J Autism Dev Disord (2013) 43:253–264
DOI 10.1007/s10803-012-1558-0

ORIGINAL PAPER

Age of First Words Predicts Cognitive Ability and Adaptive Skills in Children with ASD

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Published online: 7 June 2012

Abstract Acquiring useful language by age 5 has been identified as a strong predictor of positive outcomes in individuals with Autism Spectrum Disorders (ASD). This study examined the relationship between age of language acquisition and later functioning in children with ASD ($n = 119$). First word acquisition at a range of ages was probed for its relationship to cognitive ability and adaptive behaviors at 52 months. Results indicated that although producing first words predicted better outcome at every age examined, producing first words by 24 months was a particularly strong predictor of better outcomes. This finding suggests that the historic criterion for positive prognosis (i.e., "useful language by age 5") can be updated to a more specific criterion with an earlier developmental time point.

Keywords Autism · Autism spectrum disorders · Language acquisition · Language delay · Developmental milestones · Prognosis

Introduction

Deficits in language and communication are core features of Autism Spectrum Disorders (ASD) that are often evident early in life (American Psychiatric Association 2000). For instance, toddlers with ASD produce significantly fewer communicative acts and demonstrate significantly less joint attention than typically developing children or children with developmental delays (Shumway and Wetherby 2009). Young children with ASD display fewer gaze shifts, conventional gestures, and gestures coordinated with vocalizations and eye gaze than children with developmental delays (Stone et al. 1997). In addition to atypical social communication, many individuals with ASD struggle to acquire basic expressive language skills; for a review of language development in ASD see Frith and Happé (1994) and Rapin and Dunn (1997, 2003). Approximately one quarter of individuals with ASD remain non-verbal over the course of their lives (Lord et al. 2004). Children with ASD who *do* learn verbal communication, generally achieve language milestones later than children with typical development (Howlin 2003). Although typically developing children generally produce their first words between 12 and 18 months old (Tager-Flusberg et al. 2009; Zubrick et al. 2007), children with ASD are reported to do so at an average age of 36 months (Howlin 2003).

Age of language acquisition is an important indicator of positive prognosis and social functioning. Very early reports noted that having language by age 5–6 was an important discriminator of higher versus lower functioning individuals with ASD (Rutter 1970), as it related to better social functioning in adulthood (Eisenberg 1956; Kanner et al. 1972). The importance of language by age 5 was confirmed in a more recent report that found that adults with ASD who had acquired "useful speech" by age 5 were more social and required fewer residential support services than those who had not (Howlin et al. 2004). The observed associations between delayed language acquisition and poorer prognosis have prompted many to avoid the "wait and see" approach to late language development in young children (Buschmann et al. 2008), and instead to adopt a

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more active "watch and see" approach by monitoring development over short periods of time (3–6 months) (Paul 1996, 2000) or to implement specific interventions as soon as delayed language onset is observed (Ellis Weismer 2000; Girolametto et al. 1996).

In recent years, children can be reliably diagnosed with ASD as early as the toddler years, which allows for an investigation of the relationship between earlier aspects of language acquisition and later development (Charman et al. 2005; Lord et al. 2005; Stone et al. 2000). Studies of the relationship between standardized language scores and later functioning in ASD have clearly established an association between early language skills and later skills (Gillespie-Lynch et al. 2012; Venter et al. 1992). However, most children do not receive a comprehensive evaluation of language skills using standardized formal assessments at an early age, limiting the wide-spread use of standardized measures as a source for prognostic information.

There is a simple marker of language development, parent report of the timing of first words, that could offer valuable prognostic information. Delay in the onset of spoken language is often the most pressing concern expressed by parents of children with ASD (De Giacomo and Fombonne 1998; Howlin and Asgharian 1999; Short and Schopler 1988), indicating that this aspect of early language development is highly salient. The current study examines the relationship between early language acquisition and later functioning in children with ASD by investigating the question: does the age of a child's first word production predict later cognitive ability, adaptive behavior skills, or symptoms of ASD severity and if so, is there a particularly potent predictive age of language onset?

Method

Participants

The participants in this study were 119 children who participated in a larger ASD screening study using the Modified Checklist for Autism in Toddlers (M-CHAT; Robins et al. 1999a), a parent report autism-specific screening instrument, at the University of Connecticut. Detailed information about the M-CHAT is available elsewhere (Kleinman et al. 2008; Robins 2008; Robins et al. 2001; Robins and Dumont-Mathieu 2006). All children in the current study were screened with the M-CHAT between 16 and 30 months of age at the office of a pediatrician or Early Intervention provider. Children who screened positive on the instrument and the M-CHAT Follow Up (M-CHAT Follow Up; Robins et al. 1999b), an interview designed to verify screening responses, were offered a comprehensive developmental evaluation, and a follow up evaluation approximately 2 years later. The first-stage M-CHAT data have been described elsewhere (Kleinman et al. 2008; Robins et al. 2001); the current study focuses on data obtained from the follow up evaluation for children who went on to receive diagnoses of ASD.

All children in the current study received ASD diagnoses at the follow up evaluation based on parent interview, the Autism Diagnostic Observation Schedule (ADOS; Lord et al. 2000), the Autism Diagnostic Interview, Revised (ADI-R; Lord et al. 1994), the Childhood Autism Rating Scale (CARS; Schopler et al. 1980; Schopler et al. 1988) and clinical judgment. Diagnoses were made by a clinical psychologist or a developmental pediatrician with experience with ASD using DSM-IV-TR criteria (American Psychiatric Association 2000).

