

Vineland Adaptive Behavior Scales: II Profile of Young Children with Autism Spectrum Disorder

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Abstract Adaptive behaviour is a crucial area of assessment for individuals with Autism Spectrum Disorder (ASD). This study examined the adaptive behaviour profile of 77 young children with ASD using the Vineland-II, and analysed factors associated with adaptive functioning. Consistent with previous research with the original Vineland a distinct autism profile of Vineland-II age equivalent scores, but not standard scores, was found. Highest scores were in motor skills and lowest scores were in socialisation. The addition of the Autism Diagnostic Observation Schedule calibrated severity score did not contribute significant variance to Vineland-II scores beyond that accounted for by age and nonverbal ability. Limitations, future directions, and implications are discussed.

Keywords Adaptive behaviour · Autism · Vineland · Vineland-II · Young children

Introduction

Adaptive behaviour skills are important to the prognosis of individuals with Autism Spectrum Disorder (ASD) (Gillham et al. 2000; Goldberg et al. 2009). Adaptive behaviour refers to the skills needed by individuals to function and be self-

sufficient within their everyday environments (Sparrow et al. 2005). The Vineland Adaptive Behavior Scales (Sparrow et al. 1984) have been used extensively as a measure of adaptive behaviour in ASD (e.g., Dawson et al. 2010; Eapen et al. 2013; Green et al. 2010; Lane et al. 2013; Paynter et al. 2012). However, there has been little research into the properties of the second edition, the Vineland-II (Sparrow et al. 2005). Such research is vital for understanding the structure of adaptive behaviour for children with ASD.

Vineland Domain Score Profile

In contrast to the Vineland-II, there is a substantial body of research with the original Vineland with people with ASD. Both editions of the Vineland yield domain scores for communication, socialisation, daily living, and motor skills. However the original Vineland includes both age equivalent and standard scores for each domain, whereas the newer edition includes only standard scores. Most research with the original Vineland has found a distinct ‘autism profile’ when comparing domain scores using age equivalent scores (see Kraijer 2000 for a review; for an exception see Stone et al. 1999). For example, Carter et al. (1998) found in a mixed-age sample (2–59 years) a profile of motor skills being the highest score, followed by daily living, communication, and lowest scores in socialisation (i.e. motor skills > daily living skills > communication > socialisation). Likewise, Perry et al. (2009) found this profile in children (22 to 71 months). However, this profile has not been replicated in research with the Vineland-II.

Vineland-II Domain Score Profile

Research with the Vineland-II has found a different domain score profile using standard scores for comparison. The

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Vineland-II manual (Sparrow et al. 2005) reports two separate profiles for children and adolescents who are verbal (motor skills > communication > daily living > socialisation) and nonverbal (motor skills > daily living > socialisation > communication). This Vineland-II standard score profile for nonverbal children has been replicated in toddlers (Paul et al. 2014; Ray-Subramanian et al. 2011) and was also observed for 2–3 year-olds on the original Vineland (Stone et al. 1999). Thus, it appears a different profile, characterised by greatest weaknesses in communication, rather than socialisation has been found with the Vineland-II for children who are nonverbal and toddlers. For children who are verbal, greater weaknesses in daily living skills than communication have been found on the Vineland-II, with this reversed on the original Vineland.

Explanations for Differences in Profiles Between Versions

There are a number of potential explanations for the difference in profiles across the versions of the Vineland. It may be that differences have emerged due to changes in the revised edition such as including increased items at the floor. Differences may also be due to research with the original Vineland tending to use age equivalents for the profile (e.g., Carter et al. 1998; Perry et al. 2009), whereas research with the Vineland-II has tended to use standard scores (e.g., Sparrow et al. 2005; Paul et al. 2014; Ray-Subramanian et al. 2011). Finally, differences in participant factors may affect the observed profile.

Differences in participant factors such as age, language abilities, and/or the severity of ASD symptoms may affect the observed autism profile (Fenton et al. 2003; Perry et al. 2009). The use of a broad age range in much of the previous research (with the exception of toddler research) may obscure specific age group patterns as suggested by Stone et al. (1999) making comparisons between studies difficult. In terms of language ability, when samples have been split on the basis of language level, both groups show the same autism profile on the original Vineland when age equivalent scores are used. However, this is in contrast to the differing profiles by verbal ability reported in the Vineland-II manual (Sparrow et al. 2005).

