Sign language and spoken language development in young children: Measuring vocabulary by means of the CDI

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1. Summary

This paper reports on studies of early language development in young deaf and hearing children exposed to both a spoken language and a sign language, within the context of bilingualism and bilingual language acquisition more generally. The course of early sign language acquisition in terms of vocabulary as measured by the British Sign Language (BSL) adaptation of the MacArthur-Bates Communicative Development Inventory is described in detail for deaf children of hearing parents and deaf children of deaf parents, and compared to BSL data for hearing children of deaf parents. Additionally, data on English language development in deaf children with hearing parents exposed to both BSL and English will be compared to norms for English language development in hearing children of hearing parents. The implications of the findings will be discussed in relation to children's differing language experiences and to early diagnosis and intervention for language development in the deaf population.

2. Introduction

Bilingualism is the norm for most of the world's population. In view of the variety of experiences of acquisition and variation in levels of competence, Grosjean (1982) defines bilingualism as the regular use of more than one language in everyday life. Using this definition of bilingualism, Deaf communities can be recognised as bilingual, with most members of Deaf communities using the community's sign language and the spoken/written language of the larger hearing society, although individuals vary in their fluency in the two languages. Since bilingualism in Deaf communities involves two languages of different modalities of expression, this type of bilingualism is

commonly referred to as bimodal bilingualism, sign bilingualism, or cross-modal bilingualism, in contrast to the usual unimodal bilingualism in two spoken languages. For individuals, linguistic profiles can range from native fluency in one or both languages to delayed, partial, or even only rudimentary skills. The reasons for this variation relate to such diverse factors as the age at which hearing loss occurred, the degree of deafness, the age of exposure to the respective languages, the hearing status of the parents and their family language policy, schooling, and social networks (Grosjean 2008; van den Bogaerde and Baker 2002).

It is important to note in this context that deaf individuals have only recently been seen as bilingual (Grosjean 2008) following the recognition of sign languages as natural human languages from the 1960s onwards. However, questions concerning the use of sign languages and spoken/written languages in the education of deaf children, and the relationship of signing to the development of spoken language have preoccupied professionals and scholars for several centuries (Bagga-Gupta 2004).

Beyond controversy over approaches to communication within education, the establishment of deaf schools has been of critical importance in the development of Deaf communities and their sign languages (Ladd 2003). Bilingual development of deaf children occurs in two unusual contexts that determine the accessibility and use of sign language and spoken language, namely, (i) the unequal status of the languages at the level of parent-child transmission (more than 90 % of deaf children are born to hearing, non-signing parents) and (ii) the unequal accessibility of the languages (limited access to the speech signal). From a linguistic perspective, the spectrum of communication approaches used with deaf children ranges from strictly monolingual (oralist) to cross-modal bilingualism, with a variety of mixing of the two languages. This can be the natural outcome of bilingualism in adult input (for example deaf parents who know both a spoken language and sign language).

One major issue concerns the interaction of the two languages in their acquisition, especially in a context where bilingual approaches to early intervention with deaf children are under threat (Knoors and Marschark 2012).

3. Bilingual learners

There are relatively few longitudinal studies of cross-modal bilingualism (Petitto et al. 2001; Petitto and Holowka 2002; Baker and van den Bogaerde 2008) in either deaf or hearing children exposed to a sign language and a

spoken language. The specific circumstances that determine exposure and access to spoken languages and sign languages in deaf children raise a number of issues. Age of exposure to sign language is a critical issue for the large majority of deaf children born to non-signing hearing or deaf parents. Whether they acquire sign language successfully depends on such factors as parents' choices about language, medical advice – specifically in relation to cochlear implantation - and early intervention.

Over recent years, several hypotheses have been put forward with respect to positive and negative effects of cross-modal language interaction in cross-modal bilingual development. In research on bilingualism in two spoken languages, this is usually expressed as a facilitating vs. a delaying effect in the learning of target language properties (Odlin 2003). A variety of terminology is found in the literature, including that concerned with cross-modal bilingualism, to refer to different types of interaction between two or more languages in the course of bilingual development, such as "language transfer", "linguistic interference", "cross-linguistic influence", "code-mixing", and "linguistic interdependence".

Studies of language contact phenomena in interactions among adult bilinguals, including bilingual signers, and in the productions of bilingual learners, have shown that language mixing is closely tied to the organisation of language on the one hand, and to the functional and sociolinguistic dimensions of language use on the other hand (Grosjean 1982, 2008), with a general consensus that bilingual users, including bilingual learners, exploit their linguistic resources in both languages.

