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Early Vocabulary Development in Deaf Native Signers: A British Sign Language Adaptation of the Communicative Development Inventories

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Abstract

Background: There is a dearth of assessments of sign language development in young deaf children. This study gathered age-related scores from a sample of deaf native signing children using an adapted version of the MacArthur-Bates CDI (Fenson et al., 1994).

Method: Parental reports on children's receptive and expressive signing were collected longitudinally on 29 deaf native BSL users, aged 8-36 months, yielding 146 datasets.

Results: A smooth upward growth curve was obtained for early vocabulary development and percentile scores were derived. In the main, receptive scores were in advance of expressive scores, but not significantly so. No gender bias was observed. Correlational analysis identified factors associated with vocabulary development including parental education and mothers' training of BSL. Individual children's profiles showed a range of development and some evidence of a growth spurt. Clinical and research issues relating to the measure are discussed.

Conclusions: The study has developed a valid, reliable measure of vocabulary development in BSL. Further research is needed to investigate the relationship between vocabulary acquisition in native and non-native signers.

Keywords: sign language, early vocabulary development, assessment, deaf, CDI

Abbreviations: BSL (British Sign Language), ASL (American Sign Language), CDI (Communicative Development Inventories).

Introduction

BSL is the language of the British Deaf community (Sutton-Spence and Woll 1999). It is a visual-gestural language with a linguistic structure independent of any spoken language. Sign languages have the same capabilities as any human language and are acquired naturally by children in deaf families where sign language is used. Research on sign language acquisition among native signers has drawn parallels with hearing children exposed to a spoken language in terms of ages and stages of development (Morgan and Woll, 2002; Newport and Meier, 1985; Schick, 2003).

However, only a small minority of deaf children have deaf parents (less than 10%, Mitchell and Karchmer, 2004) and can therefore be considered to be native users of the language. The majority of deaf children are not native signers; sign language exposure is typically late and inconsistent from hearing parents and professionals with often poorly developed sign language skills. The present study investigates vocabulary development among native

signers. Compiling age-related scores on this group is a necessary first step towards developing assessments for non-native signing children who are widely recognised to be at risk for language development (Herman 1998).

Assessing deaf children's language development

While a variety of tests is used to assess developmental outcomes in speech and hearing in young deaf children, (e.g. the Listening Progress Profile, Nikolopolous, Wells and Archbold, 2000; TAIT Analysis, Tait, 1993; Rossetti Infant-Toddler Language Scale, Rossetti, 1990), few assessments exist for deaf children who are sign language users and none at all for deaf signers below the age of 3 years (see Haug and Mann, 2008, for a review of sign language assessment tools). Consequently, decisions about appropriate educational placements or recommended interventions for deaf children are frequently based on assessments of spoken and written language skills, with only impressionistic assessments being made of sign language skills (Herman, 1998).

Standardised assessments of deaf children's early sign language acquisition are needed in order to evaluate children's communication skills in sign against normative developmental milestones. However, developing appropriate assessment tools and deriving deaf norms presents many challenges. Firstly, compared to the volume of work on the acquisition of spoken languages, there is very little research on sign language development and much is based on small subject numbers (see Schick, Marschark and Spencer, 2006, for an overview). In view of the wide variations in

development typically exhibited by young children, there is a need to investigate the extent of this variability for sign languages and to confirm existing findings on larger numbers of children.

Secondly, sign language acquisition research is often based on deaf and hearing children in deaf signing families, since both grow up to be native signers. However, Herman and Roy (2000) question whether these should be considered equivalent in terms of language acquisition. Hearing children in deaf families are likely to be bilingual from an early age, whereas deaf children are monolingual in sign, at least until they start school (ibid). There is a need to establish monolingual norms in sign language if we are to monitor deaf children's progress in language development.

Thirdly, the generalisability of findings from sign language acquisition research is an issue. We referred above to the small numbers of cases that have been studied. In addition, most research is based on children acquiring ASL (e.g. Mayberry and Squires' (2006) review of research in this area refers mostly to ASL studies). Although there are some parallels in the acquisition of BSL and ASL, for historical reasons, the similarities between these languages are fewer than would be expected when considering the spoken language shared by these countries. Therefore, findings from ASL cannot automatically be generalised to BSL.

Of the limited research into BSL acquisition, a small number of studies have focused on the acquisition of grammatical features in native signers beyond 3 years of age (e.g. Herman and Roy, 2006; Kyle, 1990; Morgan, 2006). Even fewer studies have looked at deaf children below this age and none have documented vocabulary development in BSL. Further research

needs to be conducted into the acquisition of BSL and language assessments for use in the UK need to be developed on children acquiring BSL.

