Title:

The Early Sociocognitive Battery: A clinical tool for early identification of children at risk for social communication difficulties and ASD?

Running head:

Early Sociocognitive Battery

Key words 3-6

early identification, late diagnosis, social communication, ASD/autistic spectrum disorders, socioeconomic, bilingual

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Abstract

Background: A substantial proportion of preschool children referred to speech and language therapy (SLT) services have social communication difficulties and/or autistic spectrum disorders (SC&/ASD) that are not identified until late childhood. These 'late' diagnosed children miss opportunities to benefit from earlier targeted interventions. Prior evidence from a follow-up clinical sample showed that preschool performance on the Early Sociocognitive Battery (ESB) was a good predictor of children with social communication difficulties seven to eight years later.

Aims: The aims of this study were three-fold: to determine the impact of child/demographic factors on ESB performance in a community sample of young children; to assess the ESB's concurrent validity and test-retest reliability; and to use cut-offs for 'low' ESB performance derived from the community sample data to evaluate in a clinical sample the predictiveness of the ESB at 2-4 years for outcomes at 9-11 years, including parent reported SC&/ASD diagnosis.

Methods and Procedures: A community sample of 205 children aged 2-4 years was assessed on the ESB and a receptive vocabulary test. A subsample (n=20) was re-tested on the ESB within two weeks. Parents completed a questionnaire providing background child/demographic information.

The clinical sample from our previous study comprised 93 children assessed on the ESB at 2;6-<4;0 whose parents completed the Social Responsiveness Scale (SRS), our measure of social communication, when the children were 9-11 years. Cut-offs for 'low' ESB performance derived from the community sample were used to determine the predictive validity of ‘low’ ESB scores for social communication outcomes and parent reported SC&/ASD diagnosis according to age of ESB assessment.

Outcome and Results: Findings from the community sample confirmed the ESB as psychometrically robust, sensitive to age and language delay, and, in contrast to the receptive vocabulary measure, unaffected by bilingualism. While overall associations between ESB performance and later social communication difficulties in the clinical sample were particularly strong for the youngest age group (2;6-<3;0; r=.71, p<.001), ‘low’ ESB performance was equally predictive across age groups and overall identified 89% of children with ‘late’ SC&/ASD diagnoses (sensitivity), and 75% of those without (specificity).

Conclusions & Implications: Results indicate that the ESB is a valid preschool assessment suitable for use with children from diverse language backgrounds. It identifies deficits in key sociocognitive skills and is predictive of social communication difficulties in school-age children that had not been identified in preschool clinical assessment, supporting earlier targeted interventions for these children.

What this paper adds

What is already known on the subject:

- A substantial proportion of preschoolers referred to SLT services are at risk of social communication difficulties in the longer term and ‘late’ ASD diagnosis.

- Prior evidence from a follow-up clinical sample supports the predictive value of the Early Sociocognitive Battery (ESB) in identifying these preschool children at longer-term risk, but normative data on the ESB is limited.

What this study adds:

- Evidence from a large community sample of preschoolers showed the ESB was age-sensitive, identified children with language delay and, in contrast to receptive vocabulary, was unaffected by bilingualism.
- Results confirmed the reliability and validity of the ESB. Association between ESB performance of clinically referred preschoolers and later social communication was strongest in the youngest age group (2;6-<3;0) but 'low' ESB performance was highly predictive of long-term risk of ASD and social communication difficulties irrespective of age when first seen.

Clinical implications of this study:

- The ESB is a psychometrically robust largely nonverbal assessment suitable for use with young, preschool children from diverse language and cultural backgrounds.
- Its clinical value lies in the early identification of children with language delay at high risk of longer-term social communication problems and ASD.
- Identified deficits in performance on the three subtests provide targets for early intervention in at-risk preschoolers.

Introduction

Follow-up studies of school-aged children with diagnosed language disorder have revealed their increased risk of autism and social communication difficulties in later life, but questions remain about cause and effect (Conti-Ramsden et al., 2006; Howlin et al., 2000). More recently longitudinal studies of young children referred to speech and language therapy services with concerns about language have shown that early language difficulties are a ‘red flag’ for possible long-term social communication difficulties and/or possible ASD with or without persisting language disorder. A follow-up study that we conducted in the UK (Chiat & Roy 2013; Roy & Chiat, 2014) found that a third of clinically referred preschoolers had significant social communication difficulties seven to eight years later. Likewise, Swedish small sample studies (Miniscalco et al., 2006; Ek et al., 2012) found that over a third of preschoolers referred to speech and language therapy services had later social communication difficulties and clinical evaluations revealed that about a quarter received ‘late’ ASD diagnosis. It seems that, for some children, delay in language emergence is the first or most noticeable sign of developmental difficulties, and this may mask difficulties in social communication that are not confined to language and that may go undetected until the late primary school years.

In line with this view, US research on the substantial proportion of children (a third to half, Sheldrick et al., 2017) who are diagnosed with autism at 6 or more years suggests that the presence of developmental language disorder (DLD) is one of the factors associated with late identification of ASD (Davidovitch et al., 2015). According to a recent study (Brett et al., 2016), there is little evidence that the age of diagnosis is decreasing, with no change found in the median age of ASD diagnosis (55 months) in the UK across a 10 year period. Brett et al. concluded that ‘children with phenotypic characteristics that are ‘red flags’ for ASD such as language regression and language delay could be identified through primary and other health service based intervention initiatives to accelerate the ASD diagnostic process’ (p. 1983).