Children with reported language regression were excluded from the study because of the difficulty of accurately judging onset of first words. Language regression, identified from the ADI-R, was defined as the regular communicative use of at least five words (other than 'dada' or 'mama') for at least three months followed by the loss of those language skills for three or more months (Lord et al. 1994).

The sample consisted of 119 children; 75 children (63 %) with diagnoses of Autistic Disorder (AD) and 44 (37 %) with diagnoses of Pervasive Developmental Disorder, Not Otherwise Specified (PDD-NOS). The sample was primarily male (83.2 %) and White (82.4 %). Children ranged in age at the time of the evaluation from 45 to 72 months, with a mean age of 52.22 months (SD = 6.09). Table 1 presents the sample characteristics.

Measures

Assessment of First Words

Age of first words was defined as the age (in months) at which the child first produced single words, other than "mama" and "dada," in a consistent and meaningful way for the purposes of communication. This information was obtained from the caregiver during a clinical interview using the ADI-R. Following ADI-R administration protocol, parents were asked to give examples of first words; follow up questions helped clarify that words were used meaningfully, a process which has been found to promote more accurate parent recall (Hus et al. 2011).

Cognitive Development

The Mullen Scales of Early Learning (MSEL; Mullen 1997) assesses cognitive development in five domains: Gross Motor, Visual Reception, Fine Motor, Receptive Language, and Expressive Language. The Gross Motor scale was not administered in this study. The reliability and

Table 1 Sample characteristics for the Autistic Disorder, PDD-NOS, and combined (full) ASD sample

	Autistic Disorder ($n = 75$)	PDD-NOS ($n = 44$)	χ^2	t	p	d	Combined ASD Sample ($n = 119$)
Male (% of sample)	$n = 62$ (82.7 %)	$n = 37$ (84.1 %)	0.04	–	0.84	–	$n = 99$ (83.2 %)
White:Non-white:Not reported	62:7:6	36:5:3	0.525	–	0.97	–	98:12:9
Age in months at evaluation (SD)	52.75 (6.46)	51.32 (5.36)	–	1.24	0.22	0.24	52.2 (6.1)
Age in months at initial diagnosis (SD)	26.04 (4.28)	26 (4.18)	–	0.051	0.96	0.01	26 (4.2)
Age in months at first words (SD)	23.48 (11.44)	22.20 (9.0)	–	0.626	0.53	0.12	23 (10.5)
MSEL Visual Reception	31.2 (15.8; 20–74)	36.6 (16.4; 20–63)	–	−1.67	0.10	0.34	33.2 (16.2; 20–74)
MSEL Fine Motor	27.9 (11.6; 20–69)	31.6 (15.3; 20–74)	–	−1.3	0.20	0.28	29.3 (13.2; 20–74)
MSEL Receptive Language	30.0 (13.9; 20–69)	34.1 (15.5; 20-70)	–	−1.38	0.17	0.28	31.6 (14.6; 20–70)
MSEL Expressive Language	28.4 (11.6; 20–69)	31.5 (12.1; 20–58)	–	−1.26	0.21	0.26	29.6 (11.9; 20–69)
VABS Communication	68.83 (19.0; 44–116)	73.29 (20.4; 45–126)	–	−1.16	0.25	0.23	70.5 (19.6; 44–126)
VABS Daily Living Skills	59.3 (10.1; 42–89)	63.4 (12.8; 38–95)	–	−1.88	0.06	0.37	60.8 (11.3; 38–95)
VABS Socialization	64.8 (12.1; 49–96)	67.8 (10.9; 50–94)	–	−1.33	0.19	0.26	65.9 (11.7; 49–96)
VABS Motor Skills	65.9 (13.9; 43–105)	73.3 (20.3; 33–116)	–	−2.08	0.04	0.45	68.7 (16.9; 33–116)
CARS Total	31.74 (5.86; 21.5–45.5)	29.25 (5.54; 19.5–42)	–	2.23	0.03	0.43	30.8 (5.84; 19.5–45.5)
ADOS Severity Score	6.48 (2.41; 1–10)	6.03 (2.39; 1–10)	–	0.95	0.34	0.19	6.31 (2.40; 1–10)
Number of DSM-IV Symptoms	6.49 (1.84; 2–11)	6.12 (1.98; 2–10)	–	1.00	0.32	0.20	6.35 (1.89; 2–11)

Scores are presented as M (SD, range). All MSEL scores are *T* scores, with mean = 50, SD = 10. All VABS scores are standard scores, with mean = 100, SD = 15

MSEL Mullen Scales of Early Learning, *VABS* Vineland Adaptive Behavior Scales, *ADOS* Autism Diagnostic Interview Schedule, *CARS* Childhood Autism Rating Scale

validity of the measure are well established, and the Mullen Scales of Early Learning has been identified as an appropriate measure for cognitive testing for children with ASD (Filipek et al. 1999; Mullen 1997). The Mullen Scales of Early Learning was administered by doctoral students in clinical psychology familiar with early autism assessment under the supervision of a licensed psychologist.

Adaptive Functioning

The Vineland Adaptive Behavior Scales (VABS; Sparrow et al. 1984) is a standardized semi-structured caregiver interview that evaluates the adaptive functioning for Communication, Daily Living Skills, Socialization, and Motor Skill domains. The psychometrics of the measure are well established and the Vineland Adaptive Behavior Scales is a frequently used measure in clinical and research settings (Sparrow et al. 1984). In this study, the Vineland Adaptive Behavior Scales were completed by a licensed psychologist or developmental pediatrician with experience in autism assessment.

