Research Report

Assessing early communication skills at 12 months: a retrospective study of Autism Spectrum Disorder

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Abstract

Background: Early identification of Autism Spectrum Disorder (ASD) is currently limited by the absence of reliable biological markers for the disorder, as well as the reliability of screening and assessment tools for children aged between 6 and 18 months. Ongoing research has demonstrated the importance of early social communication skills in differentiating children later diagnosed with ASD from their typically developing (TD) peers, but researchers have not yet investigated whether these differences can be detected using community-ascertained systematic observation data as early as 12 months.

Aims: To investigate whether differences in early social communication skills can be detected at 12 months of age, comparing children later diagnosed with ASD, and TD peers; and to determine whether differences remain when groupings are based on age of subsequent ASD diagnosis.

Methods & Procedures: From a prospective community-ascertained sample, we collected data on children in early life, then conducted retrospective analyses for those children who were later diagnosed with ASD by the age of 7 years, compared with matched TD peers. We analysed standardized observational data of early communication skills, collected using the Communication and Symbolic Behavior Scales—Developmental Profile (CSBS-DP) Behavior Sample, when participants were 12 months of age.

Outcomes & Results: Children in the ASD group exhibited significantly lower social communication skills than the TD group, including on the Total score and Social and Symbolic Composite scores of the CSBS-DP Behavior Sample. Differences on the Total score and Social Composite were also detected for both early and late ASD diagnosis groups when compared with the TD group.

Conclusions & Implications: These findings give further support for the importance of social communication in assessing children at risk of ASD as early as 12 months of age. Future research could evaluate the sensitivity and specificity of direct observation of these early communication skills as diagnostic indicators for ASD at 12 months, and investigate whether it is possible to distinguish between ASD and other high-risk groups (e.g. developmental delay) at this age.

Keywords: autism spectrum disorders (ASD), early communication behaviours, early identification, assessment.

What this paper adds?

What is already known on the subject?
Previous retrospective and 'at-risk' clinical studies have highlighted the importance of early social communication skills as factors that can differentiate ASD and TD groups. In community-based prospective studies, significant group differences for children between 18 and 24 months of age have also been found, but research has not previously utilized prospective methods with community-ascertained samples to detect differences at 12 months.

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What this paper adds?

When comparing ASD and TD groups of children at 12 months, significant differences in social communication skills were found, with some differences also detected between the TD group and two ASD subgroups (divided into early and late diagnosis). Assessing social communication skills at 12 months may be equally useful for identifying children at risk of ASD as it is at later ages.

Introduction

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterized by difficulties in social communication and the existence of restricted and repetitive behaviours. Evidence suggests that the optimal time for intervention of ASD is between 18 months and 4 years (Prior *et al.* 2011). Current diagnostic practices do not reflect these findings. A clinical diagnosis of ASD at 2 years has been shown to remain stable for 3 years for 90% of children (Stone *et al.* 1999). However, diagnoses of ASD are typically made between 3 and 4 years of age or later (Ingersoll 2011). This is partly due to lack of biological markers, as well as the low utilization of age-appropriate diagnostic tools, though new assessments for younger children are emerging, e.g. the Autism Diagnostic Observation Schedule—2nd Edition (ADOS-2), which is appropriate for individuals who are 12 months and over (Lord *et al.* 2012).

Social communication skills are critical for the diagnosis of ASD (Wiggins *et al.* 2012). The core social communication deficits of young children with ASD include joint attention, capacity for vocal communication, conventional and symbolic gesture, and symbolic play (Wetherby and Woods 2002). Typically, this skill set develops throughout the first 24 months of life, and is dependent on the formation of pre-linguistic skills in the first 12–18 months, including 'gaze shifts, shared positive affect, gaze/point following, communication for joint attention, conventional gestures, communicative vocalizations, language comprehension, and symbolic play' (Wetherby *et al.* 2004: 474). This set of early communicative skills has been widely investigated for the identification of young children at risk of ASD, in lieu of biological markers which are yet to be reliably established (Volkmar *et al.* 2004). Research on the social communication skills of young children has endeavoured to identify skills that can detect ASD, utilizing various methodologies. However, there is limited research of children at earlier ages using direct observation data collected prior to diagnosis.

Early behavioural markers

Retrospective studies

Researchers have attempted to detect and describe the markers of ASD from as early as 12 months using retrospective methodologies including parental report and analysis of 'home videos'. Differences between children with ASD and typically developing (TD) or developmentally delayed (DD) children have been reported by parents in areas of social engagement (showing, pointing, eye gaze, interaction), receptive communication and affective engagement (Watson *et al.* 2007). Some limitations with retrospective parental report methods include the interval between observation and recollection; lack of blinding to diagnosis; and lack of clarity in descriptions of, or ages at which, behaviours were observed (Wimpory *et al.* 2000).