Late diagnosis, whether of social communication difficulties or ASD, means that children miss out on benefits that may result from an understanding of their difficulties, and interventions that specifically address and support the developments that underpin social communication. This paper focuses on an assessment we developed for early identification of these difficulties, the Early Sociocognitive Battery (ESB). The ESB aimed to provide a systematic, quantifiable measure of pivotal sociocognitive skills that many SLTs observe informally as part of their clinical assessment of young referred children. It includes three measures of children's sociocognition: social responsiveness, joint attention, and symbolic comprehension. Theoretically, these early skills are argued to underpin early word learning (Chiat, 2001; Chiat & Roy, 2008). If children are to map the word forms they hear onto their appropriate meaning, they must orientate towards people who are expressing something (social responsiveness); share the focus of attention and interest of people who are talking (joint attention); and appreciate that the words people use when they talk convey a meaning intention, for example, refer to an object (symbolic comprehension). Empirically, these early skills in social engagement and understanding are known to be associated with early language development in typically developing children and impaired in young children with ASD (see Chiat, 2001; Chiat & Roy, 2008 for a review of the evidence). We selected these measures as they require no verbal responses from the children and are more reliant on their voluntary response to input, compared with, for example, imitation tasks. Given the hazards of non-compliance in very early assessment, this is important. In the case of social responsiveness and joint attention, non-compliance indicates non-engagement which is precisely the target of the assessment. On these theoretical and empirical grounds, we hypothesised that the skills assessed in the ESB would be associated with early language delay and predictive of later social communication difficulties.

We evaluated this ‘sociocognitive hypothesis’ in a longitudinal study of preschoolers referred to SLT services with concerns about language and no diagnosis of ASD. Children were seen at three time points: at age 2;6-<4;0 , 18 months later, and seven to eight years later when they were in their last year at primary school. At the second follow-up (age 9-11 years), 18 children were diagnosed with Social Communication problems and/or ASD (SC&/ASD) according to parental report. Nearly two-thirds (11/18) fell in the group with co-occurring language problems, who had the most severe and pervasive difficulties at outcome. Nearly three-quarters (72%) with a ‘late’ SC&/ASD diagnosis were not identified by the time they entered primary school, with only 5 children diagnosed with ASD according to parental report at first follow-up (age 4-5 years) (Roy & Chiat, 2014). Based on the normative data available at that time (see below), our evaluation of early predictors revealed the ESB to be the strongest predictor of later social communication problems as measured by parental report on the Social Responsiveness Scales (SRS; Constantino & Gruber, 2005) and their contact with SLT services seven to eight years later (sensitivity .80; specificity .86), relative to early measures of receptive and expressive language and behavioural difficulties (Chiat & Roy, 2008; 2013; Roy & Chiat, 2014). These findings supported the predictive validity of the ESB and provided a substantial evidence base for the use of the ESB as a clinical assessment.

However, there were gaps in our evidence, and this paper reports new data and analyses aimed at addressing these. First, we had limited data on typically developing children, an essential component in the development of the ESB from a research tool to a clinical tool. Our first aim was therefore to collect data from a representative 'community' sample of children, enabling us to investigate the extent to which performance is affected by child/demographic factors, and to identify cut-offs for 'low' performance derived from normative scores. Second, while we had demonstrated interrater reliability and concurrent and predictive validity in our clinical study, we did not investigate test-retest reliability which is critical for clinical application (Roy & Chiat, forthcoming). Accordingly, our second aim was to retest a subsample of children (10%) in our community sample and evaluate test-retest reliability. Third, we had considered the predictiveness of the ESB for later performance on the SRS, but not for the diagnosis of SC&/ASD as reported by parents at the end of primary school, nor whether the predictiveness of the ESB for these outcomes varied according to the age when it was administered. Our third aim was to revisit our clinical data using cut-offs derived from our new 'community sample' to evaluate the predictiveness of the ESB for parent reported 'late' SC&/ASD diagnosis and to determine if the predictiveness of the ESB for social communication problems and SC&/ASD diagnosis at outcome varied according to age.

The evidence presented in this paper strengthens the foundations for clinical use of the ESB in the early identification and understanding of children with sociocognitive difficulties, at high risk of longer-term social communication difficulties and/or ASD.

Methods

Current study of community sample

Participants

Recruitment for the community sample targeted children from 2-4 years, spanning a representative range of socioeconomic status (SES: low, middle and high) and language backgrounds (monolingual, and English as an additional language (EAL) with one or more other languages at home). Research assistants (see below) recruited approximately 10 children each in nurseries or nursery schools that were accessible to them and were willing to participate. The majority of these provisions were in the Greater London area, but a third were located further afield in the Home Counties, Bristol, Gloucestershire and Northern Ireland. Given that half of young children referred to SLT services with language delay have normalised by school age (Chiat & Roy, 2008, 2013) we did not exclude preschoolers with SLT contact.

In total, 205 children were recruited. As can be seen in Table 1, the total sample included similar numbers of boys and girls, but was not evenly distributed across age. Of the four targeted six-month age groups, two reached the minimum sample size of 50 children recommended by Bishop (1998) for normative samples, but two fell short. Fifteen children (7.3%) of the total sample were older (4-<5 years), falling outside our original target age range of 2-<4 years. However, the mean ESB score for this group showed a marginal, albeit non-significant, increase and the range of ESB scores was narrower than found in the 3;6-<4;0 age group, indicating a higher proportion were performing close to ceiling. Accordingly we included these children in the analyses involving the total sample, increasing the age range of the sample to 2;0-<5;0.

This research was approved by the City, University of London School of Health Sciences Ethics Committee, and only children whose parents gave informed consent and who were themselves willing to participate were included.

Procedure

Research assistants were 12 Speech and Language Therapists who had just qualified, or those undertaking a research project for a Masters qualification. All attended a one-day ESB training and a further ESB practice session where they were observed administering the ESB and given feedback to ensure consistent and correct presentation. They were responsible for contacting nurseries and nursery schools with information sheets and consent forms, and once consent was received, providing information and consent forms for parents, administering the parent questionnaire to parents who consented, and assessing the children.

