhood cognitive status has been found to be stable across the lifespan in people with ASD [7] and can be used as a reliable predictor of cognitive functioning in adulthood [5].

The intellectual assessment of children with ASD is not a straightforward process [8]. In certain circumstances, testing may not be completed due to difficulties in communication, social interaction, transitions and motivation, which are characteristic of the disorder. A valid IQ or cognitive score depends on the competence of the person testing the children and whether cooperation and attention of the child have been established [9]. Thus, results of cognitive skills assessment may sometimes be a minimum estimate of a child's ability.

Adaptive behaviour is the ability to translate cognitive potential into real life skills [10]. Measures of adaptive behaviours, such as the Vineland Adaptive Behavior Scales-II [11,12], evaluate adaptive functioning in different domains such as communication, daily living skills and socialization. It utilizes a survey interview form based on caregiver reports and does not require an individual to respond to an examiner or perform tasks.

Adaptive behavior is highly correlated to cognitive skills on various psychological instruments and is believed to reflect higher cognitive ability [13]. Ray-Subramanian et al. [13] demonstrated that Vineland-II and Bayley-III cognitive scores were significantly correlated. Likewise, a comparison of the VABS-II adaptive behaviour composite standard score and the cognitive score obtained from the Bayley-III showed no statistical difference between the two measures [14,15]. On the other hand, a study comparing the Wechsler Preschool and Primary Scales of Intelligence, 4th edition (WPPSI-IV) and Vineland-II showed that certain adaptive behaviour domain scores (i.e. daily living skills) share high correlation with all WPPSI-IV composite scores [16].

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In individuals who cannot be assessed by standard cognitive tests, the developmental level had been estimated by measures of adaptive behaviour in prior research [5]. Despite a number of researches showing the correlation between adaptive behavior and cognitive ability using cross-sectional studies at one time point, it has not been examined whether early adaptive skills in children with ASD can be used to estimate future cognitive functioning longitudinally. This will be the first study to understand whether a standardized adaptive behaviour questionnaire obtained at the time of ASD diagnosis predicts cognitive function at a later time point.

Methods

Sample

We identified 113 consecutive patients (100 boys and 13 girls) aged 24 to 98 months who were diagnosed with ASD from January 2011 to October 2013 and had completed a cognitive assessment at a later date (Figure 1). The mean age of diagnosis was 48 months (give SD). The Wechsler Preschool and Primary Scales of Intelligence, 3rd or 4th edition (WPPSI-III/IV) or the Wechsler Nonverbal Scale of Cognitive Ability (WNV), whichever was most appropriate for the child's ability, was administered at an average of 20 months (add SD) after the diagnosis.

Procedures

We conducted a retrospective medical record review using a standardized data abstraction form to collect the following data: child and family demographic information (age at diagnosis, age at IQ administration, gender, insurance status and race), scores on the Vineland Adaptive Behavior Scales II and nonverbal scores on cognitive assessment.

Analyses

Using linear regression models with nonverbal cognitive scores as the dependent variable, we used Vineland-II scores as predictors. Covariates include the ADOS social composite score, the ADOS communication score, age at diagnosis, age at IQ administration, gender, insurance status and race. Statistical analyses were performed with the Statistical Package for the Social Sciences (SPSS version 22).

Measures

The Autism Diagnostic Observation Schedule [17] is a semi-structured assessment of communication, social interactions and relatedness, play, imagination and stereotyped and repetitive behaviors. This measure yields scores in the social domain, communication domain and a combined score.

The Autism Diagnostic Interview-Revised [18] is a semi-structured clinician-based interview for caregivers that evaluate the child's communication, social development, play and restricted, repetitive and stereotyped behaviors.

The Vineland Adaptive Behavior Scales II [11,12] is a semi-structured parent interview scale that assesses adaptive functioning in the areas of (a) communication, reflecting the child's receptive, expressive and written language skills; (b) daily living skills, reflecting the child's personal, self-care, domestic and community living skills; (c) socialization, reflecting the child's interpersonal play or leisure skills, and coping skills; and (d) motor skills, reflecting the child's gross and fine motor abilities. These domain scores are combined to yield an adaptive behaviour composite score (ABC).

The diagnosis of ASD is based on the combined results of clinical impression, ADOS scores and ADI-R results.