The CDI

The current paper presents findings of an adaptation of the MacArthur-Bates CDI (Fenson et al., 1994) for BSL and presents age-related scores on a sample of deaf native signers. The CDI are psychometrically robust parent report tools that assess early child language. Two standardised scales exist: the Infant Form (Words and Gestures) for 8-16 month olds and the Toddler Form (Words and Sentences) for 16-30 month olds. On the Infant Form, parents indicate receptive and expressive vocabulary by ticking items from 63 communicative gestures and 396 spoken words grouped into categories such as 'animals', 'toys' and 'actions'. The Toddler Form focuses on expressive vocabulary but covers more extensive categories (680 words), includes markers of grammatical development (63 sentence pairs) and mean length of the child's longest utterances.

Psychometric properties of the CDI, including internal reliability and concurrent validity, have been calculated for the original American English CDI (Fenson et al., 1994, pp. 67-76). The CDI have been found to be sensitive to age and gender (ibid), indeed there are separate norms for boys and girls. The CDI have been translated into many European languages and also into Cantonese (Tardif, 1996), Japanese (Ogura, Yamashita, Murase and Dale, 1993) and Hebrew (Maital et al., 2000). They are widely used in educational and clinical settings (see Law & Roy, 2008, for a recent review).

Anderson & Reilly (2002) developed an American Sign Language (ASL) version of the CDI. The authors observed few differences between the course of acquisition of spoken English in hearing children and ASL in deaf children. Although there was evidence of greater expressive vocabulary in deaf children younger than 18 months, by the age of 24 months, vocabulary size was the same in both languages. Interestingly, they reported no evidence of a vocabulary spurt in early ASL development, with a steady linear growth in vocabulary size observed, in contrast to spoken English.

Prezbindowski and Lederberg (2003) discussed the use of the ASL CDI with deaf children. They noted that numbers of items differed: 537 in the ASL and 680 in the American English version, with an overlap of 462 items. One area of difference was the category of animal sounds which was removed from the ASL version and replaced by items relating to deaf culture. The CDI, at least beyond the youngest age groups, are intended to be samples of current vocabulary, not exhaustive checklists. Nevertheless, it is important to establish that vocabulary pools identified for hearing samples are appropriate for use in a signed version.

Collecting age-related scores in BSL for the CDI

Normative data for spoken languages is generally collected on large numbers of native users, e.g. Fenson et al., (2000) used 1130 children for the Toddler Form and 569 children for the Infant Form of the CDI. When considering BSL, large numbers of native signers are simply not available. One solution is to collect repeated datasets on the same group of children.

Anderson and Reilly (2002) adopted this approach when developing the ASL version. They recruited 69 deaf children of deaf parents and 34 participants were tested longitudinally, yielding 110 datasets.

The present study seeks to investigate a sample of deaf native BSL users. The children reported represent approximately 30% (allowing for the high level of co-morbid disability) of the estimated number of deaf children born to deaf parents in the UK during this time period. Although small, this sample is obviously a much larger proportion of the potential population than is found in any other standardisation samples. However, there is no demographic information available on the deaf population in the UK, so determining whether the sample is representative is challenging. In the absence of data, comparisons with the UK 2001 census for hearing children are made. The degree to which demographic distributions in the deaf and hearing populations are comparable is not known.

Method

The aims of the present study were:

- to collect age-related scores of receptive and expressive BSL vocabulary from a UK sample of native deaf signers aged 8-36 months from deaf families;
- to investigate the developmental trajectories of early vocabulary development.

Participants

Deaf native signing children, all with moderate (60dB loss in the better ear) or greater hearing loss, under the age of 3 years were recruited across all regions of the UK, with the exception of Northern Ireland, the North West and the East of the UK. Recruitment was carried out using personal contacts in the Deaf community, adverts in the national magazine of the British Deaf community and a variety of e-mail group forums.

A website was created containing information about the project and all signs included in the BSL adaptation of the CDI were presented in written English and BSL (www.ucl.ac.uk/HCS/research/EBSLD/index.htm). As sign languages do not have a written form, the website allowed parents to clarify the intended meaning of a written word on the checklist, e.g. the word “home” is represented by different signs and consequently different categories according to context, i.e. “goes/stays home” (verb), versus “my home” (noun).