Other research groups have utilized home videos to retrospectively compare groups of young children (e.g. Werner and Dawson 2005). A review of home-video studies concluded that signs that differentiated autism from developmental delay in the first 2 years of life were difficulties with response to own name, looking at others, eye contact, affect and intersubjective behaviours such as shared attention (Saint-Georges *et al.* 2010). While home-video studies reduce some of the biases of parental report studies, their limitations include inconsistencies in length, quality, content and context of video samples, and variable use of control groups (Ozonoff *et al.* 2008).

Prospective studies

Prospective studies have further investigated the early social communication profiles of children with ASD, reducing some of the biases of retrospective research. Prospective parent report studies have used such tools as the Modified Checklist for Autism in Toddlers (M-CHAT) to screen toddlers during well-baby check-ups (Robins 2008). Predictive ASD markers have included difficulty or delays with interest in other children, pointing to objects, imitation of caregiver, showing objects, name orientation and following a point (Robins 2008). Another line of research using parental report involves measures such as the Communication and Symbolic Behavior Scales—Developmental Profile (CSBS-DP) (Wetherby and Prizant 2002), utilizing the Infant–Toddler Checklist (I-TC)—the parent report screener component. Veness *et al.* (2012) reported on a prospective longitudinal study using the I-TC, drawing participants from the larger Early Language in Victoria Study (ELVS) cohort and comparing groups of children

with ASD ($n = 18$), developmental delay (DD) ($n = 16$) and specific language impairment (SLI) ($n = 20$), as well as TD children ($n = 60$). In this exploratory study, Veness *et al.* demonstrated the importance of social communication skills for identifying children at risk of ASD at 12 months. They found that the ASD group was significantly poorer than TD children on each of the seven CSBS cluster scores, and all individual items except 'understanding of words'. In contrast to findings from home-video and at-risk literature, 'name orientation' did not differentiate any groups at 12 or 24 months. Also, the authors did not find any specific items that differentiated between the ASD groups and SLI or DD groups. However, in an update of this study incorporating children who had received ASD diagnoses by age 7, Veness *et al.* (2014) demonstrated that children with ASD could be differentiated from TD *and* LI groups using prospective parental report at 8, 12 and 24 months of age, particularly in the 'use of gestures' and 'use of communication' cluster scores. The ASD group could also be differentiated from all groups including DD, again on the 'use of communication' cluster but only at 24 months of age.

Prospective research has also studied those at risk of developing ASD, such as siblings of children with an ASD diagnosis, or children referred for developmental evaluation. A comprehensive review by Zwaigenbaum *et al.* (2009) summarized the findings of these report-based or observational studies, which showed that at 12–18 months old children with ASD could be distinguished from other clinical groups by deficits in any one or more of the following: visual, motor, play, social-communication, language and cognitive domains. At-risk studies have provided valuable information about the development of autism. However, preselection and recruitment biases are possible given that recruitment relies on either family background of ASD, or children referred for evaluation of DD. Also, participants in these studies may only represent 'high risk' cases, and findings may therefore not generalize to the whole population (Zwaigenbaum *et al.* 2009).

Prospective population-based studies incorporating direct observation have the most robust methodologies, and are therefore the gold standard for the study of ASD in early life. The 'One-year well-baby check-up approach' (Pierce *et al.* 2011), and the Social Attention and Communication Study (SACS) (Barbaro and Dissanayake 2012) are examples of this approach. Both research groups have developed tools to screen prospectively for ASD. The SACS predictors of ASD diagnosis included failure to exhibit pointing, waving, imitation, eye contact and response to name at 12 months, while factors relating to speech development were not significant (e.g. babbling, early words, attending to sounds) (Barbaro and Dissanayake 2012).

In contrast to less formal protocols, the CSBS-DP Behavior Sample (BS) is one of the few structured observational procedures available for infants at 12 months (Wetherby and Prizant 2002). As part of the FIRST WORDS® project, Wetherby *et al.* (2004) used BS as a secondary evaluation for children, screened with I-TC. Video recorded samples of three groups (ASD, DD, TD) of eighteen 21-month-old children were used to identify red flags for ASD in the second year of life. The results verified the BS's application as a secondary evaluation to I-TC, but did not show significant differences between ASD and DD groups. A subsequent analysis of the data using the Systematic Observation of Red Flags (SORF) for Autism Spectrum Disorders in Young Children (Wetherby and Woods 2002), revealed nine indicators that *did* differentiate ASD from DD and TD: (1) lack of appropriate gaze; (2) lack of warm, joyful expressions with gaze; (3) lack of sharing enjoyment or interest; (4) lack of response to name; (5) lack of coordination of gaze, facial expression, gesture, and sound; (6) lack of showing; (7) unusual prosody; (8) repetitive movements of the body; and (9) repetitive movements with objects. The authors identified four additional flags that differentiated ASD from TD but not DD including a lack of responding to contextual cues, pointing, vocalizations with consonants and conventional toy play (Wetherby *et al.* 2004: 485). Used together to predict group membership, the 13 red flags correctly categorized 94.4% of the participants, showing that children with ASD can be distinguished from DD and TD around 21 months on the basis of these observed behaviours. A subsequent study by Wetherby *et al.* (2007) also used BS on a similar cohort of participants (mean age of 21 months) comprising 50 children with ASD, 23 DD and 50 TD. This study found that children with ASD performed significantly poorer than DD on five communicative measures (gaze shifts, gaze/point follow, rate of communication, acts for joint attention, inventory of conventional gestures), and lower than the TD group on all measures (Wetherby *et al.* 2007). Studies investigating the early social communication skills of children with ASD have utilized a variety of methodologies, producing both complementary and contrasting findings. Increasingly rigorous and reliable evidence has been gathered, demonstrating the importance of these skills for the identification of ASD in early life.