It is unclear whether differences in ASD symptom severity affect Vineland score profiles. Across studies mixed results have been found when controlling for age and cognitive ability which both contribute significantly to variance in both Vineland and Vineland-II scores for children with ASD (e.g., Kanne et al. 2011; Klin et al. 2007; Liss et al. 2001; Perry et al. 2009; Ray-Subramanian et al. 2011). Studies finding a significant association between Vineland scores and autism symptoms have

tended to be in the direction of higher autism severity being linked to poorer adaptive behaviour (e.g., Klin et al. 2007; Kanne et al. 2011; Perry et al. 2009; Ray-Subramanian et al. 2011), but some studies have failed to find a significant association (e.g., Liss et al. 2001). Thus, differences in participant factors including age, verbal ability, cognitive level, and ASD severity may affect Vineland results for children with ASD.

Present Study

To date, research using the Vineland and Vineland-II has yielded mixed results in terms of the autism profile. Potential explanations for mixed findings include the version used, whether age equivalent or standard scores are used, and differences in participant characteristics across studies. However, clear conclusions cannot be made as there is a lack of direct comparisons of standard and age equivalent scores on the Vineland-II, and with the exception of toddler studies, existing studies have tended to use a broad age range. As the preschool period (age 2–5 years) is often the time of diagnosis and early intervention, this is a particularly important time to understand the adaptive behaviour profile of children with ASD. Thus, the primary aim of the present study was to investigate the profile of both standard and age equivalent scores on the Vineland-II for verbal and nonverbal children with ASD. On the basis of previous research with children (Carter et al. 1998; Kraijer 2000; Perry et al. 2009) we predicted the autism profile (motor skills > daily living skills > communication > socialisation) would be observed for age equivalent scores across verbal ability groups. No specific predictions were made for standard scores due to the scant research in this age range. In addition, a secondary aim of this research was to explore the effects of cognitive level and the links between ASD symptom severity and Vineland-II scores.

Method

Participants

The participants were 87 children assessed on entry to an early intervention program in Australia that required diagnosis of ASD from a medical practitioner (paediatrician, child psychiatrist, or neurologist) using DSM-IV-TR criteria (American Psychiatric Association 2000). ASD diagnosis was verified with the Autism Diagnostic Observation Schedule-Generic (ADOS-G; Lord et al. 2001), and seven participants who did not meet the criteria were subsequently excluded. A further three participants were excluded due to significant missing data, leaving a sample of 77 (64 boys and 13 girls) children aged between 29 and

66 months ($M = 42.97$, $SD = 9.59$), see Table 1 for further descriptions. A subset had comorbid diagnoses (including attention deficit hyperactivity disorder, global developmental delay, Kabuki syndrome, Fragile X, or non-syndromal chromosome disorders) and/or were from culturally and linguistically diverse backgrounds.

Procedure

Data were collected as part of the usual intake assessment for the early intervention program. Parents completed a demographic form, the Social Communication Questionnaire (SCQ), and the Vineland-II. The Mullen Scales of Early Learning and ADOS-G were administered with children by a trained assessor at the service.

Measures

Social Communication Questionnaire (SCQ; Rutter et al. 2003)

The SCQ is a 40 item questionnaire, however, for the purposes of the current study, only the first item (“*Is she/he now able to talk using short phrases or sentences?*”) was used to classify participants into verbal ($n = 26$) and nonverbal groups ($n = 51$).

Autism Diagnostic Observation Schedule-Generic (ADOS-G; Lord et al. 2001)

Diagnosis was verified, and ASD symptom severity measured, using the ADOS-G, a standardised diagnostic observational instrument that quantifies autism symptoms in social reciprocity, communication, play, and repetitive behaviours (Lord et al. 2001). It contains four modules, with the choice of module dependent on child verbal ability. Module 1 was completed by 90.9 % of participants and Module 2 by 9.1 % participants. The ADOS calibrated severity score algorithms (Gotham et al. 2007), which allow for comparison of autism severity across participants tested with different ADOS modules, were used. Severity scores were between 1 and 10, with higher scores indicating higher severity, and scores of three and under classified as non-spectrum (Gotham et al. 2007).