A total of 31 deaf native signers (19 boys and 12 girls) were recruited and parental consent obtained. Two boys were excluded: one with Prader Willi syndrome and a second found to have an unreliable dataset. The final sample comprised 29 children, yielding 146 datasets. Both measures were used to analyse demographic data. These measures were broadly comparable, but where they differed, separate figures for the 146 datasets are presented in parentheses. Of the sample, 17 were boys (59%), contributing 90 (62%) of the datasets. All families were ethnically British white. In comparison with the UK 2001 census, boys were over-represented in the current sample (UK 2001 census: 48.7%). The ethnic make up of the current sample (100% white) is also unrepresentative (UK 2001 census: 87.6% white).

The mothers of 2 children were hearing fluent signers with deaf husbands, 27 mothers were deaf and 2 children had no paternal figure in their lives. Two percent of the children were first generation native signers (i.e. their grandparents were hearing); 45% were second generation native signers and 52% had more than 3 generations of deaf people in their family. The mean age of mothers was 28 years (SD 5.29, range 17-38 years); the mean age of fathers was 32 years (SD 4.58, range 24-43 years).

Supplementary information was collected from parents in face-to-face interviews. This included self-rating of training in BSL study and educational background. For training in BSL, mothers: 76% had no training, 3% had basic training, 21% had advanced training; fathers: 69% (70%) had no training, 13% (15%) had basic training, 14% (11%) had advanced training in BSL (data was missing for one father).

Data was collected on the highest level of parental educational attainment. Mothers: 10% had no qualifications, 28% (27%) had GCSEs, 28% (29%) had A levels, 10% had a Higher Education Certificate/Diploma or NVQ 4-5 and 24% had a Higher Education Degree or NVQ 6+; fathers: 3% had no qualifications, 21% (19%) had GCSEs, 23% (26%) had A levels, 27% (26%) had a Higher Education Certificate/Diploma or NVQ 4-5 and 26% had a Higher Education Degree or NVQ 6+.

In comparison with the UK 2001 census data for father's qualifications, a higher proportion of the sample held higher educational qualifications and there were fewer with low qualifications. The latter is a consistent finding among other standardisation samples, particularly for preschool children (e.g. Fenson et al 1993; Seeff-Gabriel, Chiat & Roy, 2008)

Children were recruited throughout the duration of the project at varying ages and therefore the number of datasets in age groups varied from 15-28, with the highest number of entries in the middle age groups (see Table 1). No child had entries at all age points; however, because of the grouping into 4 month age bands, multiple entries in the same band were common. Only 3 children had no multiple entries, 2 of whom had only 2 entries in total. No case had more than 2 multiple entries and the majority had only 1. Sampling constraints due to the highly limited population of deaf native signers made this inevitable.

Insert Table 1 about here

Procedure

Permission to develop the BSL CDI was sought and obtained by the authors from the CDI Advisory Board at the beginning of the project.

Harris (2000) had adapted the Anderson and Reilly (2002) ASL version of the CDI for use with British deaf children and this formed the basis of the BSL CDI used in the current study. Among the signs replaced by Harris were items relating to American culture. Signs for body parts (signed by pointing to the relevant part) were retained and subsequent analyses revealed no differences between scores when these items were included and when they were omitted. A number of signs were added, e.g. HOW-MUCH and HOW-MANY, which are single signs in BSL, were added to the ´question words´ category. The checklist consisted of 570 items in 22 categories. Data was collected on receptive as well as expressive vocabulary.

All parents were visited initially by the researcher to explain how to use the checklist. New forms were sent quarterly and parents were paid for every 4 forms received. After each child reached the age of 18 months, parents were sent copies of their previous form so that new data could be entered on it, following recommended CDI practice. Families with internet access (approximately 90%) were shown the project website and how to use it.

Item analysis

Once data collection was completed, 20 items that were rarely selected (2 or fewer times across the entire sample for both receptive and expressive vocabulary) were excluded. These items were: for, these, basement, up-to-now, suppose, snowsuit, Indian, doughnut, gum, peanut-butter, vanilla, vitamins, watermelon, about, country, don't-care, any, each, so, imagine. Their non-appearance in the data reflects cultural differences between the UK and USA, grammatical words found in English but not BSL and vocabulary items used infrequently with young BSL users. This left a total of 550 items (final checklist available from the authors upon request).

Reliability and validity

Early in the project, 10 children selected across the range of age groups were visited on a second occasion to investigate validity. They were filmed interacting with their parents using toys and books designed to elicit many of the lexical items on the CDI, including those reported and not reported by the parents. The signs produced and clearly understood by children were coded separately by a native signer and a fluent hearing signer.

