RUNNING HEAD: VERY EARLY PROCESSING SKILLS AS PREDICTORS

Early phonological and sociocognitive skills as predictors of later language and social communication outcomes

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Abstract

Background: Previous studies of outcome for children with early language delay have focused on measures of early language as predictors of language outcome. This study investigates whether very early processing skills (VEPS) known to underpin language development will be better predictors of specific language and social communication outcomes than measures of language itself.

Method: Participants were 163 children referred to clinical services with concerns about language at 2;6-3;6 years and followed up at 4-5 years. Novel assessments of phonological and sociocognitive processing were administered at Time 1 (T1), together with a standardised test of receptive and expressive language, and parental report of expressive vocabulary. The language test was re-administered at Time 2 (T2), together with assessments of morphosyntax and parental reports of social communication.

Results: Intercorrelations at and between T1 and T2 were high, and dissociations were rare. Ordinal regressions were run, entering predictors singly and simultaneously. With the exception of the phonological task, every early measure on its own was significantly predictive of most outcomes, and receptive language was the strongest all-round predictor. Results of simultaneous entry, controlling for the effect of other predictors, showed that early language was the strongest predictor of general language outcome, but early phonology was the strongest predictor of a measure of morphosyntax, and early sociocognition the strongest predictor of social communication.

Conclusions: Language measures which draw on a wide range of skills were the strongest overall predictors of general language outcomes. However, our VEPS measures were stronger predictors of specific outcomes. The clinical and theoretical implications of these findings are discussed.

Keywords: delayed language, early clinical predictors, repetition, sociocognition, social communication, longitudinal

First concerns about a child's language typically emerge when children reach 2-3 years, and children up to 4 constitute a substantial proportion of first referrals to speech and language therapy services (Department of Health National Statistics, 2004). Yet research on the nature of difficulties and outcomes for these children remains limited: most studies have followed up 2-year-olds who are ‘late talkers’ (Paul, 1996; Rescorla, Dahlsgaard, & Roberts, 2000; Whitehurst & Fischel, 1994); a very few have investigated children referred for clinical assessment, but only at age 4 or more (Bishop & Edmundson, 1987; Tomblin, Zhang, Buckwalter, & O'Brien, 2003). Although these studies vary in the method of recruitment, age of participants, and assessments used, they have produced strikingly similar findings. All report considerable rates of 'recovery', but also reveal considerable continuity, with severity and pervasiveness of initial deficits predicting later outcomes.

The main aim of all these studies has been to determine how far performance on language, or speech and language, predict later language performance. The research reported in this paper differs both in population and aim. Our study targeted younger clinically referred children, and our aim was to investigate not only the occurrence, but the nature, of later language difficulties. By school age, children with language difficulties are known to have varied profiles. In particular, some have primary problems with the forms and structures of language, and most notably, with morphosyntax (‘typical’ Specific Language Impairment); some have difficulties with pragmatic aspects of language and social communication (Pragmatic Language Impairment); and some have difficulties in both areas (Bishop, 1998). Based on the mapping theory, a theoretical account of the developmental trajectory through which language emerges (Chiat, 2001), we identified two sets of processing skills, phonological and sociocognitive, which are known to emerge early, and to relate to later language and social communication. We hypothesised that measures of these early processing skills would be better predictors of specific outcomes than measures of early language itself.

The phonological hypothesis

Recent research has demonstrated that typically developing infants are acutely sensitive to complex properties of speech input which provide important cues to the structures of their language. They notice and recall prosodic patterns and segmental details within these patterns, and this information is argued to play a crucial role in the segmentation of words and the identification of syntactic relations between words, both key steps in language acquisition (Morgan & Demuth, 1996). On this argument that phonology 'bootstraps' the acquisition of words and syntax, we might expect deficits in early phonological processing skills to disrupt children's acquisition of words and syntax (see Chiat, 2001). A range of research findings are consistent with this expectation. In a study by Weber, Hahne, Friedrich and Friederici (2005), a small group of toddlers found to be at risk for Specific Language Impairment (SLI) had shown deficits in discriminating stress patterns at 5 months. Cross-linguistic research of school-age children with SLI has revealed selective difficulties with aspects of morphosyntax that are phonologically challenging, most notably, function words and inflections that are unstressed or subsyllabic (Leonard, 1998; Chiat, 2001). Recent research has highlighted the impaired performance of children with SLI on sentence repetition tasks (Devescovi & Caselli, 2007), with unstressed function words being particularly vulnerable (Seeff-Gabriel, Chiat, & Dodd, 2005). In addition to this evidence that phonological factors influence morphosyntactic difficulties, a raft of studies have revealed that children with SLI have difficulties with nonword repetition, a task which relies on skills in phonological processing and memory and is designed to measure these skills (Gathercole, 2006; Chiat, 2006).