Table 1 Participant characteristics

Variable	Percentage
Gender (% male)	83.11
Comorbid diagnosis	15.6
Culturally and linguistically diverse background	20.8

Vineland Adaptive Behavior Scales Second Edition: Parent/Caregiver Rating Form (Vineland-II; Sparrow et al. 2005)

The Vineland-II assesses adaptive behaviour in four domains: Communication, Daily Living skills, Socialisation, and Motor skills. It provides standard scores in each of the domains and an overall Adaptive Behaviour Composite. Lower scores indicate greater impairment in adaptive functioning. Age equivalent scores for each domain were calculated by averaging the age equivalent scores of the subdomains as has been done in previous research (e.g., Becker-Weidman 2009; Breau and Camfield 2011; Eikeseth et al. 2012; Howard et al. 2005).

Mullen Scales of Early Learning (Mullen 1995)

The Mullen Scales of Early Learning is an individually administered measure of Fine Motor, Visual Reception, Receptive Language, and Expressive Language for children from birth to 68 months of age, and Gross Motor for young children from birth to 33 months of age. Given that the majority of children in the current sample did not obtain subscale raw scores that were high enough for calculation of meaningful T scores, developmental quotients (DQ) were calculated by dividing each child’s age equivalent score by their chronological age at the time of testing, and multiplying by 100, as is common practice (see Eapen et al. 2013; Munson et al. 2008; Vivanti et al. 2014). A nonverbal composite was calculated by averaging scores on the Fine Motor and Visual Reception scales. This score was used as an estimate of cognitive ability as in previous research with this population (e.g., Akshoomoff 2006; Venker et al. 2013).

Results

Domain Score Profiles

Standard Scores

Means and standard deviations across Vineland-II domains (using standard scores) split by verbal ability are shown in Table 1. For the verbal group, the observed profile was Motor > Daily Living > Socialisation > Communication. For the nonverbal group, the observed profile was Motor > Socialisation > Daily Living > Communication. A mixed-design ANOVA (with verbal ability as the between-subjects factor and domain as the within subjects factor) with a Greenhouse-Geisser adjustment due to non-

sphericity was conducted. A significant difference across adaptive functioning domains was found, $F(2.69, 201.57) = 37.50, p < .001, \eta_p^2 = .333$. A significant difference between the verbal and nonverbal groups was also found, $F(1, 75) = 4139.53, p < .001, \eta_p^2 = .982$. There was a significant interaction between the verbal ability and Vineland-II domains, $F(2.69, 201.57) = 7.97, p < .001, \eta_p^2 = .96$, such that the profiles on the Vineland-II for the verbal and nonverbal groups were significantly different. Post hoc pairwise comparisons with no alpha adjustment indicated that for the verbal group, Socialisation and Communication domains did not differ significantly. For the nonverbal group, the difference between each domain was significant (i.e. motor > socialisation > daily living > communication skills).

Age Equivalents

Mean and standard deviations across age equivalent domain scores are shown in Table 2. For both groups, the observed pattern was Motor > Daily Living > Communication > Socialisation. The mixed-design ANOVA showed a significant difference between adaptive functioning domains, $F(3, 225) = 51.04, p < .001, \eta_p^2 = .405$. A significant difference between the verbal and nonverbal groups was also found, $F(1, 75) = 841.23, p < .001, \eta_p^2 = .92$. There was a significant interaction between the verbal ability and Vineland-II domains, $F(3, 225) = 5.73, p < .01, \eta_p^2 = .071$. As shown in Table 2, post hoc pairwise comparisons with no alpha adjustment indicated that for both verbal and nonverbal groups domain scores differed significantly from each other (i.e. Motor > Daily Living > Communication > Socialisation).

Table 2 Means and standard deviations for Vineland-II Standard Scores

Domain	Verbal group M (SD)	Nonverbal group M (SD)
Communication ^a	73.46 ^{b*.d**} (11.85)	57.24 ^{b***.c***.d***} (9.37)
Daily living ^b	77.85 ^{a*} (13.51)	64.78 ^{a***.c*.d***} (10.90)
Socialisation ^c	74.81 ^{d**} (13.16)	67.59 ^{a***.b*.d***} (9.68)
Motor ^d	82.04 ^{a***.c**} (12.85)	78.33 ^{a***.b***.c***} (13.16)
η_p^2	.61	.16

Lettered superscripts indicate which domains differ statistically significantly according to post hoc analyses using LSD

* $p < .05$; ** $p < .01$; *** $p < .001$

Associations with Chronological Age, Cognitive Ability, and Autism Severity

Correlations

Correlations between age, ADOS scores, Vineland-II domains (for both standard scores and age equivalent scores) and cognitive level with the full sample are presented in Table 3. Chronological age did not correlate significantly with Vineland-II standard scores with the exception of motor skills. Higher chronological age correlated with higher age equivalent scores as would be expected. Cognitive ability, as measured by the Mullen Nonverbal DQ, was moderately positively correlated with both types of Vineland-II scores in all domains, such that higher DQs were associated with better adaptive behaviour. Autism severity as measured by ADOS calibrated severity scores showed significant negative correlations with communication, daily living, and overall adaptive behaviour composite (ABC) standard scores, but not with socialisation or motor skill standard scores. Autism severity was significantly linked to all age equivalent scores, and also to age. More severe autism symptoms were associated with poorer adaptive functioning.