Wechsler Preschool and Primary Scale of Intelligence III/IV [19,20] is an instrument that measures general cognitive functioning and generates sub scores in verbal comprehension, perceptual reasoning, working memory and processing speed. In the WPPSI–IV, perceptual reasoning subtest was divided into fluid reasoning and visual spatial subtests.

Weschler Nonverbal Scale of Ability [21] measures general ability nonverbally. It is designed for individuals with limited language skills or individuals from diverse cultural and linguistic groups.

Due to the variable abilities of the subjects, a best estimate IQ score was derived based on the cognitive assessments completed. Performance IQ from the WPPSI-III, fluid reasoning from the WPPSI-IV and the WNV full scale score were used as best estimate nonverbal IQ.

Results

The study population was predominantly Chinese (86.7%) children with ASD, 88.5% of which were male. The average age of diagnosis was 48.4 months. Cognitive testing was performed at an average of 20 months from the time of diagnosis (Table 1).

ADOS, Vineland and cognitive scores are shown in Table 2. The adaptive behaviour profile of the cohort showed VABS-II motor score>communication>daily living>socialization scores. Best estimate nonverbal cognitive scores range from 39-152 with a mean score of 91.97 (Table 2).

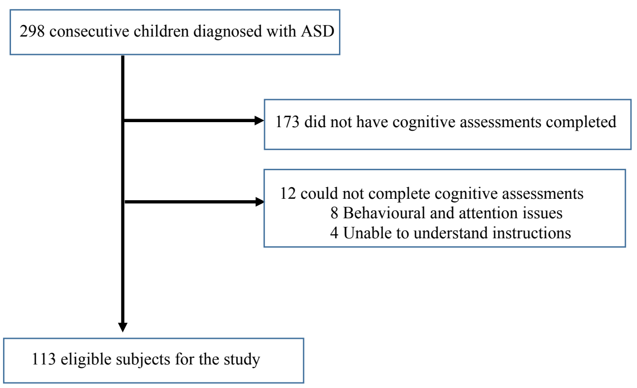

Figure 1: Flowchart of subject inclusion and exclusion in the study.

Characteristic	N	%
Gender		
Male	100	88.5
Female	13	11.5
Ethnicity		
Chinese	98	86.7
Non-Chinese	15	13.3
Diagnosis based on DSM-IV		
Autistic Disorder	69	61.1
PDD-NOS[a]	39	34.5
Asperger Syndrome	5	4.4
	Mean	**SD**
Mean Age at Diagnosis	48.42 months	15.34 months
Mean Age at Cognitive testing	67.8 months	6.11 months

[a]Pervasive Developmental Disorder-Not Otherwise Specified

Table 1: Demographic characteristics of the study cohort.

	Min	Max	Mean	SD
ADOS[a] Scores				
Communication score	2	9	5.53	1.75
Social Interaction score	3	14	8.92	2.72
Combined score	7	23	14.35	3.90
VABS[b] II Standard Score at time of diagnosis				
Adaptive Behavior Composite	54	95	73.48	9.70
Communication	42	112	77.69	15.48
Daily Living	51	101	75.74	10.95
Socialization	57	90	70.35	7.73
Motor Skills Score	59	114	82.03	11.4
Cognitive ability				
WPPSI-III[c] Performance IQ (N=72)	49	152	88.00	18.08
WPPSI-IV[d] Fluid Reasoning (N=13)	69	139	106.85	20.07
WNV[e] (N=28)	39	96	64.57	15.75
Best Estimate Nonverbal IQ (N=113)	39	152	91.97	23.87

[a]Autism Diagnostic Observation Schedule
[b]Vineland Adaptive Behavior Scale, 2nd edition
[c]Wechsler Preschool and Primary Scales of Intelligence, 3rd Edition
[d]Weschler Preschool and Primary Scales of Intelligence, 4th Edition (fluid reasoning includes matrix reasoning and picture concepts)
[e]Wechsler Non-verbal Scale of Cognitive Ability

Table 2: Mean scores, standard deviation, minimum and maximum value for the ADOS, Vineland II and best estimate IQ (N=113).

Covariate	B	Standard Error (SE)	Significance
Vineland ABC	1.441	0.209	<0.001**
Age at Diagnosis	-0.334	0.141	0.020*
Gender	4.078	5.524	0.462
Race	-6.866	5.514	0.216
Insurance Status	8.079	5.090	0.116
ADOS Communication Score	0.007	1.134	0.995
ADOS Social Score	-2.015	0.773	0.010*
Age at IQ	0.612	0.338	0.073

Note: *P<0.05, **P<0.01

Table 3: Using Vineland-II adaptive behavior composite score (ABC) as predictor of non-verbal IQ, R^2=0.446.