The case for early phonological processing skills underpinning later morphosyntactic development, and the evidence of impaired phonological skills in children with SLI, led to our hypothesis that early phonological processing skills will predict later skills in morphosyntax. In order to assess these early phonological skills, we devised the Preschool Repetition Test (PSRep), a novel word and nonword repetition task for 2-4 year olds (Roy & Chiat, 2004; Chiat & Roy, 2007). We assessed later morphosyntactic skills using an adapted version of Seeff-Gabriel's sentence imitation test.

The sociocognitive hypothesis

A very different strand of research on infants has revealed the early emergence of interpersonal skills which play a key role in the development of communication and meaning. Infants react to others' expression of emotion (Trevarthen & Aitken, 2001). They follow others' gaze and pointing to determine others' focus of interest; they alternate gaze to check that others share their focus of interest; and they point, show and give, to direct others' interest to their own object of attention (Carpenter, Nagell, & Tomasello, 1998). It has been argued that joint attention skills are crucial for language development (Baldwin, 1995). If children are to discover the meanings of others' words, they must seek the meaning intention behind those words (Tomasello, 1995). Studies by Baldwin (1995) and Tomasello (1995) have shown that infants use cues such as direction of gaze and facial expression to determine a speaker's intended reference.

While these basic skills in joint attention are necessary, they are not sufficient to determine the object of others' attention and the content of their meaning intentions. Beyond being responsive to others' verbal and nonverbal expression, infants must identify the purpose of this expression: what it is being used to express. A further level of sociocognitive processing is necessary to understand symbolic representations as 'something that someone intends to stand for or represent something else' (DeLoache, 2004). In line with this claim, many studies have found associations between deficits in symbolisation, including pretense, and deficits in early language (O'Toole & Chiat, 2006). Furthermore, in studies of children with autism, early joint attention has been found to associate with later symbolic play skills and social relationships (Sigman & Ruskin, 1999), and deficits in joint attention and symbolic play have in turn been found to predict autism and levels of language attained in children with autism (see Charman et al., 2005; Toth, Munson, Meltzoff, & Dawson, 2006).

The case for early sociocognitive skills underpinning and relating to later social relations and acquisition of language led to our hypothesis that children who show deficits in early sociocognitive skills will go on to have deficits in social communication. In order to investigate this hypothesis, we drew on previous experimental and clinical tasks to develop measures of the three sociocognitive skills we have outlined: responsiveness to others, joint attention, and symbolic understanding. These combined to yield a composite measure of sociocognitive skills.

Aims

The primary aim of this study was to evaluate the hypotheses that:

(i) phonological skills, as measured by performance on the PSRep Test at Time 1 (T1), will predict morphosyntactic skills at Time 2 (T2);

(ii) early sociocognitive skills, as measured by performance on our combined sociocognitive tasks at T1, will predict social communication skills at T2.

This aim was addressed in a longitudinal investigation of children referred with concerns about language, through a group-level analysis of relations between performance on a range of measures at the time of referral and roughly 18 months later.

Classification of performance

Crucial to the analysis of relations between performance on different measures is the way in which performance is classified. Levels of performance can be specified either in terms of a continuum or categorically (Pickles & Angold, 2003). Since our objective was to identify relations between clinically significant deficits at T1 and T2, rather than relations across the full spectrum of performance, we have mainly adopted a categorical approach. However, dichotomous variables with single cut-offs are subject to measurement error: changes in categories can stem from marginal fluctuations in scores. In order to reduce this risk, we created low and normal bands separated by a borderline band to deal with children whose performance was on the cusp. Based on the frequency distribution of percentile scores on standardised measures, we identified these 3 bands in percentile ranges, with low ≤7th, normal ≥16th, and the intervening 8th-15th borderline. In the case of measures not previously standardised or where normative data were not available, the three bands were identified by reference to our own samples of typically developing children and/or inspection of the distribution within our clinic sample (see below).

Methodology

Participants

Referral criteria for participation in this study were:

- aged 2;6-3;6 at time of referral
- reason for referral was concern about language development (not speech)
- no report of congenital problems, hearing loss, oro-motor difficulties, and no diagnosis of autism
- no concerns about nonverbal ability (see below)
- English as first/main language.

Participants matching our referral criteria were recruited from 4 inner London and 3 outer London Primary Health Care Trusts and 2 private clinics. All children whose parents gave consent were included in the study. The sample at T1 comprised 209 children, of whom three-quarters were boys. They were divided into 3 age groups: 2;6-<3;0 (n=82); 3;0-<3;6 (n=84); 3;6-4;0 (n=43). These groups included an even spread across key demographic variables (see Chiat & Roy, 2007). The sample at T2 comprised 187 of the original sample, followed up roughly 18 months later (mean=17.05 months, SD=2.81). The remaining 22 children could not be contacted.