Inter-scorer reliability on the video data by the 2 coders was investigated and found to be highly significant (r=.97 p<.001 for expressive r=.97, p<.001 for receptive vocabulary).

As a measure of concurrent validity, words ticked on the CDI checklist (filled in by parents on the day prior to filming) were compared with those coded from the video. Significant correlations were found (expressive vocabulary: r=.96, p<.001; receptive vocabulary: r=.99, p<.001), indicating valid reporting of data by parents.

To ensure that errors were not introduced through repeated sampling, the first 2 forms received for each child were closely examined to ensure consistency. Scores for the first and second datasets collected (i.e. 3 months apart) were analyzed for 21% of the children. Test-retest reliability was high for receptive (r=.86, p<.001) and expressive vocabulary (r=.95, p<.001). Individual profiles were later checked for consistency of all data, on the basis of which 1 child was removed from the dataset.

Results

Developmental changes in receptive and expressive scores: cross-sectional data

Table 2 shows the means, standard deviations and minimum and maximum expressive and receptive language scores for the total sample and by gender across the seven 4-monthly age bands. Both sets of scores show systematic increases with age and substantial individual variability as

indicated by the large standard deviations. The mean number of signs (4) produced in the youngest age group was low.

Insert Table 2 about here

Children's receptive vocabulary exceeded their expressive vocabulary at all ages, with neither scores reaching ceiling even in the oldest age group. The correlation between the two measures was highly significant ($r=.97$, $p<.001$). The effect of language status and gender was analysed through a series of related and independent t tests respectively, for each of the seven age groups to deal with the problems incurred by the repeated and incomplete datasets collected across time. Bonferroni corrections for multiple comparisons were applied, reducing the alpha level to .007.

With the exception of the youngest age group ($t_{8\text{-}11\text{months}}(16)=2.04$, $p=.06$), the differences between the mean expressive and receptive scores were significant for all groups (see Figure 1 which shows the growth chart for expressive and receptive language based on the mean scores for each age group).

Insert Figure 1 about here

In contrast, no significant differences between the mean scores for boys and girls were found in any age group, for either expressive or productive mean scores. In two t tests, expressive scores (8-11 months) and

receptive scores (20-23 months), Levene's test of unequal variances was significant and equal variances were not assumed in these cases.

Factors affecting vocabulary development

Analyses of the effect of independent variables on reported vocabulary growth is also complicated by the repeated, but incomplete data sets from our 29 participants across time. This was dealt with by calculating three separate measures of vocabulary development. Two of the measures, rate of vocabulary learning (number of items/ month) and start age for vocabulary learning (months) were derived from individual linear regressions run for each subject taking expressive vocabulary as the dependent variable and age (in months) at testing as the predictor variable. Expressive scores were used in preference to receptive scores as parental ratings of expressive vocabulary are reported to be more reliable and valid than ratings of receptive vocabulary (Law & Roy, 2008). Only subjects with more than two consecutive data entries were included in the analyses (n=25) and the two measures, rate of vocabulary learning (number of items/ month) and start age for vocabulary learning (months), were based on the slope of the regression line (the unstandardised coefficient, B) and the intercept, (constant/B), respectively. The third measure was the reported vocabulary size at 20-23 months. This age was taken as it combined a relatively high number of completed forms returned from participants (n=21) together with the fewest number of multiple entries for any one child (see Table 1). The estimated mean rate of expressive vocabulary learning was 13.5 signs/month (SD=7.49, 2.58-32.44),

the estimated mean start age of vocabulary learning was 11.61 months (SD= 2.35, 5.07-16.12), and mean reported vocabulary size was 126.89 signs (SD=93.88, 7-338, see table 1). Overall expressive vocabulary size was positively correlated with both rate of learning and start age (r=.89 and r=-.57 respectively), so children who started earlier and/or who learned at a quicker rate had a larger vocabulary by the age of 20-23 months. Rate of learning and start age were not significantly related (r=-.25).

Table 3 shows the correlations between the three measures of expressive language development (rate of development, start age of vocabulary development and vocabulary size at 20-23 months) and mothers' age, mothers' training in BSL, and mothers' and fathers' educational qualifications. For ease of presentation, only independent variables that were significantly associated with at least one of the measures of expressive language development are included in the table. A Bonferroni correction for multiple comparisons was applied, reducing the alpha level to .01.