Covariate	B	Standard Error (SE)	Significance
Vineland Communication	0.792	0.152	<0.001**
Age at Diagnosis	-0.322	0.155	0.041*
Gender	3.608	5.950	0.546
Race	-8.642	5.928	0.148
Insurance Status	4.832	5.583	0.389
ADOS Communication Score	-0.558	1.230	0.651
ADOS Social Score	-1.745	0.854	0.043*
Age at IQ	0.471	0.363	0.198

Note: *P<0.05, **P<0.01

Table 4: Using Vineland communication score as predictor of non-verbal IQ, R^2=0.359.

Regression analyses showed that the Vineland II ABC and all the domain scores significantly predict future nonverbal IQ in children with ASD (Tables 3-6). Of these, the Vineland-II ABC best predicted future nonverbal IQ (R^2=0.446, p<0.001). The ADOS socialization score contributed consistently to nonverbal IQ (Tables 3-6). The results showed that the higher the social impairment of a child, the lower the nonverbal IQ. When Vineland-II ABC and communication scores were used to predict nonverbal IQ, the age at diagnosis was a significant variable (Table 3-4). The older the child was at diagnosis, the lower the nonverbal IQ. When daily living skills score was used as predictor of nonverbal IQ, the insurance status of the patient was significantly associated with nonverbal IQ (Table 5).

Covariate	B	Standard Error (SE)	Significance
Vineland Daily Living Score	1.000	0.182	<0.001**
Age at Diagnosis	-0.229	0.147	0.123
Gender	2.738	5.862	0.641
Race	-10.892	5.770	0.062
Insurance Status	12.224	5.401	0.026
ADOS Communication Score	0.252	1.205	0.835
ADOS Social Score	-2.406	0.814	0.004**
Age at IQ	0.351	0.353	0.323

Note: *P<0.05, **P<0.01

Table 5: Using Vineland daily living score as predictor of non-verbal IQ, R^2=0.325.

Covariate	B	Standard Error (SE)	Significance
Vineland Socialization Score	1.182	0.287	<0.001**
Age at Diagnosis	-0.029	0.156	0.852
Gender	1.507	6.491	0.817
Race	-9.673	6.385	0.133
Insurance Status	10.068	5.957	0.094
ADOS Communication Score[a]	0.778	1.227	0.528
Age at IQ	0.020	0.381	0.959

Note: *P<0.05, **P<0.01
[a]ADOS social score was not used since ADOS social score and Vineland-II Socialization scores were collinear variables in this model

Table 6: Using Vineland socialization score as predictor of non-verbal IQ, R^2=0.228.

Discussion

This study showed that the composite and domain scores of the Vineland-II were significant predictors of later cognitive functioning. Similar to findings of other studies, scores on adaptive motor skills ranked highest and socialization was the lowest. Of all the VABS-II domains, the communication domain was best correlated with nonverbal ability, which was also comparable to the findings of other studies [22,23]. Among all the domain scores, the Vineland-II socialization score was the least predictive of future cognitive outcomes.

The age of diagnosis of ASD had been moving earlier into toddlerhood. At such young ages, intelligence tests could not be administered. The assessment of cognitive skills in toddlers would generally utilize developmental tests such as the Bayley Scales of Infant Development (BSID). However, the BSID was shown to be not predictive of cognitive ability 5 years later in children with ASD [24]. This might be due to the fact that toddlers with ASD often had difficulty engaging in developmental testing and the inconsistent behaviours might affect scoring accuracy, a standard adaptive skills interview with parents would therefore have utility in clinical settings and in the discussion of the child's future outcomes.

One limitation of our study was that the results could not be generalizable to the individual child since communication and social skills were different for each child. We also did not control for the amount of early intervention received by the children in our study population. Information about intervention accessed by the child was difficult to obtain since, in our setting, parents were allowed to choose the type and amount of intervention the children receive. However, our cohort was large enough to control for many variables including family and child factors such as age at diagnosis and social and communication scores on ADOS. Future studies should include an emphasis on the amount of intervention and future outcome.

Conclusion

The present study demonstrates that an adaptive behaviour parent questionnaire yields useful information about the future cognitive functioning of ASD children and may have clinical utility when cognitive assessment cannot be reliably performed at the time of diagnosis.

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