Our inclusion criterion for nonverbal ability was a score within two SDs of the mean (≥70) on the nonverbal British Ability Scales II (BAS; Elliot, 1996). Individual children's compliance with this criterion showed some change over time. At T1, 13% of the children did not meet our criterion of BAS ≥70. The final T1 sample (n=181) had a mean nonverbal IQ of 90.2, SD=12.2, with the majority (61.9%) in the normal range or above. However, by T2, two-thirds of the excluded children achieved scores ≥80. Conversely, half the children with scores below 70 at T2 had achieved scores above 70 at T1. To take account of the changes in nonverbal scores, which at times were substantial, the original exclusion criterion was modified. Only children who had scores <70 at one phase *and* <80 at the other were excluded. On this basis, 12.8% of the 187 who were followed up were excluded from the analysis, yielding a final T2 sample of 163 children with a mean age of 54.2 months, SD=5.3.

Although criteria for referral to the study excluded children whose referral report made any reference to hearing difficulties, 23% of parents responded positively to a question on the parental interview asking whether the child had ‘any diagnosed or suspected hearing loss or glue ear’. However, almost all specified this as intermittent episodes of ‘glue ear’ (see Chiat & Roy, 2007, for details).

Procedures

At T1, almost all children were seen at home, in two sessions each lasting 1-1½ hours. A small number were seen in their nursery or preschool language unit. In almost all cases, two researchers were present, enabling one to videorecord the novel assessments and to interview the parent, while the other conducted the assessments. T2 usually involved two sessions run by one researcher, one at home and one at school. Questionnaires were given to parents and teachers to return in stamped addressed envelopes.

Assessments at both phases were administered in a fixed order, designed to maximise children's engagement. However, pace of tasks was determined by the child, and testing was discontinued if a child could not be engaged or showed distress. All assessments were administered by research assistants qualified in speech and language therapy, psychology or linguistics, and experienced in assessing young children. A high level of cooperation was achieved even with the very young children at T1. Nevertheless, level of compliance varied across tasks and the number of children who attempted each task is reported in the results section.

Time 1 Assessments

The first stage of the study assessed nonverbal ability, language, and the hypothesised early processing skills.

Language and Nonverbal Abilities

Nonverbal ability was measured using the BAS II (Elliot, 1996). Language was assessed using the Pre-school Language Scale-3(UK), Auditory and Expressive (PLS; Boucher & Lewis, 1998). In addition, the 100-word version of the MacArthur Communication Development Inventory standardised on a large UK population (MCDI-UK_{SF}; Roy, Kersley, & Law, 2005) provided a measure of expressive vocabulary. Low, borderline and normal categorical scores were derived based on the criteria described above.

Very Early Processing Skills (VEPS)

The early processing skills we have identified were assessed with four novel measures described briefly below.

Phonological skills

Phonological skills were measured using the Preschool Repetition Test (Seeff-Gabriel, Chiat & Roy, forthcoming). In this test, children are asked to repeat 18 words and 18 phonologically matched nonwords, systematically varied in length and prosodic structure. The test yields measures of whole item accuracy (maximum score 36), error, and non-response. The test has been shown to have high levels of reliability and validity (Roy & Chiat, 2004; Chiat & Roy, 2007).

Sociocognitive skills

Three sets of sociocognitive skills were measured and combined to yield a sociocognitive composite.

(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, 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, miniature object, and substitute object. 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 interrater reliability for all three of these novel measures was acceptable, with intraclass correlations of α=0.9-0.96. Intercorrelations between the measures, with age controlled, ranged between r=0.3-0.6 (for full details of these tasks and their psychometric properties, see Chiat & Roy, 2006).

Categorical Performance on VEPS

Children were classified as low, borderline or normal on each of the four VEPS measures. Cut-off points for these categories were determined from samples of typically developing children for all but one measure, taking age into account since age effects were observed in both typical and atypical samples. In the case of the social responsiveness task, data from typically developing children were not available, and cut-off points were determined from the distribution of the clinic sample itself which showed no effects of age on performance. See Chiat and Roy (2006) for cut-off scores.

The sociocognitive composite was defined by combinations of categories on the three sociocognitive assessments with low=low on at least two; normal=normal on at least two; borderline=all other combinations.

Time 2 Assessments

Language and Nonverbal Abilities

At T2, measures of nonverbal ability (BAS II) and language (PLS-3(UK)) were repeated. These language tests were supplemented by measures of morphosyntax and social communication.

Morphosyntax

Sentence production

The Renfrew Action Picture Test (Renfrew, 1997) was administered. This task requires children to describe a set of pictures, and their responses are scored for information content and grammatical forms. The grammar score was used as a measure of morphosyntactic production.