Diagnostic Evaluation

The Autism Diagnostic Observation Schedule (ADOS; Lord et al. 2000) is a semi-structured standardized assessment of communication, social interaction and play used to diagnose autism spectrum disorders. The psychometrics of the instrument are strong (Lord et al. 2000). ADOS modules one and two were used in this study. The ADOS was administered by doctoral students in clinical psychology familiar with early autism assessment under the supervision of a licensed psychologist. Autism severity was calculated from raw scores (Gotham et al. 2009).

The Autism Diagnostic Interview-Revised (ADI-R; Lord et al. 1994) is a standardized semi-structured caregiver interview that assesses communication, social development, and play, and the presence of repetitive or restricted behaviors. The ADI-R has strong reliability and validity (Lord et al. 1994). Information regarding the age at which the child produced his or her first words and language regression was obtained using this measure. The ADI-R was completed by a licensed psychologist or developmental pediatrician with experience in autism assessment.

The Childhood Autism Rating Scale (CARS; Schopler et al. 1980, 1988) is a behavioral rating scale assessing the presence and severity of symptoms of ASD. The CARS items address related features of autism and an overall category rating of "general impressions" of autism. Acceptable psychometric properties have been reported for the CARS (Schopler et al. 1988). The CARS was completed by a

licensed psychologist or developmental pediatrician and a doctoral student. CARS reliability assessed by the current authors in previous analyses found agreement for CARS total scores to be very high ($r = 0.94$) and excellent agreement in regards to the overall CARS classification (e.g., autism or non-autism) ($\kappa = 0.90$; $p < 0.001$) (Chlebowski et al. 2010).

Data Analytic Plan

In order to determine the relationship between early language acquisition and later functioning in children with ASD, parents of children with ASD reported the age of their child's first word production. Examination of the relationship between age of first words and later cognitive ability, adaptive behavior, and ASD severity was conducted using the following data analytic strategies. *t* test and Chi square analyses were used to compare the diagnostic groups (Autistic Disorder vs. PDD-NOS) on demographic characteristics and clinical variables. Omnibus MANOVA, and subsequent ANOVAs were used to compare children grouped as a function of age of first words (i.e., first words by 12, 18, 24, 30, 36 months) on outcome measures of cognition, language, and autism symptomatology with post hoc analyses to examine specific group contrasts. *t* tests were used to examine cognitive and adaptive skills from children *with* versus *without first words* by salient benchmark ages (i.e., by 18, 24, 30, 36 months). Levene's test for the equality of variances was calculated for each statistic and if the error variance was not assumed to be similar across groups, the Dunnett's T3 post hoc test was performed. All other post hoc analyses were completed using Tukey's test. Effect sizes are reported using Cohen's *d* and classified as small ($d = 0.20$), medium ($d = 0.50$), or large ($d = 0.80$; Cohen 1988).

Results

Comparison Between Diagnostic Groups: Autistic Disorder Versus PDD-NOS

To examine diagnostic group differences at the time of evaluation, the AD and PDD-NOS groups were compared. There were no differences in gender, χ^2 (1, $N = 119$) = 0.04, $p = 0.84$, ethnicity, χ^2 (4, $N = 119$) = 0.53, $p = 0.97$, age of initial diagnosis, $t(103) = 0.05$, $p = 0.96$, or age at current evaluation, $t(117) = 1.24$, $p = 0.22$. Data are presented in Table 1. There was no difference between diagnostic groups in age of first words, $t(95) = 0.63$, $p = 0.53$ and the number of children who had not yet acquired their first words was equally distributed between the two groups, χ^2 (1, $N = 119$) = 2.46, $p = 0.12$ (see Table 1). Across all measures of cognitive and language ability, adaptive behavior, and ASD characteristics, the groups differed on only two measures: Vineland Motor Skills domain, with the PDD-NOS group scoring significantly higher than the AD group, $t(62) = -2.08$, $p = 0.04$, $d = 0.45$ and CARS total score, with the AD group obtaining a higher (i.e., more severe) score $t(110) = 2.22$, $p = 0.03$, $d = 0.43$. Although the difference was statistically significant, the difference in CARS scores between the two groups differed by only 2.5 points (on a scale ranging from 0 to 60) suggesting little meaningful clinical difference between the samples.

Because the groups were similar on demographic and clinical characteristics, PDD and AD samples were combined for all subsequent analyses into a single ASD sample. The mean age of first words for the full ASD sample of 119 children was 23.0 months (SD = 10.5); 19 children (16 %) had not yet produced first words at time of evaluation. Clinical characteristics are presented in Table 1. All children in the ASD sample received a thorough clinical evaluation in which they received standardized clinical measures that were assessed as "outcomes" that were potentially different depending upon the age at which each child began to produce meaningful, communicative first words.

Comparison of Outcomes: Children with Versus Without First Words by Benchmark Ages

To assess the importance of reaching the first word milestone by salient age markers, children *with* versus *without first words* by specific "benchmark" ages (i.e., by 18, 24, 30, 36 months) were compared on measures of cognitive ability, adaptive behavior, and ASD characteristics. *t* tests indicate that children without first words by the 18 month benchmark scored significantly lower than children who had produced first words by 18 months on four cognitive/language measures [MSEL Visual Reception (30.5 vs. 37.6, $t = 2.09$, $p = 0.04$, $d = 0.45$); MSEL Receptive Language (28.7 vs. 36.4, $t = 2.5$, $p = 0.015$, $d = 0.54$); MSEL Expressive Language (27.5 vs. 32.9, $t = 2.14$, $p = 0.036$, $d = 0.46$) and VABS Communication domain (67.9 vs. 75.5, $t = 1.99$, $p = 0.049$, $d = 0.4$)], all with medium effect sizes, as shown in Table 2.