The parent questionnaire included questions about children's ethnic (4 categories, see table 1) and language backgrounds (3 categories: English only, one additional language spoken at home, two or more additional languages), parents'/carers' educational qualifications (6 categories, see table 1), and children's contact with speech and language therapy services (3 categories: no contact, past contact, ongoing contact).

Children were seen individually in a quiet space in their nursery/school. Items for the Joint Attention subtest of the ESB (see below) were set out prior to the assessment session. The BPVS3 (Dunn, Dunn & Style, 2009), a receptive vocabulary test, was administered as a measure of concurrent/construct validity. This measure was selected as being an important foundation for language (Bishop, 1998), relatively quick to administer and less demanding on young children than an expressive measure. The researcher says a word and the child responds by selecting a picture from four options that best illustrates the word's meaning. Since some children were below the age of the BPVS standardisation sample, raw scores rather than standard scores were used in statistical analyses, and age was controlled.

The following three ESB measures were then administered (extracted from p.638, Chiat & Roy, 2008, with added examples in square brackets).

(i) Social responsiveness: This assessment was based on a procedure developed by Sigman, Kasari, Kwon, and Yirmiya (1992). The researcher acts out a sequence of scenarios in which she expresses six different feelings, e.g., hurt, surprise. The child's response to the researcher's expression is measured by looks to her face, either fleeting (1 point) or for at least two seconds (2 points), giving a maximum score of 12.

(ii) Joint attention: This assessment takes the form of a game which offers opportunities to engage in joint attention. The game centres on a box of six plastic eggs, brought out one at a time, and opened to reveal a small object such as a tiny bag. Larger versions of these objects are placed to the side, front and back of the child. Children are scored for alternating gaze either between the egg and researcher's face, or between the tiny object and researcher's face (1 point), and for following researcher's direction of gaze (2 points) or finger-point (1 point) at the larger object, yielding a maximum score of 18.

(iii) Symbolic comprehension: This nonverbal task draws on a procedure developed by Tomasello, Striano, and Rochat (1999). It takes the form of a game in which the researcher asks the child to find an object from a set of six, using a symbolic representation to indicate which object the child should find. The child then rolls the chosen object down a chute. There are three symbolic conditions in this task: gesture [e.g. making a cutting motion with index and middle fingers to represent plastic scissors], miniature object, and substitute object [e.g. a scallop shell used to represent a plate]. One point is awarded for correct selection of the six target objects in each of the three conditions, yielding a maximum score of 18.

The maximum total score for the ESB is 48.

Administration of the ESB is supported by a flip booklet which provides the verbal script for each task and the order of presentation of items within each. Since the ESB is designed to elicit social engagement, the tasks are undemanding and are normally presented with minimal gaps between items to maintain the child's interest and attention, i.e. as soon as the child responds and the child's score entered, the assessor proceeds to the next item. The test as a whole takes between 15-20 minutes to administer.

All 205 children in this community sample completed the ESB, and 200 completed the BPVS3. In four cases the BPVS was not administered, and in one case the completed record form was missing.

Previous clinical study

As noted above, we have previously reported findings from a study which looked at predictors of later language and communication difficulties. This study followed up preschoolers referred to SLT services in Greater London, first seen aged 2;6-<4;0 at Time 1 (T1) and seen again at two subsequent time points: Time 2 (T2), 18 months later (aged 4-5 years), and Time 3 (T3) seven-eight years later (aged 9-11 years). We evaluated the preschoolers' ESB performance relative to normative data available at the time which were limited due to funding constraints. Two of the ESB subtests were run on different groups of typically developing children, and demographic information was limited. Scores for the third subtest, social responsiveness, were not related to age, and cut-offs were derived from the clinical sample. Accordingly, ESB results reported to date (Chiat & Roy, 2008, 2013; Roy & Chiat, 2014) used a composite categorical measure derived from combining categorical scores on the three separate subtests. The dataset from the community sample reported in this paper enabled us to revisit the clinical dataset using a cut-off for 'low' scores derived from the total continuous ESB score as opposed to the categorical measure based on subtest performance that we have used to date. It also enabled us to investigate whether relations between ESB performance and social communication at follow-up varied according to age group at referral.

The follow-up sample comprised 93 children aged 9-11 years who met our nonverbal criteria at follow-up (T3), and whose parents had completed and returned the Social Responsiveness Scale (SRS; Constantino & Gruber, 2005), our measure of social communication at T3, together with a questionnaire that included ongoing contact with SLT services and details of SC&/ASD diagnoses received. The ESB was administered to all 93 children in the follow-up sample at referral (T1), as was the case for the original total sample of 208, including those children who did not meet our nonverbal criterion at T1. The mean age of this sample at T3 was 10;5 (SD=6.86 months). Over three quarters (77.4%) of the sample were boys and the majority (95.7%) had English as their first language. Just under a quarter (22.5%) came from families with below-average income (<£20K), 39.3% from middle-income families (£20K-40K) and 38.2% from families with above-average income (>£40K). Notwithstanding a disproportionate loss of children from low-income families from T1 to T3, an ANCOVA controlling for T1 age found no significant difference in the mean ESB scores between those children who were and were not included in the follow-up sample under consideration here (Estimated $mean_{FU\_YES}$=29.32 (SE=1.04); Estimated $mean_{FU\_NO}$=30.29 (SE=1.03); $F(1,186)=.44$, $p=.51$, $\eta^2=.002$). No child had a diagnosis of ASD at T1. When first seen, 30 children fell in the youngest age group (2;6-<3;0), 45 in the middle age group (3;0-<3;6) and 18 in the oldest age group (3;6-<4;0).