Sentence imitation

The Sentence Imitation Test-16 (SIT-16), which was adapted from a longer sentence repetition test (Seeff-Gabriel, Chiat, & Dodd, 2005; Seeff-Gabriel, Chiat, & Roy, forthcoming), was administered. Children are asked to repeat 16 sentences of 6 to 9 words. Their responses are scored for total content words, total function words, and total inflections correctly repeated. Based on previous findings and current hypotheses (see above), the measure to be used in the following analyses is total function words correct (maximum 58). This is supported by our finding that significantly fewer function words than content words were repeated accurately in our sample (mean difference=7.48, $t(151)=16.1$, $p<.001$). Since normative data were not available for this test, cut-offs for categorical performance were derived from the distribution of function word scores in our sample, with low ≤40; borderline=41-50; normal ≥ 51. Since performance on the SIT-16 was related to age, age was controlled in the analyses relating to this test.

Social Communication

Social communication skills were assessed using relevant subscales of the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997) and the Children's Communication Checklist (CCC-2; Bishop, 2003): the Peer and Prosocial subscales of the SDQ, and the four pragmatic subscales (Inappropriate Initiation, Stereotyped Language, Use of Context, Nonverbal Communication) and two autism-related subscales (Social Relations and Interests) of the CCC-2.

The SDQ itself specifies cut-off scores for categories of abnormal, borderline and normal (see www.sdqinfo.com), providing the three-way categorisation adopted in our study. We created an SDQ composite with low=abnormal on both subscales, or one abnormal and one borderline; normal= normal on both, or one normal and one borderline; borderline=both borderline, or one normal and one abnormal. CCC-2 provides percentile scores for each subscale, and these were used to derive categorical scores adopting the 7th percentile as low and 16th percentile as normal. We created a pragmatic composite from the six CCC-2 subscales with low=low on at least two subscales; normal=normal on at least two subscales and none low; borderline=all remaining combinations.

Statistical analysis

Analyses reported below were undertaken using SPSS v14.0 (SPSS, 2007). For all results *p* values were two tailed, and where appropriate effect sizes (η^2) or strength of association (Nagelkerke) are reported.

Results

Time 1: Language and VEPS measures

Auditory and expressive language

The mean auditory score ($mean_{auditory}$= 86.64, SD=16.02) fell just in the low average range and, as might be expected, was significantly higher than the mean expressive score ($mean_{expressive}$= 83.68, SD=14.55); ($F(1,159)=11.16$, $p<.001$, $\eta^2=.07$). The range of scores for auditory and expressive scales was comparable (auditory=77, expressive=83).

This profile of scores is reflected in the distribution of categorical performance (Table 1). Just over a third of the sample had auditory scores in the low range compared with nearly half who had low expressive scores. Half the sample had auditory scores in the normal range compared with just over a third who had normal expressive scores.

Insert Table 1 about here

Phonology

Nearly three-fifths of PSRep scores fell in the low range and just under a quarter in the normal range (Table 1; see Chiat & Roy, 2007, for detailed comparison with a typically developing sample).

Despite our selection criteria excluding children who presented with only speech problems, we suspected that the high proportion of our sample with scores in the low/borderline range might in part be due to the inclusion of children with purely speech difficulties. As with other nonword repetition tests, scoring of PSRep makes allowances for consistent speech errors which are indicative of speech difficulties. However, some speech difficulties may give rise to inconsistent errors which are indistinguishable from errors due to problems with phonological processing and memory, and result in low PSRep scores. We hypothesised that children whose poor PSRep scores were due to speech difficulties should show normal sociocognitive skills and attain vocabulary scores (MDCI-UK_{SF}) in the normal/borderline range. We identified 41 children with this profile. Follow-up data supported our hypothesis that these children's poor PSRep performance was due to speech problems: their performance at outcome did not differ from the performance of children with normal PSRep and sociocognitive scores.

Sociocognition

The distribution of the sociocognitive composite measure was almost a mirror image of the PSRep: just over three-fifths of scores were in the normal range and a fifth in the low range (Table 1).

Time 2: Language, Morphosyntax and Social Communication

Table 2 shows the percentage distribution of categorical performance for outcome measures at T2: language (auditory and expressive PLS scores), morphosyntax (function word scores on the sentence imitation task SIT-16 and grammar scores on the RAPT), and social communication (the Peer-Prosocial composite derived from the SDQ and the Pragmatic composite derived from CCC-2).