Following a long debate about separation or fusion of languages in early bilingual acquisition (Meisel 2004), there is a consensus that both languages develop separately from early on, although it is clear that for unimodal spoken language bilingualism, language mixing in young bilinguals occurs during the course of bilingual development (Genesee 2002; Hulk and Müller 2000). This is also found in studies of cross-modal acquisition of sign language and spoken language in hearing children (Petitto et al. 2001; Petitto and Holowka 2002) and deaf children in deaf families (van den Bogaerde and Baker 2002).

In the remainder of this paper we will discuss language acquisition in children acquiring BSL and English. BSL is the language of the British Deaf community (Sutton-Spence and Woll 1999). As discussed above, 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; Schick 2003). However, under 10% of deaf children have deaf parents (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 may be late and inconsistent from hearing parents and professionals with often poorly developed sign language skills (Herman 1998). The present study starts from the creation of norms for vocabulary development among native signers. Developing norms for this group is a necessary first step towards developing assessments for non-native signing children. Section 4 provides an overview of the assessment of sign language development. Section 5 describes the MacArthur-Bates Communicative Development Inventory for BSL (BSL-CDI) and normed data for native signing deaf and hearing children, together with a comparison of BSL development using the CDI with norms for British monolingual hearing children acquiring English as a first language; in Section 6 possible reasons for differences in the norms for these three groups are discussed. Section 7 presents data on the development of BSL and English using the CDI for deaf children from hearing families, and Section 8 discusses implications from these series of studies for intervention programmes for young deaf children.

4. Assessing deaf children's language development

While a variety of tests are 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), few assessments exist for deaf children who are sign language users and even fewer for signers below the age of 3 years (see Haug and Mann 2008, for a review of sign language assessment tools). 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 in the general population, 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 (2006) 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 for deaf children, bilingualism is much more variable.

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 American Sign Language (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.

Fourthly, measurements for sign language development are essential if we are to monitor deaf children's progress in language as a basis for designing appropriate interventions both for families and within formal education.

Of the limited research into BSL acquisition, most studies have focused on the acquisition of grammatical features in children beyond 3 years of age (e.g. Herman and Roy 2006; Morgan 2006). Fewer studies have looked at deaf children below this age and the current studies reported here are the first to document vocabulary development in BSL.

5. The CDI

The current paper presents findings of an adaptation and standardisation of the MacArthur-Bates CDI (Fenson et al. 1994) for BSL. The CDI are psychometrically robust parent report tools that assess early child language (see http://www.sci.sdsu.edu/cdi/). Two standardised scales exist for English: the Infant Form (Words and Gestures, CDI-WG) for 8-16 month olds and the Toddler Form (Words and Sentences, CDI-WS) for 16-30 month olds. All CDIs require parents to indicate receptive and expressive vocabulary by ticking items from lists of words grouped into categories such as "animals", "toys" and "actions".

Psychometric properties of the CDI, including internal reliability and concurrent validity, were calculated for the original American English CDI (Fenson et al. 1994: 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 around 60 languages, as diverse as Albanian, Arabic, Basque, Bengali, Cantonese, Chichewa, Korean, Malay, Maltese, Sami and Yiddish, and are widely used in educational and clinical settings

(see Law and Roy 2008, for a recent review).

Anderson and 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 from deaf families. 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. 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.

Prezbindowski and Lederberg (2003) discuss the use of the ASL CDI with deaf children. They note that numbers of items differ: 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.

5.1. Developing BSL norms for the CDI

Normative data for spoken languages is generally collected on large numbers of native users. Fenson et al. (2000) used 1130 children for the Toddler Form and 569 children for the Infant Form of the CDI. When developing sign language norms, 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 BSL study followed the same strategy (see Woolfe et al. 2010 for full details). As with ASL, a single questionnaire was created (rather than two separate Infant and Toddler forms).

5.2. Participants

Deaf and hearing native signing children aged from 8-36 months were recruited across the UK. The final sample comprised 29 deaf children and 33 hearing children, and the use of repeated datasets yielded 146 data sets, and 153 data sets respectively. As in the original CDI, the questionnaire asks parents to report on comprehension and production for each item. Since the

questionnaire is in English, a website http://www.ucl.ac.uk/HCS/research/EBSLD/ was created with video clips of signed examples of each vocabulary item, together with instructions in BSL for completing the questionnaire.