Our outcome measure of social communication at T3, the SRS, comprises 65 items measuring deficits in social behaviour associated with ASD. It is standardised for the age range 4-18 years and the full set of items yield a Total score which is transformed into a T-score (mean 50, SD 10). T-scores ≥76 are in the 'severe' range and are strongly associated with a clinically diagnosable ASD, while T-scores of 60-75 are classed as 'mild to moderate' and are typical for children with mild or 'high-functioning' ASD.

This study was approved by the Research Ethics Committee of the School of Health Sciences at City University London. Only children whose parents gave informed consent and who were themselves willing to participate were included.

Results

Current study of community sample: Effects of child/demographic factors on ESB and BPVS scores

All 205 children completed the ESB, and achieved a wide range of scores (16-48). Table 1 shows the descriptive statistics (means and SDs) and results of an ANOVA and an ANCOVA (controlling for age) analysing the effect of child and demographic factors on receptive vocabulary (BPVS3) and sociocognitive (ESB) raw scores. All post hoc pairwise comparisons reported included a Bonferroni correction for multiple comparisons.

INSERT TABLE 1 ABOUT HERE

Age

As can be seen in table 1, age had a significant effect on BPVS and on ESB total scores. For both measures the effect size for age (based on five six-month age groups, ranging from 2;0-<5;0) was large (η^2=.4 and .36 respectively). Tests of normality revealed the distribution of BPVS and ESB scores for the majority of the age groups was normal, with two exceptions. The distribution of BPVS scores in the 2;6-<3;0 age group was not normally distributed (Shapiro-Wilk(37)=.901, p=.003). This was also the case for the ESB scores in the 3;6-<4;0 age group – the largest subsample – where ceiling effects skewed the distribution (Shapiro-Wilk(70)=.946, p=.005). The analyses were repeated using Kruskal Wallis, a non-parametric test, and the results were similar: BPVS $\chi^2(4)=86.39$, $p<.001$); ESB $\chi^2(4)=62.72$, $p<.001$. Overall we can conclude that the ESB, like the BPVS, is age-sensitive with strong effect sizes.

Gender

The marginal trend for higher BPVS scores favouring girls was non-significant (see table 1). In contrast there was a small but significant gender difference in ESB total scores favouring girls. An ANOVA was undertaken to investigate this difference further with age entered as a categorical factor (age group: 5 levels) along with gender. This analysis reduced the gender effect to non-significance ($F(1,195)=1.88$, $p=.17$, $\eta^2=.01$) with a borderline interaction effect between age and gender [age $F(4,195)=29.25$, $p<.001$, $\eta^2=.38$; age*gender interaction $F(4, 195)=2.16$, $p=.08$, $\eta^2=.04$]. Inspection of plots revealed that the trend of ESB scores favouring girls was found almost exclusively in the 2;6-<3;0 age group.

Ethnicity

Children's ethnicity did not significantly affect the scores of either BPVS or ESB, and in both cases the effect size was small ($\eta^2=.02$ and .01 respectively see table 1).

Additional languages spoken at home

Exposure to additional language(s) at home had a significant effect on BPVS scores with a moderate effect size ($\eta^2=.07$, see table 1). Post hoc analysis revealed the receptive vocabulary scores of children exposed to two additional languages at home was significantly lower than those of children exposed to English only ($p=.001$) or where only one additional language was spoken at home ($p=.03$). In contrast, English as an additional language (EAL) did not affect performance on the largely nonverbal ESB, where the effect size was small ($\eta^2=.01$, see table 1).

Primary carers' educational qualifications

Similarly, primary carers' educational qualifications (our measure of SES) had a differential effect on children's BPVS and ESB scores. The effect on BPVS scores was significant with a medium to borderline-large effect size (η^2=.12, see table 1). Post hoc analysis revealed that children whose primary carers had no qualifications or vocational qualifications had significantly lower receptive vocabulary scores than those whose primary carers had degrees (p=.05; p=.01 respectively). Scores from children with primary carers with minimal qualifications (equivalent D-G GCSEs) were lower than those with degrees but not significantly so (p=.07) and the effect on ESB scores was also non-significant, with a small-moderate effect size(η^2=.05, see table 1). Post hoc analysis revealed that there was a marginal, albeit non-significant, trend for the relatively small sample of children whose primary carers had no or minimal educational qualifications to have lower ESB scores than those whose primary carers had at least attained A levels, UK academic qualifications for 18 year-old secondary school leavers.

As bilingualism had a significant effect on children's BPVS performance, the effects of educational qualifications of the primary carer were reanalysed taking the sample of monolingual children only (since only two EAL children had no or minimal educational qualifications, EAL could not be entered as a covariate). The ANCOVA results taking age as a covariate were almost identical to those reported in table 1 for the total sample [$BPVS_{monolingual}$ F(5,134)=4.26, p=.001, η^2=.14; $ESB_{monolingual}$ F(5,135)=1.99, p=.08, η^2=.07).

Contact with SLT services

Contact with SLT services had a significant and medium effect on both BPVS and ESB (η^2=.07, η^2=.1 respectively, see table1). Children with ongoing contact had substantially lower ESB scores, with mean scores 9 points lower than those with no contact, marginally lower than the mean score of the youngest age group (see table 1). Post hoc analysis revealed significant differences between the ESB scores of children with past or ongoing contact with SLT services and those with no contact ($p=.04$, $p<.001$) and between BPVS scores of those with past compared with no contact ($p=.002$). The difference in BPVS scores between those with ongoing contact and those with none was not significant ($p=.37$). These results are promising in showing the potential of the ESB to discriminate preschoolers with significant language concerns (past or current).