Comparison of children who did versus did not produce their first words by the later benchmark ages (i.e., 24, 30, or 36 months) revealed a similar pattern of results. In all cases, children who *had not* produced their first words by the given age scored significantly lower on all MSEL and VABS domains, and had significantly higher (more severe) CARS scores, than children who *had* met this milestone. There were no differences between groups for total number

Table 2 Children with versus without first words by 18 months: a comparison of outcomes at 52 months

	First words by 18 months		No words by18 months		*t*	*p*	*d*
	n	Mean (SD)	*n*	Mean (SD)			
MSEL Visual Reception	**40**	**37.6 (18.4)**	**65**	**30.5 (14.5)**	**2.09**	**0.04**	**0.45**
MSEL Fine Motor	38	31.1 (12.8)	66	28.2 (13.3)	1.06	0.29	0.22
MSEL Receptive Language	**38**	**36.4 (16.2)**	**65**	**28.7 (12.9)**	**2.5**	**0.02**	**0.54**
MSEL Eexpressive Language	**39**	**33.0 (13.4)**	**65**	**27.5 (10.5)**	**2.14**	**0.04**	**0.46**
VABS Communication	**38**	**75.5 (20.3)**	**73**	**67.9 (18.8)**	**1.99**	**0.05**	**0.40**
VABS Daily Living Skills	38	63.0 (11.7)	73	59.6 (10.9)	1.53	0.13	0.30
VABS Socialization	38	68.2 (10.4)	73	64.7 (12.2)	1.49	0.14	0.30
VABS Motor Skills	38	70.8 (16.92)	72	67.5 (16.8)	0.980	0.33	0.20
CARS Total	42	29.88 (5.05)	70	31.36 (6.24)	−1.3	0.20	0.25
ADOS Severity Score	39	6.46 (2.4)	67	6.22 (2.42)	0.489	0.63	0.10
Number of DSM-IV Symptoms	40	6.48 (2.03)	74	6.28 (1.83)	0.514	0.61	0.11

MSEL Mullen Scales of Early Learning, *VABS* Vineland Adaptive Behavior Scales, *ADOS* Autism Diagnostic Interview Schedule, *CARS* Childhood Autism Rating Scale

All MSEL scores are *T* scores, with mean = 50, SD = 10. All VABS scores are standard scores, with mean = 100, SD = 15. Due to occasional non-compliance in testing, not all children completed all the evaluation subtests; sample sizes for each subtest have been included in the table. Bold values indicates significance with a small to medium effect size; normal values indicates $p > 0.05$

Table 3 Children with versus without first words by 24 months: A comparison of outcomes at 52 months

	First words by 24 months		No words by 24 months		*t*	*p*	*d*
	n	Mean (SD)	*n*	Mean (SD)			
MSEL Visual Reception	**57**	**37.7 (17.1)**	**48**	**27.9 (13.2)**	**3.29**	**0.001**	**0.63**
MSEL Fine Motor	**55**	**31.7 (12.9)**	**49**	**26.6 (13.1)**	**2.03**	**0.05**	**0.40**
MSEL Receptive Language	***55***	***37.5 (16.1)***	***48***	***24.8 (8.8)***	***5.03***	***<0.001***	***0.96***
MSEL Expressive Language	***55***	***34.0 (12.8)***	***49***	***24.6 (8.4)***	***4.46***	***<0.001***	***0.86***
VABS Communication	***56***	***78 (20.0)***	***55***	***62.8 (15.9)***	***4.42***	***<0.001***	***0.84***
VABS Daily Living Skills	**56**	**63.3 (11.0)**	**55**	**58.2 (11.1)**	**2.44**	**0.02**	**0.46**
VABS Socialization	**56**	**69.7 (11.5)**	**55**	**62.1 (10.8)**	**3.59**	**0.001**	**0.68**
VABS Motor Skills	**56**	**71.8 (16.8)**	**54**	**65.4 (16.5)**	**2.01**	**0.05**	**0.38**
CARS Total	**61**	**29.3 (4.9)**	**51**	**32.6 (6.37)**	**−3.03**	**0.003**	**0.59**
ADOS Severity Score	56	6.18 (2.32)	50	6.46 (2.51)	−0.6	0.55	0.12
Number of DSM-IV Symptoms	59	6.39 (1.97)	50	6.31 (1.82)	0.227	0.82	0.04

All MSEL scores are *T* scores, with mean = 50, SD = 10. All VABS scores are standard scores, with mean = 100, SD = 15. Due to occasional testing non-compliance, not all children completed all the evaluation subtests; sample sizes for each subtest have been included in the table. Bolditalic values indicates significance with a large effect size; bold values indicates significance with a small to medium effect size; normal values indicates $p > 0.05$

MSEL Mullen Scales of Early Learning, *VABS* Vineland Adaptive Behavior Scales, *ADOS* Autism Diagnostic Interview Schedule, *CARS* Childhood Autism Rating Scale

of DSM-IV symptoms or ADOS severity score at any benchmark age, see Tables 3, 4, 5.