Differences between subtypes of ASD

With the introduction of DSM 5 (American Psychiatric Association 2013) there has been much discussion about subtypes in ASD diagnosis. Evidence from studies of the social communication skills of children with autism versus children with Asperger's syndrome in preschoolers (e.g. Ramberg *et al.* 1996), and early life through

retrospective parental report (e.g. Ozonoff *et al.* 2000), suggests there is little evidence of qualitative differences between these subtypes in early life. Rather the groups tend to differ in severity of symptoms along a spectrum (Macintosh and Dissanayake 2004, Wiggins *et al.* 2012).

One factor on which autism and Asperger's groups tend to differ is the age of receiving a diagnosis; with autism diagnoses generally received significantly earlier than Asperger's (Howlin and Asgharian 1999, Mandell *et al.* 2005). In order to examine differences between these subgroups based on severity of symptoms, some studies have used 'age of diagnosis' to delineate between groups, though the cut-off points utilized have varied based on study design. For example, Landa *et al.* (2007) prospectively studied a clinical sample of infants at high and low risk of ASD, including early and late ASD diagnosis groups (defined as meeting diagnostic criteria before or after 14 months). The authors compared these groups with TD children (referred to as low risk controls) and siblings of children with ASD with and without a Broader Autism Phenotype classification (BAP, defined as exhibiting social or language delays, but without a clinical judgement of ASD). Assessed using the CSBS-DP BS at 14 months, the early diagnosis group was found to be lower than non-BAP group on all BS items, and lower than all non-ASD groups (including BAP, non-BAP and TD children) on 'gaze shifts', 'action schema sequences', 'initiation of joint attention', 'behavior regulatory bids', and 'inventory of gestures and consonants in syllables'. Differences between early and late ASD diagnostic groups were also detected at this age, including the early group exhibiting lower scores on BS items 'positive affect', 'initiation of behaviour regulatory bids' and 'initiation of joint attention'. The *late* diagnosis group only differed from non-ASD groups on 'gaze shifts'. However, more significant differences between the late diagnosis group and non-ASD groups were present by 24 months, including lower scores on 'shared positive affect' and 'inventory of gestures' (Landa *et al.* 2007). In contrast to the cut-off used in Landa *et al.* (2007), Twyman *et al.* (2009) conducted a retrospective parental report study using an early diagnosis cut-off of before 36 months, finding that parents in the early diagnosis group had concerns with social development at an earlier age than those in the late diagnosis group (mean of 18 months versus a mean of 25.3 months). As reviewed above, the previous research investigating the social communication skills of children with early and late diagnoses of ASD has either been retrospective and reliant on parental report, or has utilized 'at-risk' clinical samples—the findings of which may not be generalizable to the whole population. Also, previous studies have not examined differences between ASD and TD groups as early as 12 months of age.

Current study

While there is now a large body of work that attests to early social communication skills being crucial for the detection of ASD, prospective community-based research using a direct observation tool has only compared children 18 months and older. Research with younger children has been primarily based on home videos or parent report measures, or utilizing sampling methods which may have introduced bias, such as at-risk and sibling studies. Hence, we report here the results from a systematic observation study of the social communication skills of 12 month olds drawn from a larger prospective study of language development in a community sample.

We identified children who were diagnosed with ASD by the age of 7 years, and conducted retrospective analyses of data collected at 12 months using the CSBS-DP Behavior Sample. A group of matched TD children, who had also completed this assessment at 12 months, were compared with the ASD group to investigate differences in social communication. All observations and coding were completed prior to ASD diagnosis. This study investigated: (1) if differences in early social communication skills can be detected between children with ASD and a group of matched TD peers at 12 months; and (2) whether these differences can be detected between the TD group and two ASD subgroups divided into early or late diagnosis.