Cognitive Ability and Adaptive Behaviour

To explore the impact of cognitive ability on adaptive behaviour further, participants were divided into a high functioning group ($n = 21$) that had a nonverbal score of 70 or higher ($M = 85.61, SD = 16.03, \text{range } 70.75\text{--}133.34$), and a low functioning group ($n = 57$) that had a score below 70 ($M = 47.89, SD = 21.79, \text{range } 14.41\text{--}69.54$), as per previous research with this population (e.g., Bolte and Poustka 2002; Rutter et al. 2003). Consistent with correlations, the low

Table 3 Mean and standard deviation for Vineland-II age equivalent scores

Domain	Verbal group M (SD)	Nonverbal group M (SD)
Communication ^a	29.14 ^{c***.d***} (1.44)	13.19 ^{d***} (1.03)
Daily living ^b	32.23 ^{c***.d*} (1.96)	14.77 ^{d***} (1.40)
Socialisation ^c	24.23 ^{a*.b***.d***} (1.85)	12.69 ^{d***} (1.32)
Motor ^d	36.01 ^{a***.b*.c***} (1.57)	26.55 ^{a***.b***.c***} (1.12)
η_p^2	.68	.43

Lettered superscripts indicate which domains differ statistically significantly according to post hoc analyses using LSD

* $p < .05$; ** $p < .01$; *** $p < .001$

cognitive functioning group showed significantly lower adaptive functioning as indicated by their adaptive behaviour composite (ABC) standard score ($M = 64.59$, $SD = 9.12$) compared to the high (cognitive) functioning group ($M = 85.61$, $SD = 16.03$), $F(1,76) = 19.91$, $p < .001$, $\eta_p^2 = .21$. The mean nonverbal DQ score was significantly higher than the adaptive behaviour composite score for children in the high functioning group, $t(20) = 11.78$, $p < .001$. In contrast, the mean nonverbal DQ score was significantly lower than the adaptive behaviour composite score in the low functioning group, $t(56) = -2.30$, $p < .05$.

Moderate to strong correlations between DQ and Vineland-II standard scores were found for the low functioning group across the four domains of communication ($r = .461$, $p < .001$), daily living ($r = .426$, $p < .001$), socialisation ($r = .561$, $p < .001$), and motor skills ($r = .526$, $p < .001$), as well as the overall ABC composite ($r = .586$, $p < .001$). However, no significant correlations were found between Vineland-II standard scores and DQ for the high functioning group, including the four domains of communication ($r = .062$, $p = .79$), daily living ($r = -.117$, $p = .62$), socialisation ($r = -.236$, $p = .30$), motor skills ($r = -.427$, $p = .05$), or the overall ABC composite ($r = .229$, $p = .32$).

ASD Symptom Severity and Adaptive Behaviour

A series of planned hierarchical regression analyses was completed to examine the unique contribution of ASD symptom severity in prediction of adaptive functioning.

Age and nonverbal DQ were entered in Step 1, and then the ADOS Calibrated Severity Score (CSS) was entered in Step 2 for all analyses. On standard scores, the variance explained by age and DQ ranged from 16 % for Socialisation to 32 % for Communication (see Table 4). For age equivalents, the explained variance ranged from 22 % for Socialisation to 56 % for Communication (see Table 5). The multiple correlation coefficients indicated medium to large effect sizes (Cicchetti et al. 2011). The ADOS CSS score did not contribute significant additional variance to the prediction of any Vineland-II domain or total scores, whether using standard scores or age equivalents, over that explained by age and DQ (Table 6).