Insert Table 2 about here

Auditory and expressive language

Performance on both auditory and expressive PLS had improved significantly from T1 to T2 ($mean_{auditoryT2}$=91.69, $SD_{auditoryT2}$ =16.84, ($F_{auditory}$ (1,158)=24.38, p<.001, η^2=.13); $mean_{expressiveT2}$=88.86, $SD_{expressiveT2}$ =20.99, ($F_{expressive}$ (1,158)=16.3, p<.001, η^2=.09), and both mean scores now fell in the normal range. The range of auditory and expressive scores was comparable and very similar to the range of scores found at T1 (auditory=75, expressive=81). The improvement in the group profile is reflected in the distribution of categorical performance

(Table 2), with nearly two-thirds of auditory scores and over half of expressive scores in the normal range.

Morphosyntax

The two morphosyntactic measures, RAPT grammar and function word score on the SIT-16, showed similar proportions of low performance to the PLS, with about a third of the sample scoring in the low category (Table 2). However, SIT-16 produced a relatively low proportion of normal scores (a third compared with over half on the PLS expressive and RAPT grammar; see Table 2), suggesting that sentence imitation yields more evidence of problems than expressive language measures.

Social Communication

As with sociocognitive performance at T1, more than two-thirds of the sample fell in the normal range on these social communication measures (Table 2 and see Table 1). Nevertheless, the rate of peer and prosocial problems in our sample was about 2-4 times higher than that found at this age in the general population (Meltzer, Gatard, Goodman, & Ford, 2000). Problem ratings on the CCC-2 and SDQ were related (see Table 3 below).

Associations at and between Time 1 and Time 2

Table 3 shows the intercorrelations between categorical performance on all T1 and T2 measures, and gender.

Insert Table 3 about here

Gender was unrelated to all predictor and outcome measures, and was excluded from further analysis. Performance across measures both at and across time points was highly intercorrelated, with most correlations being at least moderate. Where dissociations occurred, these were broadly in line with the phonological and sociocognitive hypotheses. At T1, the only correlation that fell short of significance, though approaching it (p=.07), was between performance on our measures of phonology (PSRep) and sociocognition (sociocognitive composite). Likewise, at T2, concurrent correlations between performance on measures of morphosyntax (SIT-16 function word score and RAPT grammar) and social communication (Peer-Prosocial composite and Pragmatic composite) were low and non-significant in 3 out of 4 cases. Importantly for our hypotheses, the most striking dissociation across the two time points was between our measure of phonology at T1 (PSRep), and our measures of social communication at T2 (Peer-Prosocial and Pragmatic composites). The only other measures to dissociate across time were PSRep at T1 and the broad measure of receptive language, auditory PLS, at T2. The findings of concurrent and longitudinal dissociations between phonology/morphosyntax on the one hand and sociocognition/social communication on the other were as expected. Contrary to expectations, however, performance on sociocognition at T1 was significantly correlated with our measures of morphosyntax (SIT-16 and RAPT grammar) at T2. Collectively, these findings suggest that, while morphosyntax and social communication are relatively independent, early sociocognitive skills are in some way implicated in the development of morphosyntax.

VEPS and Language Measures as Predictors of Language and Social Communication Outcomes

In accordance with the main aim of the study, ordinal regressions were conducted in order to evaluate the predictiveness of T1 variables (language and VEPS measures) for outcomes on T2 variables (language and social communication measures). Dummy variables of predictors were created: low and borderline categories were compared with the normal categories. For ease of presentation, only findings for low vs. normal are presented. Figures presented in bold indicate where both low and borderline variables were significant.

Language outcomes

Table 4 shows the parameter estimates (PE), standard errors (SE), Wald statistics of the T1 predictor variables for T2 language outcome measures, and Nagelkerke statistics as a measure of strength of associations. Results are presented for variables entered singly and simultaneously.

Insert Table 4 about here

As expected from the significant intercorrelations reported above, when predictors were entered singly, auditory and expressive PLS measures and the VEPS sociocognitive composite significantly predicted all language outcome measures (auditory and expressive PLS, SIT-16, and RAPT grammar). As a single measure, auditory PLS accounted for the greatest amount of variance in all language outcomes (29-39%). The PSRep was also associated with significant change in SIT-16, expressive PLS and RAPT grammar, but not auditory PLS.

Combined entry gives an indication of the relative strength of the predictors. Entry of all predictors increased the amount of variance explained in all outcome measures, with the most substantial increase (13%) found in SIT-16. In the light of results on continuity in PLS performance and significant correlations across time noted above, the finding that PLS added most to the prediction of PLS outcome is unsurprising. Unexpectedly, auditory PLS also added most to the prediction of RAPT grammar score. However, our T1 phonological measure (PSRep) emerged as the strongest predictor of our other measure of morphosyntactic outcome, SIT-16 function word score. With speech problems excluded (see above), PSRep emerged as the *only* T1 predictor that added significantly to the prediction of function word score with the full model accounting for more than half the variance (Wald $\text{statistic}_{low}=19.81$, $p<.001$; Wald $\text{statistic}_{borderline}=10.82$, $p=.001$; Nagelkerke=.53).