Methods

Overview of ELVS

The Early Language in Victoria Study (ELVS) is a prospective longitudinal population study of the development of language and literacy problems of a total of 1,910 Australian children, which commenced in 2002. Sampling methods for this study have been outlined in detail elsewhere (e.g. Reilly *et al.* 2006, Veness *et al.* 2012). Briefly, infants were recruited at 7.5–10 months from six of the 31 Local Government Areas (LGAs), in metropolitan Melbourne, Australia, chosen to represent geographically non-adjoining areas, which span the spectrum of disadvantage–advantage, and correspond to the Australian 2001 Census-based Socio-Economic Indexes for Areas (SEIFA) Index of Disadvantage. Participants were recruited through Maternal and Child Health (MCH) nurses, through universally available hearing screening sessions, or local newspaper publicity. Infants with any known developmental delay or disability (DD) were excluded at time of recruitment, along with children of caregivers who could not speak and/or understand English. Parents completed questionnaires about their child's development at 8 months, and subsequently at 1, 2, 3 and 4 years of age. This included the CSBS-DP I-TC completed by all participants

($n = 1911$) at 8 months, and participants followed up at 12 months ($n = 1725$). The attrition between the 8- and 12-month data collections were due to families failing to return questionnaires at the 12-month collection (Reilly *et al.* 2006). At 12 months, the CSBS-DP BS was administered as an additional face-to-face assessment on two subsets of the ELVS cohort ($n = 728$) as budget constraints at that time did not allow for assessment of the whole cohort. The first subgroup of participants comprised a large number of children who were identified as having a score in the lowest quartile on the 8-month I-TC, i.e. at or below the 25th percentile (raw score equivalent ≤ 32; $n = 347$). The second subgroup contained randomly selected children, matched to the first subgroup for age and gender, who achieved a percentile rank above 25 on the 8-month I-TC (raw score equivalent > 32; $n = 381$). The oversampling of the lowest quartile was completed to ensure that the research project met the aims of the main ELVS study (which included identifying potential early signs of language delay). At 4 years of age individual assessments for all ELVS participants were administered including measures of speech, language and cognition. Further details of the ELVS methodology and study sample, including parent report and face-to-face assessments are reported in Reilly *et al.* (2006) and Prior *et al.* (2008).

Participants in current study

The participants for the present study comprised two groups retrospectively drawn from the ELVS cohort: children with ASD ($n = 22$), and a control group of children with typical development (TD) ($n = 22$). The ASD group comprised the children who had been given a clinical diagnosis of ASD by a community health professional or assessment team between the ages of two and seven and had completed the CSBS Behaviour Sample at 12 months.

The TD group comprised participants who were randomly selected and then matched to the ASD group on gender and a measure of socio-economic status (the Australian 2001 Census-based Socio-Economic Indexes for Areas (SEIFA) Index of Disadvantage). The TD group had also completed the BS at 12 months, and had maintained results consistent with typical development through to 4 years. Figure 1 describes the flow of participants from completion of the I-TC at 8 months to the sampling in the current study.

Participant characteristics

The ELVS questionnaires collected demographic and background data for each participant in the wider study. Variables were chosen based on factors that are thought to influence a child's language and general development.
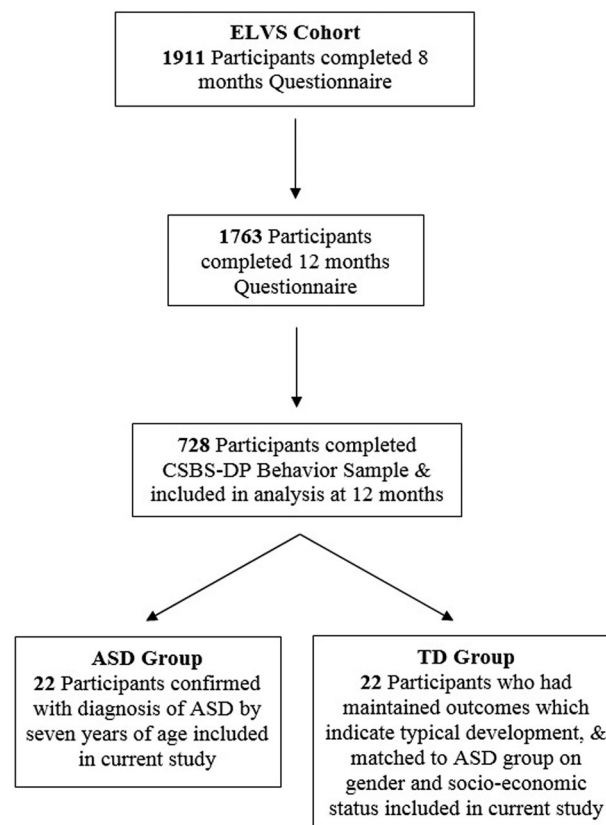

Figure 1. Flowchart of Early Language in Victoria Study (ELVS) participants and those included in the current study of Autism Spectrum Disorder (ASD) using the Communication and Symbolic Behavior Scales—Developmental Profile (CSBS-DP) Behavior Sample.

Participant characteristics are summarized in table 1. The matching process of the TD group controlled for the potential effects of gender and socio-economic status between the groups. All other salient variables were consistent between the ASD and TD groups, including twin or premature birth, birth weight and order, as well as family factors such as English speaking background, family history of language problems, maternal education, mental health and vocabulary score, and maternal age at birth of child.