Because of the potential clinical relevance of these data, the patterns of group differences were further examined. The effect sizes of the group differences grow larger as the age of comparison increases from 18 to 36 months (see Tables 2, 3, 4, 5). Group differences between children who were verbal versus non-verbal at 18 months show medium effect sizes. Similarly, the majority of group differences between verbal and non-verbal children at 24 months show medium effect sizes; however, language measures show large effect sizes (i.e., MSEL Receptive Language, $d = 0.96$; MSEL Expressive Language, $d = 0.86$; and VABS Communication, $d = 0.84$). By 30 months, group differences on measures of language skills continue to show large effect sizes (MSEL Receptive Language, $d = 1.08$; MSEL Expressive

Table 4 Children with versus without first words by 30 months: a comparison of outcomes at 52 months

	First words by 30 months		No words by 30 months		*t*	*p*	*d*
	n	Mean (SD)	*n*	Mean (SD)			
MSEL Visual Reception	**71**	**36.6 (16.6)**	**34**	**26.3 (12.8)**	**3.49**	**0.001**	**0.67**
MSEL Fine Motor	**69**	**31.5 (13.6)**	**35**	**24.9 (11.3)**	**2.64**	**0.010**	**0.52**
MSEL Receptive Language	***68***	***36.3 (15.4)***	***35***	***22.3 (6.1)***	***6.59***	***<0.001***	***1.08***
MSEL Expressive Language	***69***	***33.4 (12.4)***	***35***	***22.0 (5.7)***	***6.38***	***<0.001***	***1.07***
VABS Communication	***71***	***76.2 (19.3)***	***40***	***60.4 (15.7)***	***4.4***	***<0.001***	***0.87***
VABS Daily Living Skills	**71**	**63.3 (10.9)**	**40**	**56.3 (10.6)**	**3.3**	**0.001**	**0.65**
VABS Socialization	**71**	**68.7 (11.1)**	**40**	**60.9 (11.3)**	**3.56**	**0.001**	**0.70**
VABS Motor Skills	**71**	**71.5 (17.1)**	**39**	**63.5 (12.3)**	**2.43**	**0.02**	**0.49**
CARS Total	***75***	***29.29 (5.08)***	***37***	***33.87 (6.15)***	***−4.17***	***<0.001***	***0.84***
ADOS Severity Score	71	6.14 (2.35)	35	6.66 (2.51)	−1.04	0.30	0.22
Number of DSM-IV Symptoms	74	6.32 (2.08)	40	6.40 (1.52)	−0.22	0.82	0.04

All MSEL scores are *T* scores, with mean = 50, SD = 10.All VABS scores are standard scores, with mean = 100, SD = 15. Due to occasional testing non-compliance, not all children completed all the evaluation subtests; sample sizes for each subtest have been included in the table. Bolditalic values indicates significance with a large effect size; bold values indicates significance with a small to medium effect size; normal values indicates $p > 0.05$

MSEL Mullen Scales of Early Learning, *VABS* Vineland Adaptive Behavior Scales, *ADOS* Autism Diagnostic Interview Schedule, *CARS* Childhood Autism Rating Scale

Table 5 Children with versus without first words by 36 months: a comparison of outcomes at 52 months

	First words by 36 months		No words by 36 months		*t*	*p*	*d*
	n	Mean (SD)	*n*	Mean (SD)			
MSEL Visual Reception	**84**	**35.2 (16.4)**	**21**	**25.3 (12.7)**	**2.99**	**0.005**	**0.63**
MSEL Fine Motor	**82**	**31.0 (13.7)**	**22**	**22.8 (8.1)**	**3.59**	**0.001**	**0.65**
MSEL Receptive Language	***81***	***34.3 (15.1)***	***22***	***21.4 (5.0)***	***6.48***	***<0.001***	***0.95***
MSEL Expressive Language	***82***	***31.8 (12.2)***	***22***	***21.3 (5.3)***	***5.94***	***<0.001***	***0.94***
VABS Communication	***85***	***74.7 (19.2)***	***26***	***56.9 (13.9)***	***5.19***	***<0.001***	***0.98***
VABS Daily Living Skills	***85***	***62.7 (11.0)***	***26***	***54.5 (7.8)***	***3.42***	***0.001***	***0.80***
VABS Socialization	***85***	***68.1 (11.4)***	***26***	***58.9 (10.2)***	***3.67***	***<0.001***	***0.82***
VABS Motor Skills	**84**	**71.1 (16.3)**	**26**	**60.9 (16.7)**	**2.79**	**0.006**	**0.63**
CARS Total	***88***	***29.6 (5.1)***	***24***	***35.06 (6.67)***	***−4.34***	***<0.001***	***1.00***
ADOS Severity Score	84	6.3 (2.3)	22	6.27 (2.91)	0.07	0.94	0.01
Number of DSM-IV Symptoms	88	6.2 (2.0)	26	6.73 (1.34)	−1.45	0.15	0.28

All MSEL scores are *T* scores, with mean = 50, SD = 10.All VABS scores are standard scores, with mean = 100, SD = 15. Due to occasional testing non-compliance, not all children completed all the evaluation subtests; sample sizes for each subtest have been included in the table. Bolditalic values shading indicates significance with a large effect size; bold values indicates significance with a small to medium effect size; normal values indicates $p > 0.05$

MSEL Mullen Scales of Early Learning, *VABS* Vineland Adaptive Behavior Scales, *ADOS* Autism Diagnostic Interview Schedule, *CARS* Childhood Autism Rating Scale

Language, $d = 1.07$; and VABS Communication, $d = 0.87$) and the difference between CARS scores increases to a large effect ($d = 0.84$). All other significant group differences continue to have medium effects. By age 36 months, all significant group differences have large effect sizes, with the exception of medium effect sizes for the MSEL Visual Reception, and MSEL and VABS motor domains.

Analyses to this point indicated that, when comparing children who had versus had not produced first words by four different benchmark ages, the verbal children consistently scored higher on cognitive assessments (e.g., MSEL Visual Reception, Expressive and Receptive Language), and as the benchmark age increased, they also scored higher on communicative skills (e.g., VABS Communication domain) and

lower on autism severity (e.g., CARS total score). The effect sizes also increased as the benchmark comparison point increased. In no comparisons did the groups differ in number of DSM-IV symptoms or ADOS severity score.