Discussion

This study aimed to investigate the Vineland-II profile of adaptive behaviour in verbal and nonverbal young children with ASD and the impact of cognitive ability and ASD symptom severity. When age equivalent Vineland-II scores are used, both verbal and nonverbal groups display the autism profile as hypothesised (motor skills > daily living skills > communication > socialisation). Different profiles emerge for the two groups when standard scores are used. Cognitive ability and age account for a significant proportion of the variance in adaptive behaviour. Further, those with higher cognitive abilities show significantly lower adaptive behaviour skills (using standard scores) than their cognitive skills (using DQs) would predict. In

Table 4 Correlations between Vineland-II Standard (SS) and Age Equivalent (AE) Scores, cognitive level, and autism severity (N = 77)

	1	2	3	4	5	6	7	8	9	10	11
1. Age in Months	1										
2. ADOS calibrated severity score	-.251*	1									
<i>Vineland-II</i>											
3. Communication SS	.062	-.281*	1								
4. Daily living SS	.012	-.328**	.633***	1							
5. Socialisation SS	-.142	-.161	.510***	.687***	1						
6. Motor skills SS	-.311**	-.121	.350**	.516***	.605***	1					
7. Adaptive Behaviour Composite (ABC) SS	-.123	-.245*	.751***	.872***	.857***	.747***	1				
8. Communication AE	.613***	-.377**	.772***	.465***	.284*	-.005	.453***	1			
9. Daily living AE	.532***	-.367**	.571***	.818***	.498***	.225	.648***	.747***	1		
10. Socialisation AE	.282*	-.253*	.527***	.698***	.876***	.401***	.768***	.573***	.750***	1	
11. Motor AE	.389***	-.294**	.404***	.521***	.482***	.705***	.634***	.494***	.633***	.617***	1
12. Mullen Nonverbal DQ	-.001	-.350**	.563***	.514***	.370**	.369**	.534***	.427***	.435***	.369**	.380**

ADOS Autism Diagnostic Observation Schedule, SS standard score, AE age equivalent

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 5 Hierarchical regression analyses of Vineland-II standard scores and age, DQ, and ADOS Calibrated Severity Score (CSS)

Step		Communication	Daily Living	Socialisation	Motor	ABC
Step 1	R^2	.32***	.27***	.16**	.23***	.30***
Age	β (B)	.06 (.08)	.12 (.02)	-.14 (-.17)	-.31 (-.44)**	-.12 (-.13)
DQ	β (B)	.56 (.33)***	.51 (.31)***	.37 (.19)**	.37 (.23)**	.53 (.26)***
Step 2	ΔR^2	.01	.03	.01	.01	.01
ADOS	β (B)	-.09 (-.61)	-.18 (-1.35)	-.08 (-.54)	-.09 (-.67)	-.11 (-.65)
CSS						
Total	R^2	.33***	.29***	.16**	.24***	.31***

ADOS CSS Autism Diagnostic Observation Schedule Calibrated Severity Score; ABC Vineland Adaptive Behaviour Composite

** $p < .01$; *** $p < .001$

Table 6 Hierarchical regression analyses of Vineland-II age equivalent scores and age, DQ, and ADOS Calibrated Severity Score (CSS)

Step		Communication	Daily living	Socialisation	Motor
Step 1	R^2	.56***	.47***	.22***	.30***
Age	β (B)	.61 (.67)***	.53 (.72)***	.28 (.32)**	.39 (.37)***
DQ	β (B)	.43 (.21)***	.44 (.26)***	.37 (.18)**	.38 (.16)***
Step 2	ΔR^2	.01	.01	.00	.01
ADOS CSS	β (B)	-.09 (-.55)	-.10 (-.73)	-.07 (-.40)	-.08 (-.41)
Total	R^2	.75***	.48***	.22***	.30***

DQ: Developmental Quotient; ADOS CCS: Autism Diagnostic Observation Schedule Calibrated Severity Score

** $p < .01$; *** $p < .001$

contrast, children with lower cognitive abilities show adaptive behaviour skills that are higher than their cognitive abilities. The severity of autism symptoms does not make a significant contribution to the prediction of adaptive behaviour over age and cognitive ability.