Concurrent/construct validity

Concurrent/construct validity was evaluated by calculating correlations between BPVS and ESB. As BPVS performance was affected by EAL but ESB was not, the association between BPVS and ESB scores was investigated in the sample of children with English only spoken at home ($n=144$) to avoid possible confounding effects of EAL masking relations between these measures. Partial correlations controlling for age with the total sample of monolingual children, and with the subsample of monolingual children that fell within the recommended age range targeted by the BPVS which starts at three years ($n=97$), were $r=.35$ ($p<.001$) and $r=.41$ ($p<.001$) respectively, supporting the concurrent validity of the ESB in a community sample.

Test-retest reliability

Re-tests were carried out with just under 10% of the sample, with ten SLTs re-testing, on average, two of the children they had tested. Analyses were carried out to check the representativeness of the re-test sample (see table 2).

INSERT TABLE 2 ABOUT HERE

These analyses revealed that the 20 participants in the re-test subsample (9.8% of the total sample) did not differ from the rest of the sample (185 children) on any child/ demographic variables, or ESB scores (see table 2). The retest sample can therefore be considered representative of the sample as a whole. An intraclass correlation (ICC) value of .95 was obtained between ESB scores achieved by the re-test sample on first and second testing, indicating that the ESB achieved an acceptable level of performance stability across the two administrations.

Summary

The results reported for the community sample show the ESB to be psychometrically robust, age-sensitive, suitable for use with children from diverse language backgrounds, and less affected by SES than receptive vocabulary. They also indicate the potential of the ESB to identify preschoolers referred to clinical services with concerns about language and communication.

Re-visiting predictiveness of the ESB for outcomes in clinical study

As noted above, we have previously considered the sensitivity and specificity of the ESB and established the predictive value of low ESB scores for long-term social communication problems as measured by parental responses to the Social Responsiveness Scale using combined categorical scores on the separate ESB subtests (Chiat & Roy, 2013; Roy & Chiat, 2014). In this paper, we use the data from our community sample to derive cut-offs for 'low' performance on the ESB total score. The cut-off was set at -2SD for each of the three age groups represented in the clinical sample (see table 1). To evaluate predictiveness of ESB total scores for social communication outcomes, we investigate relations between ESB total scores at 2;6-<4;0 years (T1) and SRS total T-scores as well as, for the first time, clinical SC&/ASD diagnoses at 9-11 years (T3) according to parental reports. We also consider the effect of age at which the ESB was administered on these long-term associations.

Table 3 shows the distribution of ESB total scores at T1 according to age group, and the distribution of SRS (Social Responsiveness Scale) total T-scores at T3 according to T1 age group.

INSERT TABLE 3 ABOUT HERE

As might be expected from the community sample scores, age had a significant and large effect on ESB raw scores in the clinical sample (η^2=.13, see table 3). Accordingly, age was taken into account in the correlational analysis for the total sample (see table 4 below). Comparison with results of the community sample (table 1) show the ESB scores for children aged 3;6-<4;0 in the clinical sample were in line with children approximately a year younger (aged 2;6-<3;0) in the community sample. The mean SRS scores for all three T1 age groups were below the SRS cut-off of 60 and fell within the normal range of social communication scores for 9-11 year olds, with a small but non-significant trend towards lower (i.e. less problematic) SRS total T-scores in the oldest age group.

Scores on both measures were widely distributed as indicated by the SDs (see table 3). Correlations between these were found to be significant for the total sample and for each age group, though the strength of these associations varied with age group (see table 4).

INSERT TABLE 4 ABOUT HERE

The strongest association between ESB total scores at T1 and SRS total T-scores at T3 was in the youngest age group, significantly higher than the correlation found for the 3;0-<3;6 age group (Fisher r to z transformation, Z=-2.1, p=.03).

In order to investigate these T1 age differences in correlations between ESB total scores and SRS total T-scores further, three scattergrams were created plotting ESB scores against SRS scores in the three age groups, with X and Y reference lines showing cut-offs on both measures (see figure 1). As noted above (introduction), 18 children at outcome had a diagnosis of SC&/ASD according to parental reports. Of these, 13 had a diagnosis of ASD with (n=5) or without (n=8) a co-occurring diagnosis of SC, and 5 children were diagnosed with SC only. These parent-reported diagnoses are indicated by markers in the three scattergrams in order to show the distribution of 'late' SC &/ ASD diagnosis according to SRS total T-scores, ESB cut-offs for low scores and age.

INSERT FIGURE 1 ABOUT HERE

The cut-off scores at -2SD on the ESB were 22, 30 and 32 for age groups 2;6-<3;0, 3;0-<3;6, and 3;6-<4;0 respectively. Using these cut-offs, just over a third of the clinical sample had 'low' ESB scores at T1 (35/93, 37.6%), with 13/30 (43.3%) aged 2;6-<3;0, 17/45 (37.8%) aged 3;0-<3;6, and 5/18 (27.8%) aged 3;6-<4;0. As can be seen in figure 1, the very low ESB scorers in the youngest age group (2;6-<3;0), most of whom had SRS total T-scores in the severe range and were diagnosed with SC&/ASD by T3, contributed to the strong correlation found between ESB and SRS T-scores noted above. Nonetheless, if we exclude the one child in the 3;0-<3;6 age group whose ESB score was zero, the size of the correlation in this age group increased to -.46 (p=.002), and the between-group difference in correlations was reduced to be non-significant.