Comparison of Outcomes Among First Word Groups

In order to more directly examine the association between age of first words and later functioning, children were grouped according to age of their first words by 6 month increments centered at 12, 18, 24, 30, or 36 months; an additional group was created for those who remained nonverbal at 40 months (≤15, 16–21, 22–27, 28–33, 34–39, ≥40 months). One way ANOVAs comparing these six first word groups indicated that the average interval between initial ASD diagnosis and current evaluation was similar across the six first word groups, $F(5, 99) = 0.25$, $p = 0.94$, and that age at the current evaluation was not significantly different across groups, $F(5, 113) = 0.78$, $p = 0.57$. Omnibus MANOVA suggested significant differences among the groups when compared across outcome measures of cognition, language, and ASD severity, $F(5, 45) = 1.69$, $p = 0.006$, Wilk's $\lambda = 0.377$. Additional ANOVAs were used to compare the six first word groups on these measures.

One way ANOVAs comparing the six first word groups revealed significant differences for CARS total score and all of the MSEL and VABS domains (all p's < 0.03), with the exception of the MSEL Fine Motor and VABS Motor domains (which trended towards significance), indicating significantly different cognitive and adaptive skills across groups. Consistent with prior findings, there were no group differences in ADOS severity score or number of DSM-IV symptoms. Results are presented in Table 6 and Figs. 1 (MSEL) and 2 (VABS).

Post hoc comparisons revealed *similar* performance among children in the 12, 18, and 24 month first word groups on MSEL language domains (i.e. Receptive and Expressive Language), VABS Communication and Social domains, and CARS total score. In contrast, for *each* of these measures, children in the 12, 18, and 24 month first word groups performed significantly better than children who spoke their first words after 24 months. Dunnett's T3 post hoc comparisons indicate that children in the 24 month first word group scored significantly higher on MSEL language domains than children in the 30, 36, or ≥40 month first word groups (see Table 6 for group means). Additionally, Tukey's post hoc comparisons indicate that children in the 24 month first word group scored higher on the VABS Communication and Social domains and significantly lower (less impaired) on the CARS than the group of children who produced first words after 40 months (see Table 6 for group means).

In sum, results from t tests indicate that, for language, cognitive, and symptom severity domains, the group of children producing communicative meaningful words by a given age (i.e., 18, 24, 30, 36 months) performed significantly better than the group of children who remained nonverbal at that benchmark. This difference was present as early as 18 months. Furthermore, as the age of comparison increased, more comparisons yielded significant results, and effect sizes became larger. All comparisons, (except for ADOS severity score and DSM-IV total symptoms, which were not significantly different at any comparison

Table 6 Comparison of performance between children with varying first word acquisition age, assessed at mean age 52 months

Age at first words	≤15 months Mean (SD)	16–21 months Mean (SD)	22–27 months Mean (SD)	28–33 months Mean (SD)	34–39 months Mean (SD)	≥40 months Mean (SD)	F	p
Sample Size	$n = 27$	$n = 24$	$n = 15$	$n = 16$	$n = 11$	$n = 26$		
MSEL Visual Reception	39.8 (18.7)	35.6 (16.2)	37.8 (14.6)	32.1 (15.2)	23.5 (7.2)	25.3 (13.0)	3.13	0.01
MSEL Fine Motor	34.4 (13.6)	28.0 (12.4)	33.8 (12.3)	30.3 (15.5)	26.6 (15.6)	22.9 (8.3)	2.25	0.06
MSEL Receptive Language	39.4 (17.1)	35.2 (15.5)	38.5 (13.8)	29.4 (11.3)	21.2 (4.2)	21.5 (5.1)	6.67	<0.001
MSEL Expressive Language	33.6 (12.9)	33.3 (13.8)	35.3 (10.3)	29.7 (10.7)	21.4 (4.6)	21.4 (5.4)	5.5	<0.001
VABS Communication	75.9 (19.9)	78.9 (20.2)	78.4 (20.2)	71.1 (16.4)	63.1 (16.2)	56.9 (14.2)	5.08	<0.001
VABS Daily Living Skills	64.1 (12.6)	61.6 (7.9)	63.5 (11.7)	63.8 (11.5)	58.5 (11.0)	54.4 (9.9)	2.78	0.02
VABS Socialization	68.0 (9.9)	70.1 (11.7)	72.1 (13.2)	66.3 (11.8)	62.6 (9.9)	58.4 (10.0)	4.19	0.002
VABS Motor Skills	72.0 (15.4)	69.4 (18.1)	72.7 (18.0)	72.9 (18.0)	68.3 (10.4)	60.0 (16.5)	1.96	0.09
CARS Total	29.34 (4.75)	29.85 (5.23)	26.73 (4.79)	31.43 (5.07)	31.5 (4.75)	35.04 (6.82)	4.93	0.001
ADOS Severity Score	6.08 (2.06)	6.41 (2.77)	5.91 (1.7)	6.20 (2.65)	7.64 (1.57)	6.10 (2.86)	0.820	0.54
Number of DSM-IV Symptoms	6.72 (2.05)	6.0 (1.79)	6.15 (2.48)	5.94 (2.27)	6.27 (1.42)	6.72 (1.37)	0.722	0.61

All MSEL scores are T scores, with mean = 50, SD = 10. All VABS scores are standard scores, with mean = 100, SD = 15

MSEL Mullen Scales of Early Learning, *VABS* Vineland Adaptive Behavior Scales, *ADOS* Autism Diagnostic Interview Schedule, *CARS* Childhood Autism Rating Scale