Domain Score Profiles

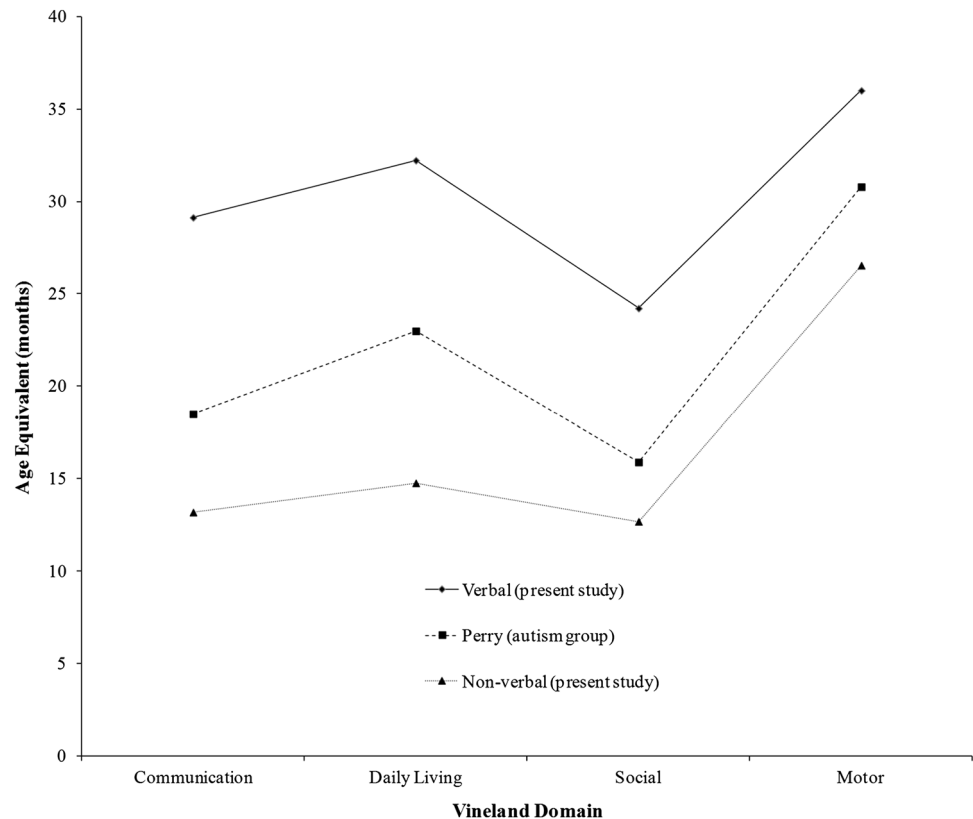
Our finding of the autism profile with age equivalent scores is illustrated in Fig. 1. This profile is consistent with most previous research with the original Vineland (Bolte and Poustka 2002; Carter et al. 1998; Gillham et al. 2000; Perry et al. 2009). The predicted profile, with greatest weaknesses in socialisation, is seen for both children with verbal skills and those who were nonverbal.

We found two different profiles for the verbal and nonverbal groups on standard scores that also differed from the autism profile found with age equivalent scores. The standard score profile is also different in this sample compared to the profile described in the Vineland-II manual as illustrated in Fig. 2. In both samples, highest scores (although below the population mean of 100) are seen in motor skills for both groups, and the nonverbal group shows greatest needs in communication, as may be

expected from group assignment. However, differences in the pattern of relative strengths and weaknesses are observed in the remaining domains. The discrepancies between the current results and the data reported in the Vineland-II manual may be due to differences in the sample’s age group with a diverse age range (3–16 years) included in the manual sample with only 16 verbal children and 14 nonverbal children in the 3–6 years age range.

When standard scores are used, children with ASD in both verbal ability groups exhibit more difficulties as a group with communication than with socialisation. Given that research has consistently shown that the greatest deficits associated with ASD are related to social functioning (e.g., Gillham et al. 2000; Mougá et al. 2014), it appears that age equivalent scores might be more sensitive to the areas of need in this population. The discrepancies in the profile when standard scores or age equivalent scores are used may be due to continued floor effects for young children with ASD, as was suggested on the original Vineland (Carter et al. 1998; Perry et al. 2009). Although the revised Vineland-II now includes additional items and changes the basal procedures, the discrepancies may be due to young children with ASD showing a higher degree of impairment in comparison to standard score norms; age

Fig. 1 Age equivalent Vineland-II profile Present Study versus Perry et al., (2009)



equivalent scores may be more sensitive to variations in the lower range of ability. Consistent with this, previous research has suggested that standard scores in Vineland-II are not sensitive enough in measuring changes in the skills of children with ASD during intervention (Bacon et al. 2014; Gabriels et al. 2007). In addition, Gabriels et al. (2007) has highlighted the value of using age equivalent scores to evaluate outcomes, as standard scores are based on progression in typical development that may not be sensitive to developments over time in children with ASD who generally develop skills at a slower rate.