Turning to clinical diagnosis at T3, as noted above, nearly a fifth of the total sample (19.4%, 18/93) were reported to have a SC&/ASD diagnosis at T3: nearly a quarter of the two younger age groups (23.3%, 7/30 and 22.2%, 10/45) and just over a twentieth of the oldest age group (5.5%, 1/18)(see markers in figure 1). The trend towards a lower rate of diagnosis with age was not significant ($\chi^2(2)=2.74$, p=.25). As can be seen in figure 1, the majority of children with a diagnosis had low ESB scores (below -2SD) at T1. Sensitivity overall was 89% (16/18), and by age group at referral, 86% (6/7) aged 2;6-<3;0, 90% (9/10) aged 3;0-<3;6, and 100% (1/1) aged 3;6-4;0. In terms of specificity for the sample as a whole, 75% (56/75) of children without a T3 diagnosis had ESB scores above the cut-off, and by age group, 70% (16/23) aged 2;6-<3;0, 77% (27/35) aged 3;0-<3;6, and 76% (13/17) aged 3;6-<4;0. There were only two false negatives in terms of reported SC&/ASD diagnosis, but 19 false positives. Of the two false negatives, one child in the youngest age group had received an ASD diagnosis, and the second with a SC diagnosis was in the middle age group, 3;0 -<3;6. In both cases parental overall ratings of their behaviour at T1 fell in the normal range. However, as can be seen from figure 1, nearly half (9/19) of the false positives with low ESB scores and without a T3 diagnosis had SRS total T-scores above the cut-off for the mild-to-moderate range (≥60, typical of children with mild or 'high functioning' ASD), with two falling in the severe range (≥76, strongly associated with clinically diagnosed ASD). A fifth (4/19) were still in contact with SLT services and over a third (7/19) had low receptive language standard scores (<80) at T3. The one child noted above in the 3;0-<3;6 age group who had an ESB score of zero but a SRS total T-score in the normal range had very low receptive language scores at T1 and T3. Only five children scored zero on the ESB at T1, and as can be seen in figure 1, the other four children had received a clinical diagnosis of ASD according to parental report at outcome.

These results support the predictive value of ESB scores in identifying children at risk of a 'late' SC&/ASD diagnosis, with 89% of children with a clinical diagnosis as reported by parents scoring below the cut-off on the ESB.

Discussion

The ESB battery was designed to provide a systematic and objective measure of skills informally observed and assessed by early years SLTs (Roy et al., 2017). The assessment requires minimal verbal comprehension and no verbal responses from the child, so performance should not be affected by differences in language experience. However, evidence on performance of typically developing children to date was limited, and our previous clinical studies relied on unpublished data from relatively small samples of typically developing children to derive cut-offs for 'low' performance on each subtest. Accordingly, the first aim of this paper was to provide data on a larger, more representative community sample, to investigate the impact of key child/demographic factors on performance, and to derive cut-off for 'low' performance on the test as a whole.

Findings from this community sample of 205 children vindicated the potential value of the ESB as a clinical tool suitable for use with children from diverse language and cultural backgrounds and sensitive to age and language delay in the preschool years. Performance on the ESB was not affected by ethnicity or language background, in contrast to the BPVS which, as expected, was sensitive to young children's exposure to English. Our findings underscore the potential role of the ESB in supporting decision-making by clinicians faced with the challenges of understanding the nature of language delay in the considerable proportion of EAL children referred to SLT services in the early years. Recent statistics indicate over a fifth of primary-aged children in the UK and over half of those in Inner London have EAL, with achievement gaps between children with and without EAL at their highest in the early school and preschool years (Strand et al., 2015).

Our findings also indicate the potential value of the ESB for clinicians working with children from socioeconomically disadvantaged backgrounds, who, like EAL preschoolers, are at risk of reduced exposure to vocabulary and language delay (Roy & Chiat, 2013). As with EAL, primary carers' educational qualifications (as a measure of SES) had less effect on ESB performance compared with receptive vocabulary performance, where the effect size was large. However, there was a trend for lower ESB scores. Further investigation is required to determine the impact of low educational level of primary carers on ESB performance and the association with SES-related differences in the prevalence of language delay (Roy & Chiat, 2013) and/or in the quantity and quality of early parent-child communication (Hirsch-Pasek et al. 2015).

Addressing our second aim, findings from the community sample confirmed the concurrent validity and previously established psychometric robustness of the ESB (see Chiat & Roy, 2008), and demonstrated for the first time its test-retest reliability. Overall the evidence from our UK samples of typically developing and clinically referred children converge in supporting the reliability and validity of the ESB.

Turning to our third aim, we consider what the paper adds to our previous findings on predictive reliability. Our current analyses, which used the continuous ESB total score and cut-offs for 'low' scores (below -2SDs) derived from our community sample, add to our previously reported evidence of the predictive value of the ESB in a number ways. First, we found that, at group level, the average ESB performance of 2- and 3-year-olds in our clinical sample was delayed relative to typically developing children, with the mean of the clinical group aged 3;0-<3;6 closest to peers one year younger. The magnitude of the delay at group level, combined with the substantial variance in the group, highlights the degree of deficits in the low-scoring preschoolers. This is particularly striking when most of the skills measured are expected to be in place by 2 years. Second, our findings revealed the predictive value and sensitivity of the ESB for parent reported clinical diagnoses, identifying 89% of children with a 'late' diagnosis of SC&/ASD, together with 75% specificity. The low cut-off of -2SD yielding these high levels of sensitivity and specificity indicates that it is very low scores on the ESB that are informative about longer term outcomes and intervention needs. Third, the compliance rate for clinically referred children, as for children from the community sample, was high. Non-compliance was relatively rare (2% of the original clinical sample at T1) and informative: four out of five children with zero scores at T1 had received a 'late' ASD diagnosis according to parental report. Fourth, there was some indication that children aged 2;6-<3;6 were more at risk of 'late' diagnosis than older children. Only one child in the 3;6-<4;0 age group (about a twentieth of the group, compared with just over a fifth in the younger age groups) had a 'late' ASD diagnosis with a SRS T-score in the severe range. If this finding is replicated in a larger sample it may be indicative of the increasing stabilisation and differentiation of language problems associated with age (Bishop et al., 2017) with children at risk of ASD less likely to be referred to SLT with language problems, and perhaps referred to other paediatric services. Finally, for 'low' ESB scorers without a clinical diagnosis but with later social communication problems according to the SRS, difficulties in social reciprocity may become more pronounced or more evident as they face the challenges of adolescent life (Sheldrick et al., 2017). Overall our finding that few of the false positives were problem-free at the end of their primary school years suggests these children, like their 'late' diagnosed peers, could benefit from early intervention.