Insert Table 3 about here

A substantial proportion of studies of early vocabulary development in the hearing population using CDIs are cross-sectional in design and most adopt vocabulary size as the dependent measure. An exception was Bauer, Goldfield & Reznick's (2002) use of rates of growth in their study of individual growth profiles of CDI – Words and Gestures scores. As can be seen in Table 3, all three measures of expressive language development were significantly associated with two of the four independent variables, although the strength of

the association and the independent variable concerned varied across measures. It is interesting to note in Table 3 that once the correction for multiple comparisons was applied, the only significant associations between independent factors and vocabulary growth and vocabulary size, were found in relation to mothers' training in BSL and mothers' educational qualifications, accounting for 35-48 % of the variance in scores.

Individual growth trajectories: longitudinal data

Figure 2 shows the developmental trajectories for 25 children's expressive vocabulary over time (4 children with only 2 consecutive growth points were excluded). Three children had 3 or more non-consecutive data entry points. In these three cases (cases 3, 19, 27) an estimate of the data for the missing month was calculated (the mid-point between the scores of the next lowest and next highest age ranges) and used to plot growth trajectories. Individual growth plots were inspected and three broad groups of trajectories were identifiable. A group of 3 'late entry' children, whose first data entry point was aged (24-27 months), showed above average vocabulary development (between 200-350 expressive signs at this age). Three children (cases 9, 21 & 25) present as 'slow language developers' with vocabulary scores at 24-27 months falling below the mean for that age and in 2 cases, falling below the 10^{th} percentile. In almost half of the remaining 19 children there was evidence of a vocabulary growth spurt, typically occurring at a vocabulary level of 50 signs and/or in the age range 16-19 months. This pattern was most marked in children with relatively fast growth trajectories (see Figure 2).

Insert Figure 2 about here

Percentile scores for receptive and expressive sign language

As no significant gender differences between receptive and expressive sign language emerged for any age group, percentile scores were calculated for the sample as a whole only. Percentile equivalent scores (10^{th}, 25^{th}, 50^{th}, 75^{th} and 90^{th}) were derived from the receptive and expressive raw scores for each age range (see Appendix).

Two growth curve graphs of the mean receptive and expressive scores by age range for each percentile level were plotted. Irregularities in the growth curves were smoothed (see Rust and Golombok, 1999) and 3 receptive and 3 expressive scores adjusted accordingly. Two children in the sample (7%) had scores below 40, the 10^{th} percentile score at (24-27) months, with scores of 28 (case 9) and 39 (case 25) (see Figure 2) and might be seen as children 'at risk' of delayed sign language development.

Discussion

The current study has produced a BSL adaptation of the CDI based on a sample of deaf children aged 8-36 months from across the UK. The measure was found to be reliable and valid.

Although the BSL CDI contains some changes from the original spoken CDI, there are no data on sign frequency or age of acquisition of individual signs in BSL to form an independent basis for the selection of lexical items. The assignment of signs to existing lexical categories is at times problematic;

categories found in English do not map directly on to BSL signs, e.g. noun/verb pairs such as toothbrush, cook, etc. By analysing individual items, we have attempted to ensure they are valid for deaf children acquiring BSL as a first language. In general, CDI translations need to incorporate detailed analysis and replacement of lexical items to ensure that a translated scale is linguistically relevant.

The pattern of results in the main was very similar to the CDI English versions derived from hearing children (Fenson et al, 1994; Feldman et al. 2000; Roy, Kersley & Law 2005). Like hearing parents, the deaf parents in our sample reported data that showed age-related changes in their children's sign language. The BSL data yielded a smooth upward growth curve for early vocabulary development, comparable to that found for spoken language (Fenson et al. 1994). Likewise, one of the most striking findings was the wide variability in the size of children's reported vocabularies at initial assessment and across the course of development (Fenson et al., 2000). This was particularly marked in the younger age groups where the standard deviations exceeded the mean scores.

As expected, children's receptive vocabulary consistently and significantly outpaced their expressive vocabulary for all age groups with the exception of the youngest (8-11months). The current BSL version of the CDI assessed both receptive and expressive vocabulary across the age ranges, whereas dual assessment of both applies only to the younger version of the spoken CDI (Infant Form 0;8-1;4). Above this age, reports are limited to expressive vocabulary only, primarily due to concerns about the reliability of parents' judgment of their children's receptive vocabulary, which by the

second year is extensive (Erikkson, Westerlund and Berglund, 2002; Thal et al., 1999; Tomasello and Mervis, 1994). We found the correlation between receptive and expressive skills to be high and their growth curves similar. However, in the absence of independent measures to validate the receptive scores, we would argue that the expressive scale should be taken as the measurement of choice, particularly for older age groups.