The pattern of results was very similar to the CDI English language versions (Fenson et al. 1994). 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 (Woolfe et al. 2010 and Figures 2a and 2b below). Likewise, one of the most striking findings was the wide variability in children's reported vocabularies at initial assessment and across the course of development. This was particularly marked in the younger age groups where the standard deviations exceeded the mean scores. Figure 1 plots the individual developmental trajectories, and the wide variation in BSL development in native signers can be seen, comparable to that found in hearing children acquiring a spoken first language.

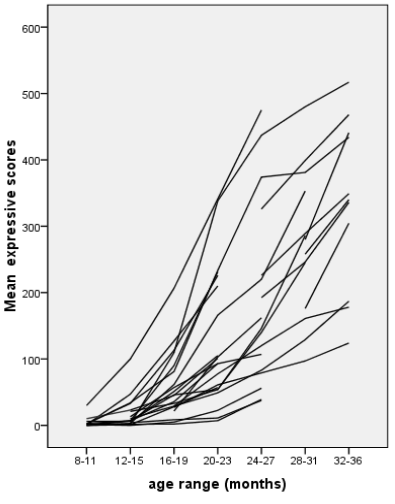


Figure 1. Individual trajectories for BSL production

As expected, children's receptive vocabulary consistently outpaced their expressive vocabulary. The individual developmental trajectories revealed a small proportion (7%) of the sample with slow BSL development, of whom 2 cases achieved scores below the 10th percentile. Figure 2a indicates the 10th, 25th, 50th, 75th and 90th percentiles for comprehension by deaf native signers across 7 age bands (8-11m, 12-15m, 16-19m, 20-23m, 24-27m, 28-31m, and 32-36m) and Figure 2b the percentiles for BSL production.

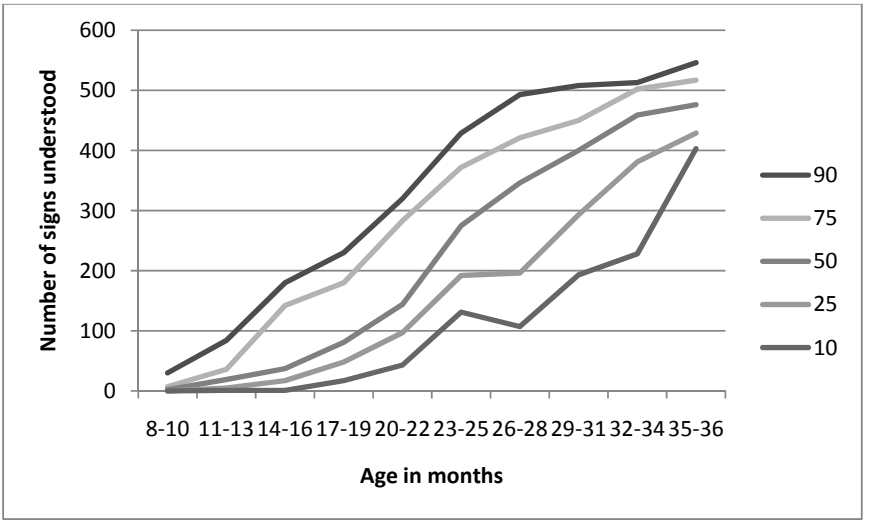


Figure 2a Percentiles for BSL comprehension in deaf native signing children

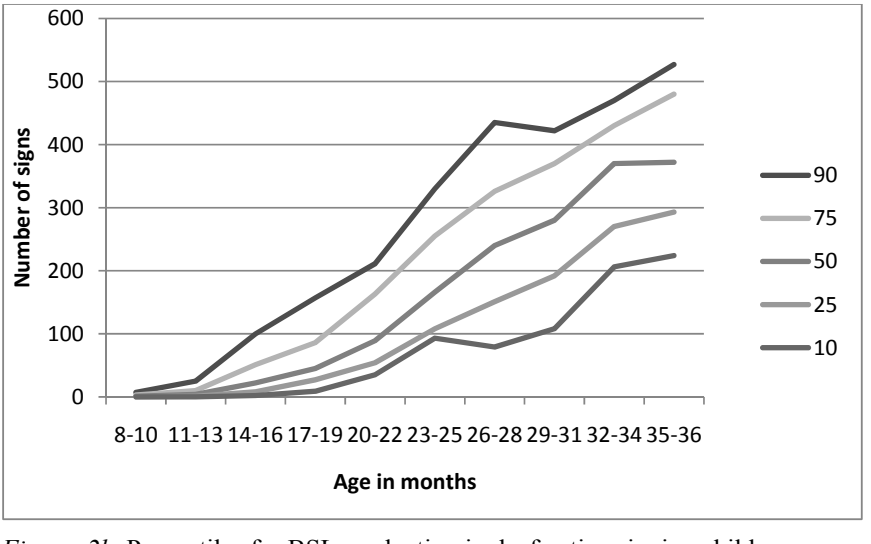


Figure. 2b Percentiles for BSL production in deaf native signing children

6. Deaf and hearing children compared

Although it had been originally intended to combine data from hearing and deaf native signing children, evidence from other research suggested that these two groups receive different input, even in sign language, and might