Given that prediction of outcomes is particularly hard in children aged three years and under with language delay (Bishop et al., 2017), it is worth considering why the ESB does better as an early predictor. One possible reason is the nature of the skills assessed. Most of the skills measured by the ESB are very early developing and largely in place in 2-3-year-olds. In other words we are looking at deficits in developed skills as opposed to delays in skills that are still developing. These 'skills-in-the-making' contribute to the individual differences and variability underlying the so-called 'noise' of early language development. Repetition tasks, for example, involve a range of disparate skills and processes that continue to develop across a number of years, any one of which may be delayed and affect long term prediction (Chiat & Roy, 2013). A second reason may be the nature of the assessment itself. The battery offers the child a succession of opportunities or social challenges for demonstrating sociocognitive responses that arise infrequently in everyday life. In line with this, a recent study highlights the problems associated with the relative infrequency of atypical behaviour in children with ASD. Observations of two 10-minute video clips of ADOS sessions by expert clinicians blind to children's diagnostic status provided insufficient information about atypical behaviour to reliably detect ASD (Gabrielson et al., 2015). The compliance rate on the ESB was very high, and given the nature of the test, high rates of non-response or total lack of engagement are informative. All of the children in the clinical sample completed the ESB, and of those low-scoring children who scored zero on the whole test, the majority had significant social communication problems at outcome.

Clinical implications

In the light of our findings, the ESB has a significant role to play not only in the early identification of social communication difficulties, but also in guiding targeted interventions for 'at-risk' children (Warreyn et al., 2014). Results from an ESB assessment provide therapists with a profile of the child's strengths and difficulties in sociocognitive skills. Recent evidence suggests that early intervention targeting these skills is beneficial in ameliorating deficits in joint attention and play in children with ASD (Murza et al., 2016; Wallace & Rogers, 2010) and may also support language gains, particularly with preverbal children (Weismer & Kover, 2016). In addition, SLTs have reported parents' enhanced understanding of their child's sociocognitive deficits when feedback is provided alongside the opportunity to watch the session and see their child's responses to the ESB tasks for themselves. As a task that involves minimal verbal comprehension and no verbal output, and has been found to elicit a high compliance rate, the ESB has a role to play in strategies such as the US 'Know the signs; act early' campaign (Sheldrick et al., 2017) aimed at the earlier detection of 'late' diagnosed children and reaching children from low SES backgrounds and under-served populations (Daniels & Mandell, 2014). By raising clinicians' and parents' awareness of deficits in pivotal skills at an early age, prior to any clinical diagnosis, ESB results support 'streamlining the process from first concern to eventual diagnosis' (Daniels & Mandell, 2014, p.587).

Limitations and further research

Whilst the results from our community sample of 205 typically developing children are informative and encouraging, the sample size in some age groups was sub-optimal and further data collection is required for full standardisation. Overall, age-related ESB scores are strikingly similar across studies and time, but normative data from a fully representative sample is needed to complete the transition of the ESB from a research measure to a clinical tool (Roy et al., 2017; Roy, Chiat & Warwick, 2019). A second limitation is our reliance on parental report of diagnosis at 9-11 years without information about the clinical source or criteria used to diagnose ASD. Details on the exact age of diagnosis are also lacking, although we do know that the majority (nearly three quarters) received their SC&/ASD diagnosis during their primary school years, *after t*he first follow-up at 4-5 years, and none were diagnosed in this way as preschoolers. These limitations should be addressed in future research. On the strength of our findings on parent-reported diagnosis of ASD in children referred to speech and language therapy, future research should investigate the potential of the ESB to support early diagnosis of ASD in other clinical populations, most notably early referrals to children's mental health services.

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Table 1. Effect of child and demographic factors on BPVS and ESB scores in the community sample

Factor	Receptive vocabulary BPVS raw scores				ESB total raw scores			
	n	Mean / Est. mean	SD/SE	p value η^2	n	Mean / Est. mean	SD/SE	p value η^2
Age								
2;0-<2;6	28	19.79	9.16	F(4,195)=32.72 ,	30	29.47	5.16	F(4,200)=28.62
2;6-<3;0	37	27.57	12.22	p<.001,	38	35.53	6.9	p<.001
3;0-<3;6	50	36.62	12.9	η^2=.4	50	38.88	4.54	η^2=.36
3;6-<4;0	70	47.79	15.3		72	40.39	4.44	
4;0 +	15	56.07	19.49		15	41.13	4.31	
Gender								
Boys	104	36.65	1.28	F(1,197)=2.16 ,	107	36.78	0.5	F(1,202)=5.31
Girls	96	39.37	1.34	p=.14, η^2=.01	98	38.44	0.52	p=.02, η^2=.03
Ethnicity								
White	140	38.35	1.11	F(3,194)=1.35,	142	37.28	.44	F(3,199)=.78
Black	17	34.95	3.2	p=.26,	18	37.17	1.23	p=.51
Asian/Chinese	14	33.11	3.5	η^2=.02	14	38.86	1.35	η^2=.01
Mixed	28	40.55	2.48		29	38.49	.97	
Languages spoken at home/EAL								
English only	144	39.64	1.06	F(2,195)=7.84 ,	145	37.34	.43	F(2,200) =1.47
Plus one	46	35.72	1.87	p=.001,	48	38.55	.75	p=.23
Plus two/more	9	23.49	4.23	η^2=.07	11	36.05	1.57	η^2=.01
PC educational qualifications								
None	3	20.14	7.22	F(5,189)=5.29 ,	3	34.56	2.96	F(5,194) =2.2
GCSE D-G	12	31.10	3.62	p<.001,	12	33.55	1.48	p=.06
GCSE A*-C	22	34.84	2.67	η^2=.12	25	36.94	1.02	η^2=.05
A level	26	36.58	2.45		26	38.57	1.00	
Vocational qualifications /other	32	33.36	2.21		32	38.33	0.91	
Degree	101	42.06	1.33		103	37.95	0.51	
Contact with SLT services								
None	184	38.95	.94	F(2,195)=6.89 ,	189	37.99	.36	F(2,200) =10.82
Past	10	24.57	4.05	p=.001,	10	33.88	1.58	p<.001
Ongoing	5	29.92	5.75	η^2=.07	5	28.82	2.24	η^2=.1