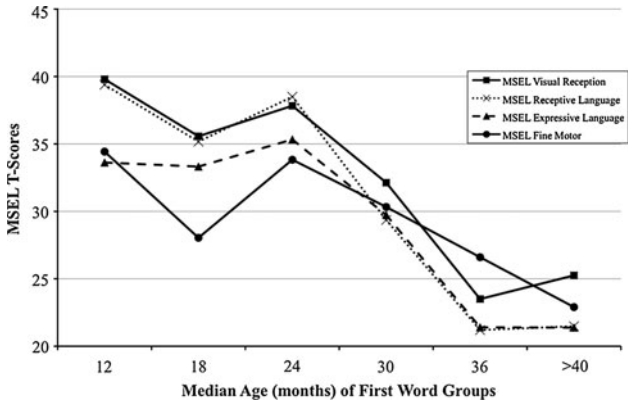

Fig. 1 Age of first words as related to performance on MSEL at a mean age of 52 months

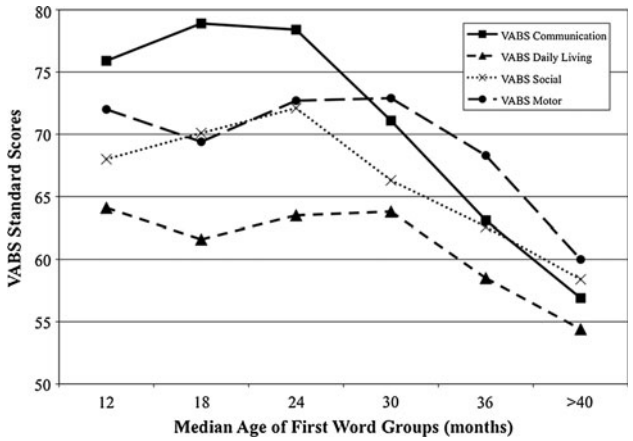

Fig. 2 Age of first words as related to performance on VABS at a mean age of 52 months

point), were significant by 24 months, with medium effect sizes or larger, indicating that achieving first words by 24 months is a powerful prognostic indicator. Group comparisons of the age of first words indicated that there was an inflection point in the data, such that first words by 24 months was associated with significantly better performance on MSEL language domains, VABS Communication and Social domains, and CARS total score compared to first words by 30 months or later.

Discussion

In the current study of the relationship between early language skills (i.e. age of first word production) and later functioning in children with ASD, results indicated that earlier age of first word acquisition was associated with higher cognitive ability and adaptive skills when measured later in childhood. These results were similar across subgroups of children with PDD-NOS and AD, a finding consistent with previous reports (Matson and Neal 2010). Additionally, the current results suggest that achieving first words by 24 months is a particularly salient marker of prognosis; children who spoke their first words by 24 months tended to have higher cognitive ability, and language skills when measured later in childhood than those children who spoke first words later, while outcomes did not differ among children showing first words at 12, 18, and 24 months.

Results suggest that the historic criteria for positive prognosis (i.e. "useful language by age 5") can be revised with a more specific criterion and an earlier developmental time point. Specifically, across all measured domains of cognitive ability and adaptive skills, children who acquired their first words by 24 months demonstrated higher cognitive ability and more sophisticated adaptive behaviors than children who spoke their first words when they were older than 24 months. Results were clear in demonstrating that word acquisition by *each* of the benchmarks was associated with better language outcomes; therefore, if language is not present by 24 months, it is still clinically beneficial to intervene to promote its acquisition before each of the subsequent benchmarks. In addition, all of the children in the present study were screened, diagnosed and referred for treatment by 30 months; findings may not generalize to children who are diagnosed later.

Notably, although speaking first words at earlier ages was associated with better later outcomes at age 52 months, group performance across domains of cognitive ability and adaptive behavior was well below average, consistent with reports of significant deficits in children with ASD (Happé and Frith 1996). Even for the group of ASD children who spoke their first words earliest in development ($\leq$15 months), performance across domains was at least two standard deviations below average, indicating significant, clinically meaningful deficits in these areas.

In addition to assessing the association between age of first words and cognitive outcomes, we examined its relationship with autism symptomatology. Although all the analyses of CARS scores revealed a positive relationship between age of first words and CARS total score, such that later-speaking children had higher (more severe) scores on the CARS, there was no such association between age of first words and ADOS severity score or number of endorsed DSM-IV symptoms. In the current study, CARS scores were based on observable behaviors during the assessment, assessment testing data, and caregiver report. As such, the total CARS score may reflect more than autism severity—it may also be an index of the child's overall level of functioning. In contrast, ADOS scores and the total number of DSM-IV symptoms may serve as a more specific measure of symptom severity. Further, since assessment of verbal

communication skill is an item on the CARS that directly contributes to overall score, it is reasonable that CARS scores were higher for children with lower language skills.

More broadly speaking, previous research has found that early cognitive functioning has stronger predictive value for outcome than early assessment of severity of autism symptoms (Stevens et al. 2000) and it is possible that, more generally, cognitive outcomes are not strongly tied to the severity of ASD symptoms. The relationship between developmental variables, including age of first words, and later ASD symptoms is yet to be fully established.

Determining the association between age of first words and later functioning has several important implications. First, this association provides parents and professionals a simple and widely accessible method of predicting later functioning in young children with ASD. Clarifying the relationship between early skills/behaviors and later development may indicate the need for early intervention, and may assist parents, clinicians, and other professionals in making important treatment decisions. The current study examined outcomes at 52 months of age; future studies that examine the association between age of first words and later development (i.e. functioning in later childhood, adolescence, and adulthood) are needed to understand the nature of the relationship between age of first words and outcomes more fully.