therefore differ in language development. The most comprehensive series of studies of input provided by deaf mothers to their children are those undertaken by van den Bogaerde and Baker with deaf families in the Netherlands. In one of their studies (van den Bogaerde and Baker 2002), they analysed the differences between input to deaf children and input to hearing children. One marked difference was that the deaf mothers of hearing children voiced nearly 100% of the words they produced; voicing was much more variable with deaf children. There was also much more code-blending – the mixing within sentences of elements from both languages – with hearing children.

When we compared the BSL development of deaf and hearing children of deaf parents we found differences in their BSL development. We of course do not have data on the English language development of the hearing children of deaf parents, since it is impossible to ask for a parental report on English comprehension and production. However, in light of the likely greater input of English to hearing children than to deaf children by deaf parents, it is instructive to compare the data we have for BSL development in these children with English development in hearing children with hearing parents. Figures 3a and 3b provide data for the three groups (English language data is taken from Hamilton et al. 2000; BSL data from Woolfe et al. 2010). Although there are similar patterns of development, there are differences between the groups.

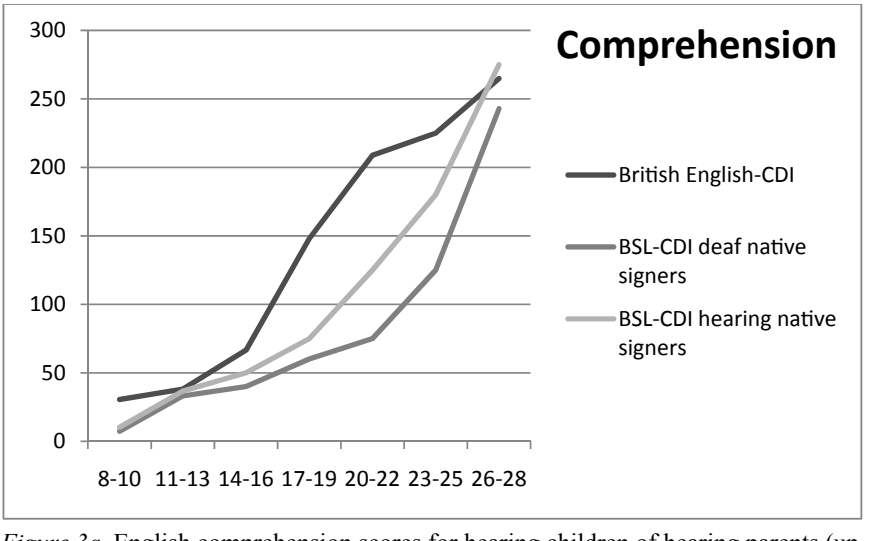


Figure 3a English comprehension scores for hearing children of hearing parents (upper line) using British English CDI); BSL comprehension scores for hearing children of deaf parents (middle line) using BSL CDI; BSL comprehension scores for deaf children of deaf parents (lower line) using BSL CDI