However, there are areas of difference. Our current analyses showed no gender bias, which is in contrast to findings of the CDI for spoken languages (and not reported for the ASL CDI). Parents of hearing children have consistently reported gender differences favouring girls, although the amount of variance accounted for by gender varies across studies (Bauer et al., 2002; Fenson et al., 1993, 1994; Reese and Reed, 2000). Our sample had a higher proportion of boys than girls compared with national figures (59% vs 49%, UK Census 2001 for children under 10), and the overall sample was relatively small. It is possible that with larger numbers, a gender bias may emerge. An alternative hypothesis is that gender differences in language acquisition are specific to the oral modality of spoken languages and that these differences are not present for visual-gestural forms of communication, i.e. children acquiring a sign language. Further research is needed to shed light on this area.

This study has highlighted important factors that are associated with early sign language development. The present study found parental education and training in BSL to be significantly related to children's vocabulary development. The extent to which parental education has been reported as a significant factor in hearing youngsters' early-reported

vocabularies is largely a function of the representativeness of the samples: reported in SES representative samples (Arriaga et al., 1998; Reilly et al., 2007; Roy, Kersley and Law, 2005), but not found in more middle class biased samples (Fenson et al, 1994; Hamilton, Plunkett and Shafer, 2000). Anderson & Reilly (2002) do not provide any information about occupation or level of parental education in their ASL study, but it is not surprising that level of parental education affects the language development of deaf children in deaf families in the same way as reported for hearing families with hearing children. Native signers benefit from a more homogeneous language experience than non-native signers, but even within this group, parental training in BSL and parental education have emerged as factors associated with children's language development. This finding has particular resonance for deaf children with non-native signing backgrounds, for whom highly variable input is the norm.

A limitation of the current study is its reliance on repeated measures, with consequences for the independence of the data. However, with such a small population, there is no alternative approach to the problem of developing much needed measures. An advantage to the collection of longitudinal data is that we have been able to explore the vocabulary development of individual children in the sample. While there is considerable variability in the rate of development and the age when development starts, there is some evidence that the trajectories of children acquiring BSL show clear growth spurts in vocabulary acquisition, equivalent to those of hearing children acquiring a spoken lexicon (e.g. Goldfield and Reznick 1990). This is in contrast to Anderson and Reilly (2002), who reported no growth spurts in

ASL in their sample. However, their finding may stem from the limited number of widely spaced growth points used in the ASL study (6 month intervals on average in the ASL study compared with 4 months in the current study).

Another difference between the present study and that of Anderson and Reilly (2002) is the size of the lexicon among the youngest age groups. Children acquiring BSL produced an average of 4 signs between 8-11 months, which is approximately half that of children acquiring ASL at the same age.

The individual developmental trajectories revealed a small proportion (7%) of our sample with slow BSL development, of whom 2 cases achieved scores below the 10th percentile. Interestingly, this proportion is the same as the figure typically reported as the level of specific language impairment in the general population (Tomblin et al., 1997). However, Feldman et al. (2000) cautioned against the use of the CDI to identify children at risk of language deficits and more generally the viability of CDIs as sensitive clinical tools has been questioned (see Law & Roy, 2008). On the other hand, if parents complete the checklist prior to and as part of a wider clinical assessment, it not only provides baseline information for the clinician but also affords parents an opportunity to become actively involved in the assessment process (Miller, Sedey and Miolo, 1995; Prezbindowski and Lederberg, 2003). This may be particularly significant for deaf parents if no sign language interpreter is present at the assessment.

As a research tool, like the spoken CDIs, much can be learnt at a group level about the developmental sequelae of 'later talkers/signers' from

follow-up studies of children with scores falling below the 10th percentile (Thal et al., 1999; Dale et al., 2003; Heilmann et al., 2005).

The BSL CDI is an important contribution to the assessment deaf children's achievements in language and has potential value in research as a means of matching subjects, thereby reducing the methodological limitations often found in studies with young deaf signing children.

Further research is needed to investigate the relationship between vocabulary acquisition in native and non-native signers.