Second, the association between age of first words and later functioning suggests delayed language development should be considered a serious concern in young children, especially if delays co-occur with the presence of any ASD symptoms (Filipek et al. 1999; Goldstein 2002; Wetherby et al. 2004). Prior research has argued strenuously against the "wait and see" approach to language delay (e.g., Buschmann et al. 2008); the results presented here represent further support for taking delays in language development seriously. Further, although the current results suggest that delayed language, especially after 24 months, is associated with poorer outcomes, parents and professionals should continue to work diligently to promote language development in children, as prior research (Rutter 1970) has demonstrated better outcomes for children who acquire language by age 5 or 6 than for those who did not.

The current study raises several important considerations for future research. In this study, all families were given referrals for early intervention services upon receiving their child's initial diagnosis; however, information regarding the amount and type of intervention actually received was not collected, and as such the potential mediation of treatment on the relationship between children's age of first words and later outcomes is unknown. Given that the positive effects of early intervention have been well-documented (Dawson and Osterling 1997; Koegel and Koegel 1988; Lovaas 1987), future research is warranted to clarify the relationship between the age of first words, intervention variables (e.g. type of intervention, amount of service provided), and later outcomes. For example, Lovaas-based approaches and the Early Start Denver Model have been shown to yield improvements across a number of developmental domains, including gains in language skills (as reviewed by Warren et al. 2011).

It is important to note that, although the focus of the current study is on the emergence of first words, it is not advocating first words or functional speech as the *only* target of intervention. Research indicates that effective early intervention utilizes a developmental framework that emphasizes social communication such as joint attention (Tager-Flusberg et al. 2009; Wetherby et al. 2004), gesture use (Paparella et al. 2011), as well as spoken language. Rather, the data here support parent and clinician sensitivity to the emergence of first words as an indicator of the need for intervention, especially in the context of other ASD symptomology.

The interaction of language regression with other outcomes similarly requires additional research. Children with language regression, as defined by a loss of five or more words, were excluded because of the great difficulty in establishing firmly when communicative, meaningful word use is finally solidly established, even given direct clinical assessment. A significant subset of children with ASD have reported regression; rates range from 5.5 % (Siperstein and Volkmar 2004) to 46 % (Ozonoff et al. 2005) and the relationship between timing of first words and later outcomes in this subset of children is unknown. The relationship between first words and outcome observed in the current study may not hold for children with language regression. Future studies examining potential differences between the relationship between age of first words and outcomes in ASD children with and without language regression are needed.

It should be noted that, although we found a strong relationship between age of first words and later functioning, reliance on retrospective parent report of first words acquisition may limit the reliability of these findings. While previous research suggests that parent recognition of early language emergence is reliable in typical development (Rescorla and Alley 2001; Zubrick et al. 2007), and that these data can be informative in other studies of long-term language outcomes (Eigsti et al. 2007), a recent study (Hus et al. 2011) reported that parents of children with ASD have difficulty reporting the age of language milestones reliably. Specifically, parents are said to report greater delays as their child aged. In the current study, we used the "best practice" method and criteria for determining first words based on the ADI-R; parents were asked to provide examples of first words, and clinicians asked follow up questions to determine if these words were used in a meaningful way (Hus et al. 2011). This strategy was

utilized to promote more accurate parent recall. Additionally, because our subjects were relatively young at the time of the evaluation (average age of 52 months), for a number of our subjects, little time had passed between the age at which children began speaking and the time that parents were asked to report, a fact which likely promoted more accurate recall. Future research on the timing of developmental milestones and later outcomes should include longitudinal approaches.

The current study cannot address issues of causality—whether cognitive functioning drives the timing of language acquisition, or vice versa. Indeed, it is likely that influence runs in multiple directions, and that causality is not deterministic. Better prognosis in ASD has also been associated with a host of other early abilities (for review, see Levy and Perry 2011). The wide variety of skills associated with better outcomes makes it difficult to determine the necessary requirements for positive outcomes. That is, production of first words may serve as a marker, or be causally linked to outcomes. Regardless, the data indicate strong and inverse relationship between age of first words and later cognitive ability and adaptive skills.

Finally, the typical language acquisition literature has examined the relevance of early language milestones for later acquisition and long-term cognitive outcomes. For example, studies suggest that vocabulary size at 25 months is an important predictor of cognitive outcomes at age 8 years (Marchman and Fernald 2008) and researchers have suggested a lexical "threshold" in language development, where a certain size vocabulary is needed to serve as a foundation to support other aspects of language, especially, syntactic development (Devescovi et al. 2005; Fenson et al. 1994). In this sense, the current findings are consistent with the typical language acquisition literature, in suggesting that early language abilities provide a critical foundation for multiple aspects of child development.

In summary, the current study of 119 children with ASD suggests that the age at which children speak their first words is strongly associated with better outcomes later in childhood. Specifically, children with first words by 24 months had higher cognitive ability and better adaptive skills than children who did not reach this milestone until later in life. Identifying that acquisition of first words by 24 months is associated with a more positive prognosis strengthens the evidence against the "wait and see" approach to language delay, and provides powerful support for parents and professionals to seek evaluation and intervention when language delay occurs in the presence of any ASD symptoms.

Acknowledgments We would like to thank all the children and families who participated in our study. We gratefully acknowledge the ongoing participation of pediatricians and staff in their offices, as well as providers in the Connecticut and Massachusetts Birth-to-Three Early Intervention systems. We would like to acknowledge the clinicians, current and former graduate students, and dedicated undergraduate research assistants who were invaluable in conducting all aspects of the screening study. This study was supported by NIH grant R01 HD039961 and Maternal and Child Health Bureau grant R40 MC00270 and prior grants from the National Association for Autism Research, NIMH, and the Department of Education. This work was supported in part by R01- MH076189-01A1to DAF.

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