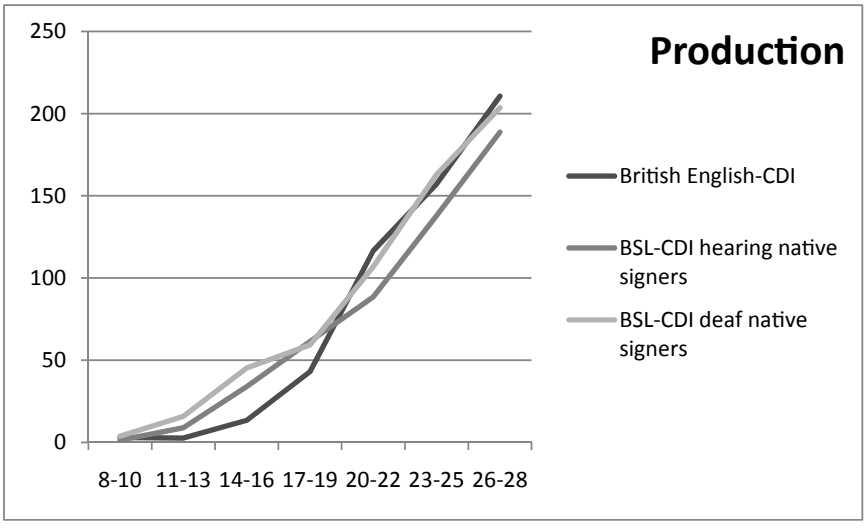


Figure 3b English production scores for hearing children of hearing parents using British English CDI; BSL production scores for hearing children of deaf parents using BSL-CDI; BSL production scores for deaf children of deaf parents using BSL-CDI

There are significant differences between the reported comprehension scores for the three groups of children, with the two hearing groups reported to understand more words or signs than the deaf group. While it may be assumed that monolingual children have higher receptive vocabulary in their one language than bilingual children have in either of their two languages, this does not account for why the hearing children of deaf parents comprehend more signs than the deaf children of deaf parents. There are smaller differences between the three groups in production, although the differences are significant between 20 months and 26 months. The higher mean scores for vocabulary – whether in BSL or in English – in hearing children may be the result of differences in their experience of language learning compared to that of deaf children. The data may reflect the fact that both hearing children of hearing parents and hearing children of deaf parents have the advantage of being able to look at a referent while hearing their parents name it, while deaf children must learn to alternate their attention between the adult (to see the sign) and the referent (to find out what the sign means). This alternation of attention may take time to achieve and may thus explain the slower rate of development for the deaf children.

7. Deaf children in hearing families

Since 2000, Britain has had universal neonatal hearing screening. As a result the median age of identification of deafness and enrolment in intervention programmes is now 10 weeks of age. Following this dramatic change in experiences of deaf children and their families, *Positive Support in the Lives of Deaf Children and their Families*, a collaborative project between the University of Manchester and the Deafness Cognition and Language Research Centre (DCAL) at University College London and funded by the Big Lottery Fund (http://www.positivesuppport.info) undertook parent-led monitoring of key outcomes for deaf children in the first years of life, relating these to type and extent of specific interventions, such as audiological services, pre-school educational services, and speech and language therapy (Bamford et al. 2009). Outcomes measured included language, communication, social behaviour, family functioning, and motor and physical development. All data were collected by means of questionnaires completed by the parents or by professionals working with the families. The language outcome measures comprised two CDIs: English (Hamilton, Plunkett, and Schafer 2000) and the BSL CDI (Woolfe et al. 2010). The project collected data from 72 deaf children with hearing parents. Parents were all native speakers of English and had no experience of BSL use before the birth of their deaf child. All parents enrolled in the project received a letter with two questionnaires enclosed (the British English CDI and the BSL CDI), inviting them to complete either or both, depending on what language or languages their child was acquiring. The standard CDI procedure was followed: for both checklists, parents were asked to indicate if their child comprehended and/or produced each item. As for the deaf families in the original study, parents were invited to visit the website http://www.ucl.ac.uk/HCS/research/EBSLD/ which contained video clips of signed examples of each vocabulary item.

One or both of the questionnaires was completed by parents when the child reached 24m or at the end of the project if the child was at that time less than 24m. A follow-up data collection exercise took place 12 months after the end of the project.

A number of analyses have been undertaken of the CDI data in both English and BSL for this group of deaf children of hearing parents. Their data have also been compared with hearing monolingual children acquiring English as a first language (Hamilton, Plunkett, and Schafer 2000), and with the deaf native signer group (Woolfe et al. 2010) The data presented here come from 29 deaf children aged around 24 months at the first point of data collection. Table 1 presents demographic data for these children. The sample

comprised 16 bilingual children (children for whom BSL and English CDIs were completed) and 13 monolingual children (children for whom only English CDIs were completed). Over half of the monolingual children had moderate hearing losses; over half of the bilingual children were severely to profoundly deaf; but it should be noted that hearing loss was not the sole determinant of bilingual or monolingual development, since some children in all hearing loss groups had BSL exposure.