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Table 1: Distribution of datasets according to child and age range

Case number n=29	Gender $n_{B=17}$ $n_{G=12}$	Age categories (months)							Total1
		8-11	12-15	16-19	20-23	24-27	28-31	32-36	
1	B		1	2	1	1	2		7
2	B						1	2	3
3	G	1	1	2		2			6
4	B						1	1	2
5	G			2	1	1	1	1	6
6	B	1	1	2	1	1	1		7
7	G	2	1	1	1				5
8	B		2	1	1	1			5
9	B		1	2	1	2			6
10	B	1	1	2	1	1	1	1	8
11	G	1	2	1	1				5
12	B		1	1	2	1	1	1	7
13	G					2	1	2	5
14	B					2	1	2	5
15	B	1	2	1	1	1	1		7
16	B				2	1	1	2	6
17	G					1	1	2	4
18	G	2	1	1	2				6
19	B			1	1		1	1	4
20	B	2	1	1	2				6
21	B	1	1	1	2	1			6
22	G	1	1						2
23	B		1	1	2				4
24	B	2	1	1	1				5
25	G		2	1	1	1			5
26	G	1	1	2	1				5
27	G	1	1		1				3
28	G			2	1	1			4
29	B						1	1	2
Total 2		17	23	28	27	20	15	16	146

Total 1= total number of datasets per child
Total 2= total number of datasets per age range

Table 2: Means, standard deviations, minimum and maximum receptive and expressive scores by age range

Age range (months)	n	Total expressive				Total receptive			
		Mean	SD	Min	Max	Mean	SD	Min	Max
Total sample									
8-11	17	3.76	7.3	0	30	10.29	20.01	0	84
12-15	23	15.83	22.58	0	100	36.61	45.56	0	187
16-19	28	59.29	58.61	2	239	106.32	96.22	10	341
20-23	27	126.89	93.88	7	338	174.26	114.07	22	375
24-27	20	203.6	145.07	28	501	252.7	143.48	68	531
28-31	15	268.33	106.78	97	480	331.07	98.87	159	502
32-36	16	348.13	114.88	124	517	405.31	92.65	229	522
Boys									
8-11	8	1.12	1.64	0	5	6.38	8.11	0	25
12-15	13	10.92	10.94	0	33	31.62	31.44	0	114
16-19	16	52.31	44.66	5	178	95.94	74.6	10	247
20-23	18	129.72	98.15	11	338	175.39	112.55	22	356
24-27	12	171.67	126.51	28	437	230	128	71	435
28-31	12	267.33	105.61	97	480	339.5	95.55	185	502
32-36	11	340.82	118.6	124	517	403.36	90.25	252	522
Girls									
8-11	9	6.11	9.55	0	30	13.78	26.72	0	84
12-15	10	22.2	31.73	0	100	43.1	60.61	0	187

16-19	12	68.58	74.47	2	239	120.17	121.54	10	341
20-23	9	121.22	90.1	7	297	172	123.92	28	375
24-27	8	251.5	166.13	39	501	286.75	167.11	68	531
28-31	3	272.33	135.77	129	399	297.33	126.79	159	408
32-36	5	364.2	117.73	187	491	409.6	108.6	229	505

Table 3: Correlations between three measures of expressive vocabulary development and mothers' age, mothers' training in BSL, and mothers' and fathers' educational qualifications.

	Mother's age		Mothers' training in BSL		Mothers' educational qualifications		Fathers' educational qualifications	
	r	*p*	r	*p*	r	*p*	r	*p*
Rate of learning (n=25)	.41	.04	.29	.16	.39	.05	.36	.08
Start age of vocabulary learning (months) (n=25)	-.15	.46	-.35	.08	-52	.008	-.41	.05
Vocabulary size (20-23 months) (n=21)	.23	.32	.59	.005	.69	<.001	.23	.33