Measures and procedures

Determining an ASD diagnosis

As previously reported by Veness *et al.* (2014), information regarding the clinical ASD diagnosis of children was based on the standard diagnostic criteria of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV). These diagnoses were made external to the ELVS research team, according to standard clinical practice in Australia, by multidisciplinary teams including paediatricians, speech pathologists and psychologists. Parents reported via questionnaire or telephone if their child had

Table 1. Summary of participant demographic characteristics

Characteristic	TD (n = 22)				ASD (n = 22)			
	n	%	Mean	SD	n	%	Mean	SD
Male gender	18	81.8			18	81.8		
Twin birth	1	4.5			2	9.1		
Premature birth (< 36 weeks)	0	–			1	4.5		
Birth weight (kg)			3.7	0.57			3.3	0.67
Birth order								
First	9	40.9			10	45.5		
Second	11	50.0			11	50.0		
Third	1	4.5			1	4.5		
Fourth	1	4.5			0	–		
Non-English-speaking background	0	–			0	–		
Socioeconomic disadvantage[a]			1044	62			1046	37
Family history language problems	7	31.2			11	50.0		
Maternal education level								
Year 10 or less	1	4.5			0	–		
Year 11	2	9.1			3	13.6		
Year 12	7	31.8			11	50		
Degree/postgraduate qualification	12	54.5			8	36.4		
Maternal mental health problems indicated[b]	8	36.4			8	36.4		
Maternal vocabulary score[c]			29	3.5			31	4.4
Maternal age at birth of child, years			33	5.1			33	5.4

Notes: [a]Measured by the census-based Socioeconomic Indexes for Areas (SEIFA).
[b]Measured by the Kessler screen for Psychological Stress.
[c]Raw scores were obtained on the modified version of the Mill Hill vocabulary scale—high scores indicate better vocabulary (maximum score of 44).
SD, standard deviation.

been diagnosed with ASD, and these details were confirmed by an experienced autism clinician and researcher (third author) who liaised with families via telephone at the time of receiving questionnaires between 4 and 7 years of age. Participants were not included in the current study if their diagnoses were unclear or unconfirmed.

As a secondary analysis, this study delineated between two subgroups of children with ASD. Because of the finding in the literature that more severe forms of autism tend to be diagnosed earlier, and due to the heterogeneity in diagnostic labels received by the children in our sample, we created two subgroups based on age of diagnosis. The ASD group was divided into two subgroups: 'early' diagnosis (defined as prior to or at 4 years and 11 months) and 'late' diagnosis (defined as 5 years onwards). Two participants within the ASD group were excluded from this analysis as no reliable data about the date of their diagnosis could be collected. The control group for this comparison was a randomly selected 12 participants from the 22 TD controls. These subgroupings, along with the gender, measures of socioeconomic status, and diagnostic labels are displayed in table 2.

Determining typical development

The control group for this study were children who consistently displayed typical development, as defined by scores on the MacArthur–Bates Communicative Development Inventory (CDI) above or equal to the 16th percentile at 2 years old; and scores on the Clinical Evaluation of Language Fundamentals—Preschool—2 no more than 1.25 standard deviations below the mean at 4 years.

Measuring early social communication

The CSBS-DP BS (Wetherby and Prizant 2002), was the primary measure determining early communicative skills in this study. The BS is one of three components of the CSBS-DP, which also include the Infant–Toddler Checklist (I-TC) and the Caregiver Questionnaire (CQ). The BS is a face-to-face evaluation of the child with parent and clinician, which is videotaped and then analysed. The primary objective of the BS is to evaluate seven key early communication skills (clusters) within three composites: Social, Speech and Symbolic (Wetherby and Prizant 2002). The psychometric evaluations of both I-TC and BS have been reported by its authors (Wetherby and Prizant 2002), including analyses of participants aged 12 months. Predictive validity has also been reported, with significant correlations between many items measured using BS at a mean age of 14 months, and language outcomes at 3 years, as measured by the Mullen Scales of Early Learning (Watt *et al.* 2006). The BS items 'acts for joint attention', 'inventory of gestures' and 'comprehension',

Table 2. Gender distribution, socio-economic indices, and diagnostic information for early and late diagnoses, and a control group

	Time of diagnosis		
Characteristic	Early ASD ($n = 8$)	Late ASD ($n = 12$)	TD ($n = 12$)
Male gender, n (%)	7 (87.5)	10 (83.3)	9 (75)
Socioeconomic disadvantage[a], mean (SD)	1048.66 (46.3)	1048.22 (33.0)	1030.30 (58.2)
Age of ASD diagnosis, mean (range), years	3.47 (2–4.67)	6.64 (5–7)	–
ASD diagnosis, n			
Autism Spectrum Disorder Pervasive Developmental Disorder-Not otherwise specified	1	0	–
Autism	3	0	–
Autism/ASD	1	0	–
ASD	2	1	–
High Functioning Autism	1	2	–
Borderline ASD	0	1	–
ASD/Asperger's Syndrome	0	1	–
Asperger's Syndrome	0	7	–

Notes: [a]Measured by the census-based Socioeconomic Indexes for Areas (SEIFA).
SD, standard deviation. Key for HF Autism, PDD-NOS.

correlated with both receptive and expressive language scores on the Mullen Scales at 3 years. The BS item 'symbolic play' correlated with the receptive language score only, while 'inventory of consonants' correlated with expressive language score only. Moderate correlations between scores on the I-TC and BS were also shown when reinvestigated with an Australian sample (Eadie *et al.* 2010), particularly on the Social ($r = 0.35$), Speech ($r = 0.30$), Symbolic Composites ($r = 0.37$), and Total score ($r = 0.43$).