Table 2. Comparison of 're-test' sample with 'no re-test' sample on key variables

Variable	Re-test		Results
	Yes (n=20)	No (n=164)	
Age (months)	Mean=40.4 SD=5.76	Mean=38.95 SD=7.88	t=-1.02, p=.32 (equal variances not assumed)
∑ ESB score	Mean=39.65 SD=6.46	Mean=37.21 SD=6.31	$F(1,181)=2.04$, $p=.16$, $\eta^2=.01$ (age controlled)
Age categories	Fishers exact =7.45 p=.09		
Gender	$\chi^2(1)=.71$, $p=.40$		
PC Educational qualifications	Fishers exact=2.8, p=.81		
Ethnicity	Fishers exact=2.97, p=.37		
EAL	Fishers exact=1.29, p=.50		
Contact with SLT	Fishers exact=1.31, p=.47		

Table 3. Mean and SD by age group for ESB total raw scores at Time 1 (T1) and SRS total T scores at Time 3 (T3)

Measure	2;6-<3;0 n=30 Mean (SD)	3;0-<3;6 n=45 Mean (SD)	3;6-<4;0 n=18 Mean (SD)	F(df), p value η^2
T1: ESB total raw score	23.33 (12.16)	31.42 (11.73)	34.06 (8.9)	$F(2,90)=6.5$, $p=.002$ $\eta^2=.13$
T3: SRS total T score	56.60 (17.41)	57.49 (18.21)	49.83 (14.83)	$F(2,90)= 1.31$, $p=.28$ $\eta^2=.03$

Normality tests revealed that only the ESB scores for the youngest age group were normally distributed (p=.24, Shapiro-Wilk). Accordingly the analyses were repeated using Kruskal Wallis, a non-parametric test, and the results were similar: ESB $\chi^2(2)=11.66$, $p=.003$; SRS $\chi^2(2)=3.6$, $p=.17$).

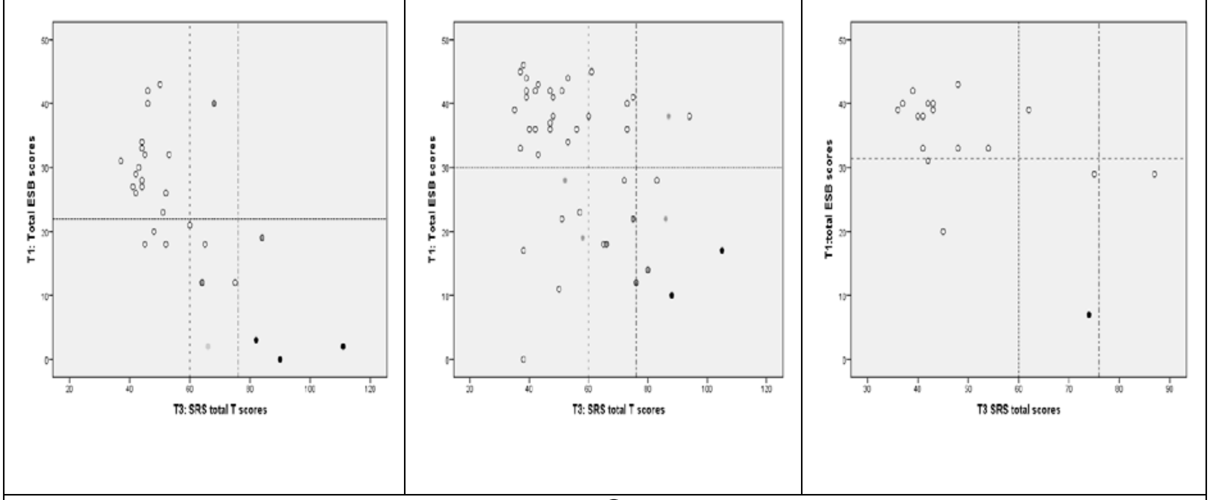
Table 4. Correlations between ESB total raw scores at T1 and SRS total T scores at T3 for the total sample and by T1 age group

Total sample[+] n=93	2;6-<3;0 n=30	3;0-<3;6 n=45	3;6-<4;0 n=18
-.5***	-.71***	-.35*	-.56*

[+]Age controlled ***p<.001

Figure 1. Scattergrams showing the relation between ESB total scores at T1 (age 2;6-<4;0) and SRS T total -scores and clinical diagnosis seven years later at T3 (age 9-11 years), according to age group at T1

2;6-<3;0	3;0-<3;6	3;6-<4;0



○ Neither ● Social Communication ◎ ASD ● ASD and Social Communication

Filled dots in the scattergrams indicate children who had received a clinical diagnosis of Social Communication and/or ASD at T3 (no child at T1 had a clinical diagnosis of ASD/social communication). The dotted X reference line represents the cut-off for low ESB (-2SDs). The dotted Y reference lines represent cut-off scores of 60 and 76 on the SRS, corresponding to cut-offs for ‘mild to moderate’ (typical of children with mild or ‘high functioning’ ASD); and ‘severe’ (strongly associated with clinically diagnosed ASD).