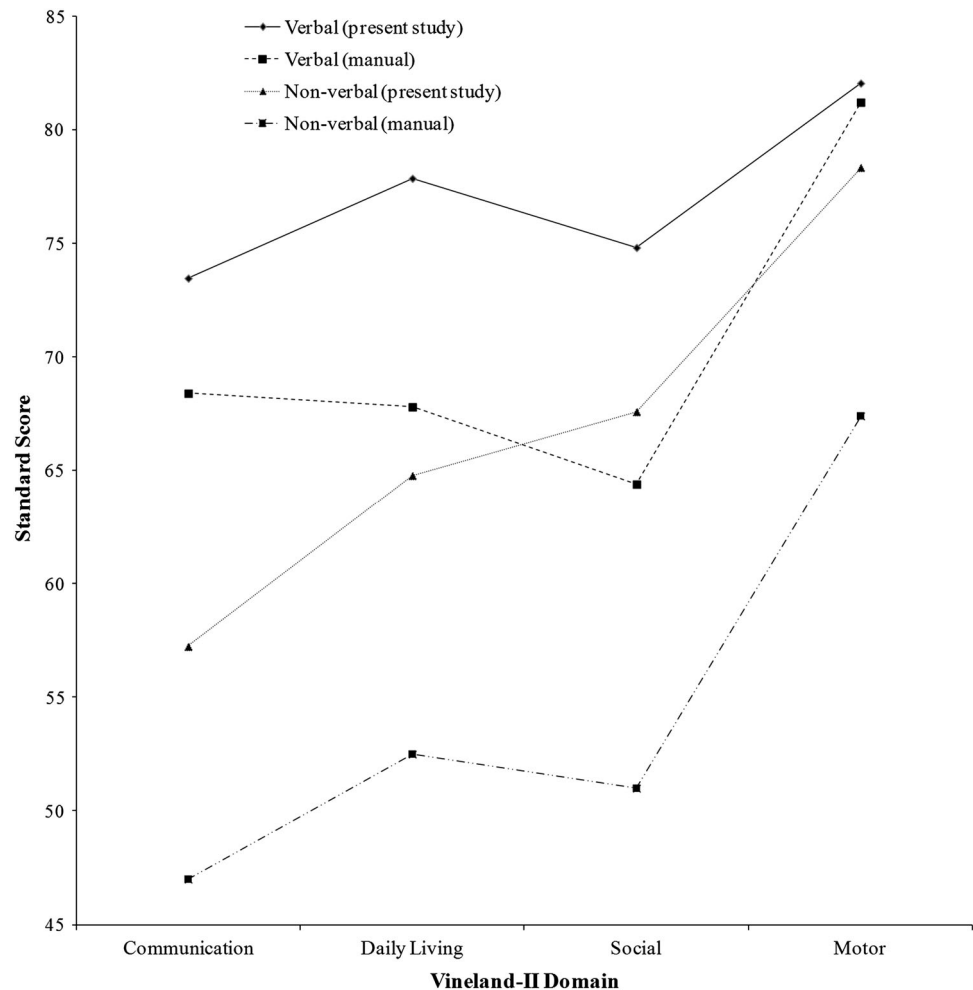
Associations with Chronological Age, Cognitive Ability, and Autism Severity

Consistent with previous research (e.g., Perry et al. 2009; Ray-Subramanian et al. 2011) there is a significant relationship between age, cognitive level, and adaptive behaviour. However, this relationship differs for high versus low functioning groups, a finding that is consistent with previous research (Bolte and Poustka 2002; Freeman et al. 1999; Gabriels et al. 2007; Liss et al. 2001; Perry et al. 2009). In the low cognitive functioning group, children's overall adaptive behaviour score and domain scores were higher than their cognitive scores. Perry et al. (2009) suggested that this pattern may be explained by the

children with low cognitive functioning having received good coaching in daily living skills. Alternatively, it may be that children have reached their maximum potential in terms of adaptive behaviour and are constrained by their below average cognitive ability. In contrast, children with higher cognitive functioning have lower adaptive behaviour scores when compared to their cognitive scores, indicating that more cognitively able individuals present with symptoms that impact their ability to function in daily life.