Assessment sessions were administered to participants between 11.5 and 13.5 months by experienced research assistants with backgrounds in speech pathology and psychology. Assessors were blind to whether infants had scored above or below the 25th percentile on the CSBS IT-C. The CSBS-DP BS was administered, rated and scored according to the manual specifications. The scoring of the samples was completed by the same research assistants who conducted the assessments, within 1–2 weeks of data collection. At the time of collection and coding, the infants were approximately 12 months of age and no diagnostic information was available on any participants. A randomly selected 10% of Behavior Samples from each researcher were used to calculate intra-rater reliability. Ten videoed samples and five researchers were used to calculate inter-rater reliability. Using the 'intraclass correlation coefficient', scores were calculated using random effects models (Goldstein 1995). For intra-rater reliability, correlation coefficients were acceptable, ranging from 0.82 to 0.88 across the Total and three composite scores (0.75 represents good reliability) (Portney and Watkins 2000). Similarly, inter-rater reliability had acceptable coefficients of above 0.8 for all measures except the Speech Composite (coefficient of 0.68) (Eadie *et al.* 2010).

Data analysis

The BS Total and Composite standard scores were compared using a series of independent two-sample *t*-tests to quantify any significant differences between the ASD and TD groups. Due to the number of *t*-tests, we controlled for Type I error using a Bonferroni correction. The statistical power of tests is decreased by small sample sizes, making it more difficult to detect a significant result. Therefore, effect sizes for each test were also calculated as a measure of 'clinical significance' (Bain and Dollaghan 1991). For these analyses, effect sizes were calculated using Cohen's *d* for *t*-tests, and interpreted according to the criteria $d \geq 0.20$ is small, 0.50 is medium and 0.80 is large (Cohen 1988). This effect size is a measure of the difference between the sample means, which quantifies the strength of a relationship between two variables (Portney and Watkins 2000).

Further analysis was conducted comparing the ASD 'early' and 'late' diagnosis subgroups and the TD subgroup (described above) using a series of one-way analyses of variance (ANOVA). Again to control for Type I error, a Bonferroni correction was applied. Effect sizes were also calculated on these comparisons, using partial eta squared ($\eta^2_{partial}$) for ANOVAs (Cohen 1988). This effect size measures the proportion of variance of the dependent variable which is accounted for by the independent variable (Portney and Watkins 2000), and was interpreted using Cohen's (1988) criteria: where $\eta^2_{partial} \geq 0.01$, 0.06 and 0.14 are considered to reflect small, medium and large effects, respectively. When significant results were found, post-hoc analyses were conducted using the Bonferroni post-hoc procedure which makes pairwise comparisons based on the *t*-statistic but adjusts the observed significance level in light of multiple

comparisons being made (by means of multiplying *p*-values by the number of tests completed). This makes it possible to interpret these values against an α level of 0.05 (Norusis 1994). For post-hoc analyses, Cohen's *d* was also used to calculate effect sizes. The Statistical Package for the Social Sciences (SPSS) (Norusis 1994) was used to perform all statistical analyses.

Results

Group differences in social communication skills

Total and Social, Speech, and Symbolic Composite scores on the CSBS BS are displayed in table 3. Group comparisons revealed significant differences in the Total score ($p = 0.006$, large effect size: $d = 0.814$), the Social Composite ($p = 0.006$, medium effect size: $d = 0.759$) and Symbolic Composite ($p = 0.012$, large effect size: $d = 0.924$), with the ASD group performing below the TD controls in each. A non-significant difference with a small effect size was found for the Speech Composite ($d = 0.492$).

A series of ANOVAs was completed on the above measures, comparing three groups: 'early' and 'late' ASD diagnosis groups and the TD controls (table 4).

The results revealed significant differences with large effect sizes for the Total score [$F(2, 29) = 6.508$, $p = 0.005$, $\eta^2_{partial} = 0.310$] and for the Social Composite [$F(2, 29) = 5.749$, $p = 0.008$, $\eta^2_{partial} = 0.284$]. There was also a non-significant difference with a large effect size for the Symbolic Composite [$F(2, 29) = 3.222$, $p = 0.054$, $\eta^2_{partial} = 0.182$], and no significant difference for the Speech Composite, as was expected given the result for the *t*-tests above. Post-hoc comparisons found that for the Total score, both early ($p = 0.011$, $d = 1.616$) and late ASD groups ($p = 0.019$, $d = 1.144$) were significantly lower than the TD controls, both with large effect sizes. This was also the case for the Social Composite (early: $p = 0.013$, $d = 1.406$; late: $p = 0.040$, $d = 1.024$). The early and late groups were not significantly different from one another for either the Total score ($p = 0.856$, $d = 0.249$) or Social Composite ($p = 0.787$; $d = 0.382$), each with small effect sizes.