Social communication outcomes

Table 5 shows the parameter estimates (PE), standard errors (SE), Wald statistics of the T1 predictor variables for T2 social communication outcome measures (Peer-Prosocial and Pragmatic composites), and Nagelkerke statistics as a measure of strength of associations. Results are presented for predictors entered singly and simultaneously.

Insert Table 5 about here

Entered singly, all predictors with the exception of PSRep were associated with significant change in the Peer-Prosocial composite and the Pragmatic composite. However, when all predictors were entered simultaneously, only our T1 sociocognitive measure emerged as a unique predictor of T2 social communication outcomes. In this case, combined entry compared with single entry of predictors accounted for little or no additional variance. Overall T1 predictors accounted for substantially less variance in social communication compared with language and morphosyntactic outcomes.

Discussion

To the best of our knowledge, this is the first large-scale study of very young clinically referred children. Most studies of 2-3 year olds have investigated language profiles and ‘normalisation’ of late talkers identified from population samples, rather than children who have been clinically referred, with the 4 year olds investigated by Bishop and Edmundson (1987) being one of the youngest clinical samples. Given the dearth of evidence on very early clinical referrals, our findings on standardised language measures as well as on the novel VEPS measures provide unique information about the profile of this group. Even though the children had been referred with concerns about language, notable proportions scored in the normal range (>15th percentile) on the standardised language measure: half on the auditory scales and over a third on the expressive scales. Nevertheless, nearly half scored in the low category (<8th

percentile) on the expressive scales, and just over a third on the auditory scales. Performance on the novel VEPS measures revealed interestingly different distributions. The PSRep Test produced the highest rate of problems, with the majority of scores in the low category. This could in part be due to the presence of children with purely speech difficulties that affected repetition scores but were not the target of this test. However, excluding these children still left 50% of the sample with scores in the low category, a rate about 7 times higher than that found for typically developing samples (Chiat & Roy, 2007). This finding points to widespread difficulties with phonological processing in this young clinically referred group. In contrast, the sociocognitive composite produced the lowest rate of problems, indicating the relative rarity of impairment in the basic interpersonal skills we assessed.

While the distribution of performance on T1 measures varied, intercorrelations between these were common. Only the association between PSRep and sociocognitive scores was non significant. T1 measures were in turn significantly correlated with performance on almost all measures taken at T2, which were themselves intercorrelated. Non significant correlations were the exception and involved measures that were hypothesised to be most distinct, with skills in phonology (PSRep) and morphosyntax (SIT-16, RAPT grammar), on the one hand, dissociating from skills in sociocognition and social communication (Pragmatic and Peer-Prosocial), on the other.

In line with the high level of intercorrelations, when all T1 measures were entered individually in a regression analysis, most T1 measures were predictive of most T2 measures. Contrary to our hypotheses, T1 measures of language predicted specific outcomes at a similar level to T1 measures of early processing skills which were proposed to underpin and be more predictive of those outcomes. Indeed, the measure of early receptive language (auditory PLS) emerged as the most powerful all-round single predictor, identifying at an early age children who are likely to have persistent language problems of some kind. It was, however, less effective in identifying the *nature* of longer-term problems, and the different skills and deficits which may underlie early receptive language performance.

Simultaneous entry of predictors, controlling for the effect of other variables entered, revealed more specific relations between predictors and outcomes. Auditory PLS remained the strongest predictor of general language outcome, both auditory and expressive. It was also the strongest predictor of outcome on RAPT grammar. This unexpected finding may reflect the demands of the RAPT task beyond knowledge of morphosyntax. In line with this view, both our sociocognitive measure and our phonological measure remained significant predictors. In contrast, our phonological measure, PSRep, emerged as the strongest predictor of our purest measure of morphosyntactic outcome, function word score on the SIT-16. When children with poor repetition skills due to speech difficulties were excluded from the sample it emerged as uniquely predictive.

Turning to social communication outcomes, as measured by the Pragmatic and the Peer-Prosocial composites, results were more clear-cut. Although the PLS was significant when predictors were entered separately, with simultaneous entry, only our early sociocognitive composite emerged as a unique predictor of social communication outcome.

In summary, results of intercorrelational and regression analyses indicate that dissociations were relatively rare, and that a measure of receptive language – auditory PLS – was the strongest predictor of pervasive outcome difficulties, but when deficits were specific, skills hypothesised to underpin specific outcomes were the best predictors of those outcomes. These findings have important theoretical and clinical implications.

Theoretically, they provide further evidence for precursors of language identified in research on typically developing children and atypically developing children, including children with SLI and children with autism. They go beyond this evidence, suggesting that *specific* early processing skills are precursors of *specific more complex* outcomes, and may serve as predictors of specific deficits in language and social communication.