Figure 1: Graph to show mean expressive and receptive scores by age range

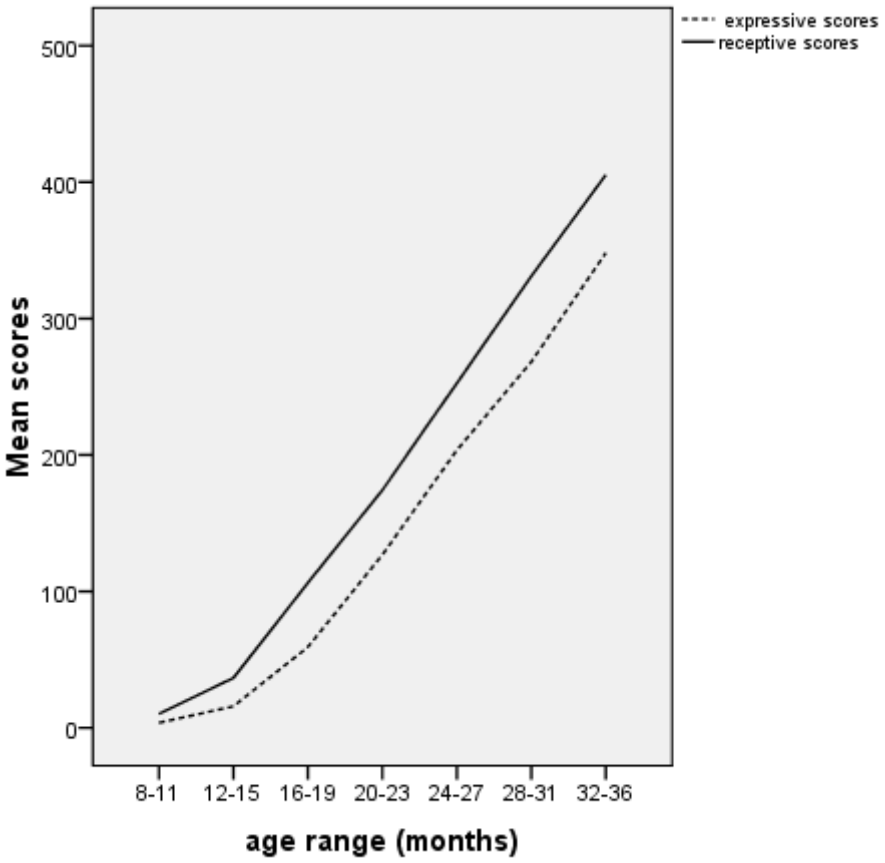
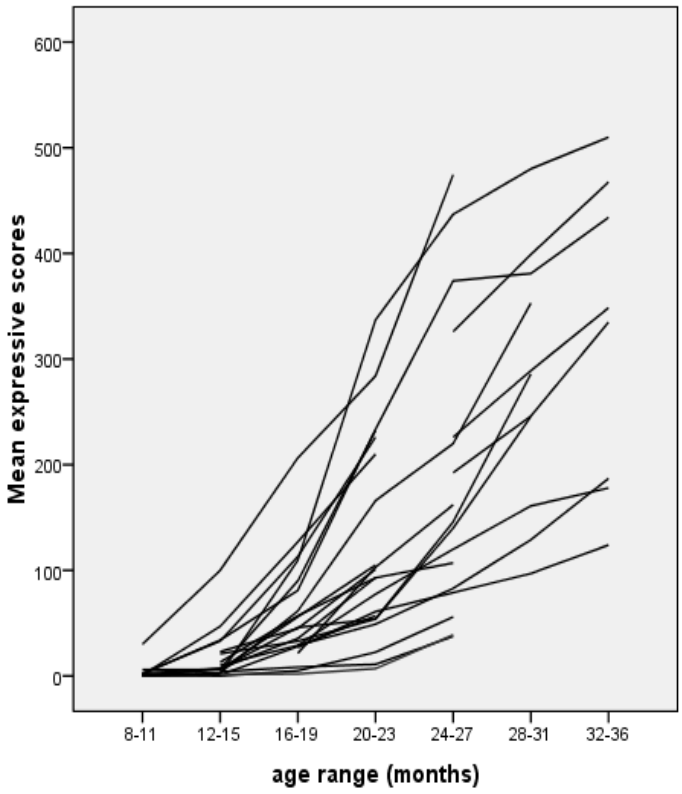


Figure 2: Individual growth trajectories for mean expressive scores across the age ranges



Appendix: Raw receptive and expressive scores corresponding to percentile scores by age range

Age range (months)	Percentiles									
	Expressive					Receptive				
	10	25	50	75	90	10	25	50	75	90
8-11	0	0	1	5	14	0	2	4	10	37
12-15	0	2	7	23	42	0	4	25	46	107
16-19	5	20	43	80	174	15	34	61	174	277
20-23	18	54	98	197	275	32	*78*	140	302	351
24-27	40	89	157	312	*380*	71	125	227	378	*445*
28-31	116	176	280	*375*	431	175	241	336	*425*	485
32- 36	*180*	275	357	444	499	245	314	440	470	510

Numbers in italics have been adjusted for smooth growth curves

Key points:

- There are no measures of early vocabulary development standardised on deaf children.
- Exposure to sign within the deaf population is highly variable. Native signers are a more homogeneous subset of the deaf population.
- Data is presented on the developmental trajectories of children acquiring BSL and factors associated with development.
- The measure can be used to monitor early language development in BSL in native signers and identify children who may be at risk of language delay.