Discussion

The purpose of this study was to compare the social communication skills of children with ASD with those of TD children, matched for indicators of socio-economic disadvantage and gender, at 12 months of age. It was a retrospective analysis of data collected prospectively as part of the Early Language in Victoria Study (ELVS).

The pre-linguistic skills observed on the CSBS-DP BS develop into the skills which are often difficult for preschool children with ASD, including joint attention, conventional and symbolic gesture, capacity for vocal communication and symbolic play. Our findings demonstrated clear differences in the abilities of 12 month olds subsequently diagnosed with ASD, when compared with TD peers. In particular, significant differences were found on Social and Symbolic Composites (as well as the Total score). This confirms similar findings, using the same measure, from at-risk research at 14–24 months (Landa *et al.* 2007), and community-based studies with children 18 months and older (Wetherby *et al.* 2004). The study provides further evidence of the importance of social communication skills in the detection of differences in very young children with and without ASD. It also aligns with research using prospective parental report (Veness *et al.* 2012, 2014), which differentiated 12 month olds with ASD from TD children on the Total score, and clusters which form the Social and Symbolic Composites of the CSBS-DP IT-C.

The skills in the Social Composite comprise emotion and eye gaze, communication, and gestures, while the understanding and object use are encompassed by the Symbolic Composite. The importance of these areas for delineating ASD at 12 months reflects previous knowledge from retrospective parental report (Watson *et al.* 2007), home-video studies (Saint-Georges *et al.* 2010), checklists (Robins 2008), and at-risk child research (Zwaigenbaum *et al.* 2009). Most research has noted social or symbolic deficits in the children with ASD (e.g. joint attention, name orientation, showing objects, affect and sociability).

In contrast, this study found no significant difference between the ASD and TD groups at 12 months on the Speech Composite (which includes skills involved with production of Sounds and Words). This corresponds with previous research on the CSBS BS at 21 months (Wetherby *et al.* 2004), and from other methodologies at 12 months (e.g. Barbaro and Dissanayake 2012). This finding is likely due to the small amount of sounds and words in the child's inventory at this age.

When examining the age of diagnosis groupings, both early (before 5 years of age) and late (after 5 years) ASD diagnosis groups were significantly lower than TD controls on the Total score and Social Composite of the BS. However, these differences were not detectable for the Symbolic Composite. This may suggest that when compared with their TD peers, children with both early and late diagnoses of ASD demonstrate differences in overall social communication, as well as specific differences in skills measured by the Social Composite, including emotion and eye gaze, communication and gestures. In the comparison of the three groups, differences were not significant for the Speech Composite (as expected), nor the Symbolic Composite, perhaps suggesting more similarity in these skills when compared

Table 3. Group comparisons on Composite and Total standard scores for the Communication and Symbolic Behavior Scales—Developmental Profile Behavior Sample at 12 months of age

	Group	Mean	SD	Range	t	d.f.	p	Effect size[a]
Total Score	ASD	88.05	10.078	73–110	−2.909	42	0.006*	0.814
	TD	97.68	11.826	73–115				
Social Composite	ASD	8.64	2.105	5–12	−2.873	42	0.006*	0.759
	TD	10.82	2.872	5–16				
Speech Composite	ASD	9.14	2.396	7–13	−1.669	42	0.102	0.492
	TD	10.36	2.479	7–14				
Symbolic Composite	ASD	7.09	2.068	5–12	−2.617	42	0.012*	0.924
	TD	9.00	2.726	4–13				

Notes: [a]Effect size is based on Cohen's $d \geq 0.20$ is small, 0.50 is medium and 0.80 is large. *$p < 0.013$ (Bonferroni-corrected value).
d.f., Degrees of freedom; CI, confidence interval.

Table 4. Early and late diagnoses, and TD controls: comparison of scores on Communication and Symbolic Behavior Scales—Developmental Profile Behavior Sample at 12 months of age

	Early ASD			Late ASD			TD					
BS standard scores	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	F	p	Effect size[a]
Total Score	87.00	8.018	77–97	89.42	11.188	76–100	101.42	9.746	81–115	6.508	0.005*	0.310
Social Composite	8.25	1.832	6–11	9.00	2.089	6–12	11.42	2.610	6–16	5.749	0.008*	0.284
Speech Composite	9.00	2.070	7–13	9.25	2.832	7–13	9.92	2.392	7–13	0.377	0.689	0.025
Symbolic Composite	7.13	1.553	5–10	7.08	2.575	5–12	9.25	2.454	5–13	3.222	0.054	0.182

Notes: [a]Effect size based on $\eta^2_{partial} \geq 0.01$ is small, 0.06 is medium and 0.14 is large. *$p < 0.013$ (Bonferroni-corrected value).
SD, standard deviation.

according to the age of diagnosis. Other possible explanations for this result could be insufficient power due to a small sample size (the large effect size of the Symbolic Composite comparison supports this explanation), or limitations with the tool's measurement of social communication skills. This finding builds upon the work of Landa *et al.* (2007) who studied 14 month olds from an 'at-risk' clinical sample, albeit with an older age cut-off. Landa *et al.* also found differences between a TD group and both early and later diagnosis groups (defined as meeting diagnostic criteria before or after 14 months), but the late diagnosis group only differed from TD on one item, 'gaze shifts'. The current study provides further support for the differences between TD children and those in early or late ASD groups, but with data obtained from a community sample.