Considering first the phonology-morphosyntax relationship, it might be argued that the predictor PSRep and outcome measure SIT-16 were related because both were repetition tasks. However, the material to be repeated was qualitatively different. While the PSRep Test targeted single words and nonwords outside any morphosyntactic structure, the SIT-16 targeted sentences and revealed that function words were significantly more vulnerable than content words. This differential vulnerability of morphosyntactic categories supports our argument that sentence imitation draws on morphosyntactic skills, and is in keeping with our claim that the most vulnerable categories are those which are phonologically weak and therefore phonologically challenging (Leonard, 1998; Chiat, 2001).

Findings on the relationship between early sociocognition and later social communication are striking, since these entailed distinct measures of distinct behaviours: observational measures of social responsiveness, joint attention, and symbolic understanding at T1, and parental questionnaires about more complex interpersonal relations at T2.

Turning to clinical implications, our findings suggest that a general language test such as PLS, in particular the auditory scale, is a good starting-point for assessment, since performance on this task was broadly predictive. However, general language measures are not informative about the specific skills that underlie children’s language performance, as revealed by the VEPS measures. This information is essential for more targeted clinical interventions.

Both clinical and theoretical inferences from our study raise some wider issues and require some caveats. First, our study provided a salutary reminder that tasks designed to tap quite specific and basic skills are by no means 'pure': they draw on other non-targeted skills which may mask relations to outcome. Repetition relies on willingness to imitate, which is lacking in a proportion of children at this age. It also relies on a number of skills, including speech production (Gathercole, 2006), which are not the target of the task. Some speech production difficulties may lead to repetition errors that are not due to limitations in phonological processing and memory, which are the target of the task. We have shown that children with low repetition but adequate early vocabulary scores had normal morphosyntactic outcome, suggesting that early repetition is optimally predictive if combined with a measure of expressive vocabulary.

In considering clinical implications, limitations of our analyses must be borne in mind. The analyses reported in this paper have evaluated our hypotheses only at a group level. In order to make inferences about outcome at an individual level, further analyses are planned to determine sensitivity and specificity of predictor measures.

Finally, the early processing skills we have identified are not exhaustive. Our findings invite further research on early processing skills which underpin and may be predictive of later language. Recent research on typically developing infants is highlighting further processing skills that underpin the development of meaning, most notably, skills in identifying language-relevant features of objects and actions (Hirsh-Pasek & Golinkoff, 2006). Investigation of these skills in clinically referred children may throw further light on key precursors of language and lead to tighter prediction of outcomes for clinically referred children.

Based on the processing skills investigated in this study, we conclude that early measures of phonological and sociocognitive skills are differentially informative about outcomes and can make a distinct contribution to the prediction of specific language and social communication difficulties. We suggest that theories and evidence of relations between early processing skills and complex outcomes may provide new insights into the complex and heterogeneous profiles of disorders such as SLI and PLI.

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Table 1: Percentage distribution of categorical performance on Time 1 language and VEPS measures

Measure	N	Categories (%)		
		Low	Borderline	Normal
Language				
Auditory PLS	160	35	13.8	51.3
Expressive PLS	160	45.6	15.6	38.8
VEPS				
Phonology: PSRep	147	57.8	17.7	24.5
Sociocognitive composite	163	20.2	17.2	62.6

Table 2: Percentage distribution of categorical performance on Time 2 language, morphosyntax and social communication

Measure	n	Categories (%)		
		Low	Borderline	Normal
Language				
Auditory PLS	162	26.5	8	65.4
Expressive PLS	162	36.4	8.6	54.9
Morphosyntax				
SIT-16	152	28.9	34.9	36.2
RAPT grammar	156	37.8	4.5	57.7
Social communication				
SDQ composite	143	8.4	15.4	76.2
CCC-2 composite	115*	15.7	17.4	67

*excluding 10 void cases

Table 3: Correlation matrix showing intercorrelations between T1 predictors and T2 outcome measures and gender