Autism severity was negatively related to age equivalent adaptive behaviour scores, and with daily living, communication, and overall standard scores. This finding is consistent with previous research that has identified marked difficulties in adaptive behaviour for children with ASD relative to other comparison groups (e.g., Gillham et al. 2000; Mougá et al. 2014). However, it appears that the links of autism severity with adaptive behaviour may be explained by age and/or cognitive ability as there was no significant independent contribution to Vineland-II scores once these were controlled. Ray-Subramanian et al. (2011) likewise found that ADOS calibrated severity score did not add a significant contribution to Vineland scores once age and cognitive ability were controlled in a toddler sample. This was in contrast to Kanne et al. (2011) who found that using the ADOS calibrated severity score did add a

Fig. 2 Standard score profile Vineland-II profile Present Study versus Vineland-II manual (Sparrow et al. 2005)



significant contribution above age and cognitive level assessed with the Differential Ability Scales and across a wider age range (4–17 years). It may be that the relationship is affected by the age of participants or the specific cognitive measure.

Strengths, Limitations, and Future Directions

The present study has several notable strengths, but also some limitations that should be kept in mind when interpreting the findings. We focused on an important stage in the lives of children with ASD, the age of entry to early intervention and we recruited a relatively large sample. Groups were split on non-verbal ability using 70 as a cut-off as per previous research (e.g., Bolte and Poustka 2002; Ben-Itzhak et al. 2014) to compare profiles across low and high-functioning groups. However some children scored close to 70 and future research with a larger sample may consider excluding children who scored similarly (e.g., 65–75) to compare more clearly divergent groups to strengthen our findings.

Diagnoses had been made using the DSM-IV-TR criteria prior to the release of the DSM-5 (American Psychiatric Association 2013) and we focused on the profile in young children. It is unclear if the results are generalisable to those who are now being diagnosed under the revised DSM-5 criteria. Future research with other age groups using DSM-5 diagnoses would enhance our understanding of the development of adaptive behaviour skills across age groups and allow comparison of potential differences in profiles at different development stages. Further, longitudinal research would be valuable for tracking trajectories over time and the inclusion of comparison groups of both typically-developing children and those with other developmental disabilities (e.g., intellectual impairment) would be of value to deepen our understanding of the specificity of the proposed autism profile. Finally, additional research into subdomain comparisons may also provide further understanding. Such research could aid in diagnosis and treatment through providing insight into the whether the profile is unique to ASD which may be useful in differential diagnosis and informing treatment planning.

Implications

This research provides important insight into measurement of adaptive behaviour in young children with ASD including the type of score used (age equivalent vs. standard score) for interpretation of results and the impact of cognitive level. This study shows, as with the original Vineland, age equivalent scores on the Vineland-II when calculated from subdomain scores, may be a more sensitive measure. This finding is important for clinical practice, and indeed test developers, as it suggests that age equivalents should be calculated and used for interpretation and may be more sensitive to monitoring progress in intervention. Further, this research highlights the importance of considering levels of cognitive functioning when interpreting the results of adaptive behaviour measures. Although children who are functioning at higher cognitive levels may also demonstrate higher levels of adaptive behaviour, some may have greater deficits in adaptive functioning. This discrepancy is important, as if assessed on intellectual ability alone, children with higher cognitive scores may be presumed also to have similarly high levels of adaptive functioning. Conversely, children with lower levels of cognitive functioning may display relative strengths in adaptive behaviour that need to be recognised. It is clear from these findings that assessments of adaptive behaviour should always be included in a comprehensive evaluation of children with ASD.

Conclusion

This study has made an important contribution to understanding the structure of adaptive behaviour in children with ASD in the preschool years through a direct comparison of profiles obtained from standard scores and age equivalent scores for both verbal and nonverbal children. The presence of a distinct autism age equivalent domain score profile highlights the strengths and weaknesses in adaptive functioning for young children with ASD. Such information is valuable in understanding the nature of presenting challenges in ASD. Importantly, we have shown that age equivalent scores appear to be more sensitive for ascertainment of adaptive behaviour skills in young children with ASD. The use of age equivalent scores should assist in the evaluation of young children with ASD in early intervention by providing a sensitive measure of the vital area of adaptive skills that will facilitate intervention planning and monitoring of progress.

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Author Contributions SY was responsible for data analysis and interpretation as well as drafting the initial manuscript as part of her Masters in Educational Psychology studies. JP and LG provided supervision to SY. JP made substantial contributions to the conception and design of the study, as well as data collection, and assisted in interpretation of data analyses, preparing the manuscript for publication, and finalising the manuscript including revisions following peer reviews. LG made substantial contributions in study planning, preparation of gatekeeper approvals, manuscript preparation, and revising the manuscript critically for important intellectual content including responding to peer reviews. All authors read and approved the final version of the manuscript for publication.

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