Interestingly, when the early and late ASD groups were compared with each other in this study, there were no significant differences on any of the scores. This may indicate that these groups share similarities in their profile of social communication skills at 12 months, aligning with previous research showing that distinct subtypes of ASD are difficult to distinguish, and that a dimensional view of ASD may be most accurate for young children (Wiggins *et al.* 2012).

The above findings provide further evidence of the importance of social communication skills for early ASD identification, which has been demonstrated in other prospective research using non-standardized tools at this age (Barbaro and Dissanayake 2012, Pierce *et al.* 2011).

The red flags identified by Barbaro and Dissanayake are similar to those measured in the present study in the Social Composite of the BS (eye gaze, communication and gestures). In addition, the factors that did not distinguish the ASD groups using Barbaro and Dissanayake's measure (i.e. babbling, early words, attending to sounds) are analogous to the Speech Composite (non-significant in this study). This study adds to the growing literature of measures of social communication skills that show potential for detecting differences between children with and without ASD in early life.

This study did not endeavour to determine the red flags for ASD at 12 months. Rather, it built on previous research to provide further evidence that differences in social communication skills between ASD and TD groups can be detected via direct observation at 12 months of age using a robust prospective sampling procedure and a standardized tool. The long term goal of investigating ASD in the first year of life is to enable earlier and more precise identification and diagnosis. As further evidence is gathered, information regarding the developmental course of ASD has the potential to shape more comprehensive ways to screen and identify children at risk of autism at an early age (Wetherby *et al.* 2004). In this way, current diagnostic practices will likely be modified to harness what is known about the presentation of ASD in the first and second year of life. Despite the issues around labelling of children and reliability of diagnoses, receiving a timely diagnosis is important for many reasons. It is needed to access

funding and services, which may be otherwise unavailable; and has the potential to provide information about the most suitable intervention. This study has provided further evidence that social communication skills are central to early ASD identification.

Methodological strengths

Many of the methodological strengths of this study were in its rigorous sampling and assessment measures. For example, the original sampling through MCH nurses allowed recruitment of a representative sample of the general population. Also, because of the prospective design at the time of data collection and coding, parents and researchers did not have access to information regarding diagnosis. Retrospective analysis using confirmed ASD diagnoses from data until age seven, removed potential ambiguity and instability of 'best estimate diagnoses'. The random selection of the TD group matched to the ASD group controlled for gender and socio-economic status, allowing for the mitigation of the effects of these variables on early social communication. Finally, the use of a standardized, valid, and reliable tool (including inter- and intra-rater reliability for this use; Eadie *et al.* 2010), reduced the biases found in other methodologies.

Limitations of study and future directions

The sample was relatively small, a limitation often encountered in studies of children with ASD. Despite this, the large effect sizes illustrated the potential clinical importance of the comparisons. Also, given the literature showing the difficulty distinguishing ASD from other populations at risk of social communication difficulties, this study was also limited by its lack of comparisons of ASD with DD and/or SLI groups. Future research could include prospective studies of cohorts of young children at risk of ASD and/or other developmental delays, using direct observation measures of social communication skills, such as the CSBS-DP BS. Furthermore, future studies could determine the sensitivity and specificity of such measures for the identification of ASD at 12 months, and investigate whether it is possible to distinguish between ASD and other high-risk groups at this age, similar to methodology used with studies using the IT-C (e.g. Veness *et al.* 2014). If needed, fine-grained analysis using additional tools (e.g. Systematic Observation of Red Flags (SORF) for Autism Spectrum Disorders in Young Children) could also be completed to investigate the utility of such analysis at 12 months. In particular, these analyses could aim to confirm previous findings of the importance of use of gesture (e.g. giving, pointing, and showing gestures) and use of communication (e.g. gaining attention, requesting, and joint attention) at 12 months (Barbaro and Dissanayake 2012, Veness *et al.* 2014).

Conclusions

Significant differences in social communication skills were detected between children with and without ASD using the CSBS-DP BS at 12 months. When groupings based on age of subsequent ASD diagnosis were compared, significant differences remained for the Social Composite, encompassing emotion and eye gaze, communication, and gestures, as well as overall social communication skills, as measured by the Total score. Using a rigorous prospective and community-based sampling method, with all assessments and coding completed prior to ASD diagnosis, this study provides stronger and more reliable evidence of the importance of social communication skills for the early detection of ASD. The findings warrant the gathering of further evidence of how social communication skills can identify ASD as early as 12 months and inform the timely and appropriate provision of early intervention.

Acknowledgements

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