		1. Gender	2. T1 AudPLS	3. T1 ExprPLS	4. T1 PSRep	5. T1 Sociocog	6. T2 AudPLS	7. T2 Expr PLS	8. T2 SIT-16	9. T2 RAPT gram	10. T2 Peer-Pro
1. Gender	r p	1									
2. T1 AudPLS	r p	.02 .77	1								
3. T1 ExprPLS	r p	.06 .46	.59 <.001	1							
4. T1 PSRep	r p	-.05 .55	.24 .004	.36 <.001	1						
5. T1 Sociocog	r p	.14 .08	.42 <.001	.44 <.001	.15 .07	1					
6. T2 AudPLS	r p	.03 .67	.52 <.001	.41 <.001	.-.023 .79	.34 <.001	1				
7. T2 ExprPLS	r p	.05 .51	.6 <.001	.53 <.001	.18 .03	.4 <.001	.71 <.001	1			
8. T2 SIT-16	r p	-.09 .27	.49 <.001	.51 <.001	.41 <.001	.32 <.001	.48 <.001	.66 <.001	1		
9. T2 RAPTgram	r p	.02 .81	.51 <.001	.43 <.001	.32 <.001	32 <.001	.33 <.001	.52 <.001	.58 <.001	1	
10. T2 Peer-Pro	r p	.07 .43	.25 002	.22 .008	.11 .2	.35 <.001	.31 <.001	.3 <.001	.17 .06	.06 .46	1
11. T2 Pragmatic	r p	-.04 .67	.29 .03	.3 .001	-.04 .66	.37 <.001	.39 <.001	.33 <.001	.3 .001	.15 .1	.52 <.001

1. Gender, 2. T1 Auditory PLS, 3. T1 Expressive PLS, 4. T1 PSRep, 5. T1 Sociocognitive, 6. T2 Auditory PLS, 7. T2 Expressive PLS, 8. T2 RAPT grammar, 9. T2 SIT-16, 10. T2 SDQ Peer-prosocial, 11. T2 CCC-2 Pragmatic.

Table 4: T1 standard language measures and VEPS tasks as predictors of T2 language outcome for the total sample

Time 1 Predictors	Time 2 language outcome measures							
	Auditory PLS		Expressive PLS		SIT-16 (50)		RAPT grammar	
	Single	All	Single	All	Single	All	Single	All
1.PLS aud: PE (SE)	**-2.74 (.44)**	**-2.42 (.6)**	**-2.95 (.42)**	**-1.95 (.52)**	-2.3 (.39)	-1.35 (.5)	**-2.42 (.41)**	**-1.94 (.54)**
Wald	**38.3*****	**16.26*****	**49.33*****	**13.86*****	34.32***	7.18**	**34.54*****	**12.94*****
2.PLS exp: PE (SE)	**-2.23 (.46)**	-.99 (.63)	**-2.91 (.47)**	**-1.59 (.59)**	-2.3 (.39)	-1.14 (.5)	**-2.07 (.41)**	-.59 (.55)
Wald	**23.28*****	2.46 ns	**38.96*****	**7.36****	35.39***	5.3*	**25.86*****	1.15 ns
3.PS Rep: PE (SE)	.008 (.43)	1.39 (.61)	-.94 (.44)	-.21 (.57)	**-2.3 (.48)**	**-1.83 (.53)**	**-1.87 (.53)**	-1.29 (.61)
Wald	.000 ns	5.19*	4.68*	.13 ns	**23.19*****	**12.03*****	**12.53*****	4.56*
4.Sociocog: PE (SE)	**-1.69 (.42)**	-.47 (.58)	**-1.94 (.43)**	-.75 (.57)	**-.1.5 (.42)**	**-.**7 (.54)	**-1.69 (.45)**	-1.21 (.59)
Wald	**16.44*****	.66 ns	**20.34*****	1.74 ns	**12.73*****	1.7 ns	**13.98*****	4.26*
Nagelkerke: 1	.32		.39		.34		.29	
2	.21	.35	.34	.44	.34	.47	.22	.38
3	.002		.04		.28		.13	
4	.14		.18		.21		.13	

1. PLS auditory, 2. PLS expressive, 3. PSRep, 4. Sociocognitive.

Table 5: Standard language measures and VEPS tasks as predictors of social communication outcomes for the total sample

Time1 Predictors		Time 2 social communication outcome			
		Peer-Prosocial		Pragmatic	
		Single	All	Single	All
1.PLS aud:	PE(SE)	-1.59 (.46)	-.65 (.61)	-1.2 (.42)	-.19 (.6)
	Wald	11.89**	1.14 ns	8.07 **	.1 ns
2.PLS exp:	PE (SE)	-1.52 (.5)	-.48 (.69)	-1.21 (.45)	-.84 (.58)
	Wald	9.21**	.47 ns	8.17**	2.06 ns
3.PSRep:	PE(SE)	-.76 (.61)	-.25 (.68)	.16 (.45)	.66 (.53)
	Wald	1.55 ns	.14 ns	.13ns	1.52ns
4.Sociocog:	PE(SE)	-1.87 (.45)	-1.22 (.61)	-1.92 (.46)	-1.74 (.58)
	Wald	17.35**	4.02*	17.46***	9.03**
Nagelkerke					
1		.12	.13	.08	.18
2		.10		.08	
3		.03		.001	
4		.16		.15	

1. PLS auditory, 2. PLS expressive, 3. PSRep, 4. Sociocognitive.