Table 1. Deaf children of hearing parents

Groups	Age (months)	Mean age (months)	% Moderately deaf	% Moderate-severely deaf	% Severely deaf	% Profoundly deaf
Bilingual (N = 16)	18–24	23.2	29	21	43	7
Monolingual (N = 13)	14–24	20.6	53	14	29	4

Figure 4 below indicates comprehension and production scores in English (UK CDI) and BSL (BSL CDI) for the bilingual deaf children. There were no significant differences between language proficiency in children with different degrees of hearing loss, but there was a non-significant tendency for profoundly deaf children to be weakest in English and strongest in BSL.

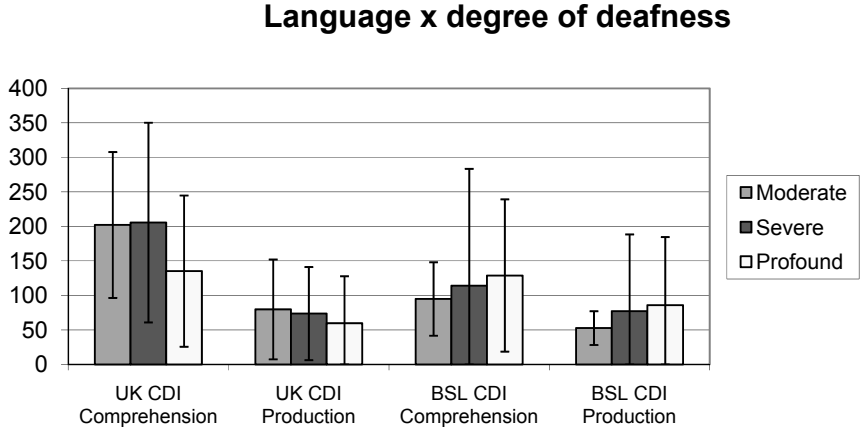


Figure 4. Vocabulary size in bilingual deaf children at 24 months.

Figure 5 below compares the children's vocabulary size in English and BSL. There were no significant differences between English and BSL skills in either comprehension or production, but the very substantial individual differences in vocabulary size between children should be noted. Interestingly, parents report greater comprehension of English than of BSL, but because data were collected without direct observation it is impossible to know whether these children really can comprehend as many spoken English words as their parents believe them to.

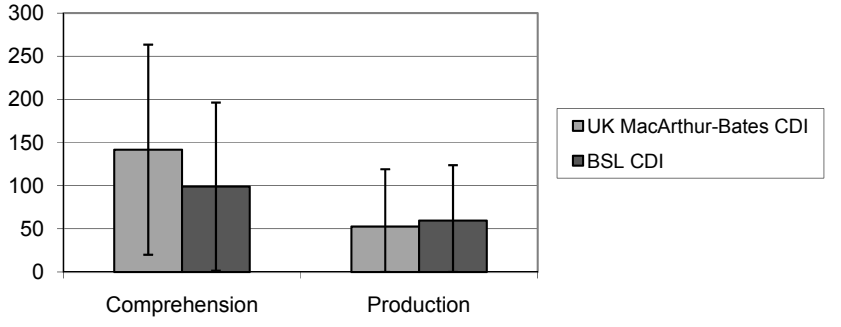


Figure 5. Comparison of English and BSL vocabulary size in deaf children with hearing parents

How do the deaf children with hearing parents compare in terms of BSL vocabulary size to deaf children with deaf parents? Figure 6 shows the number of signs comprehended and produced by the two groups of children. Perhaps not surprisingly, the native signers have significantly greater vocabularies in both comprehension and production as assessed through the BSL CDI ($p<.01$). It should be noted however, that there is extensive individual variation in both groups, so some deaf children with hearing parents are performing as well as deaf children with deaf parents

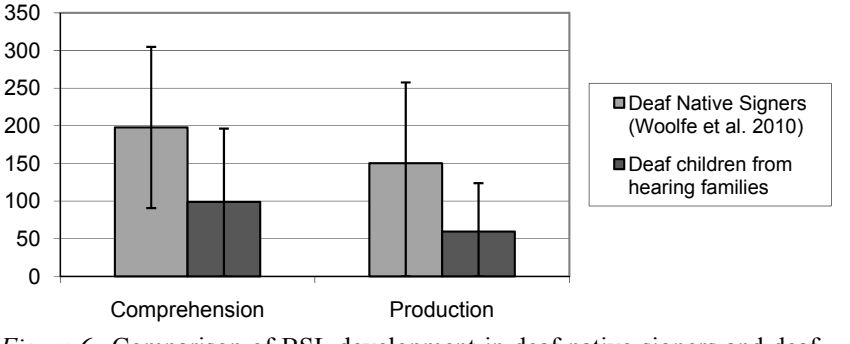
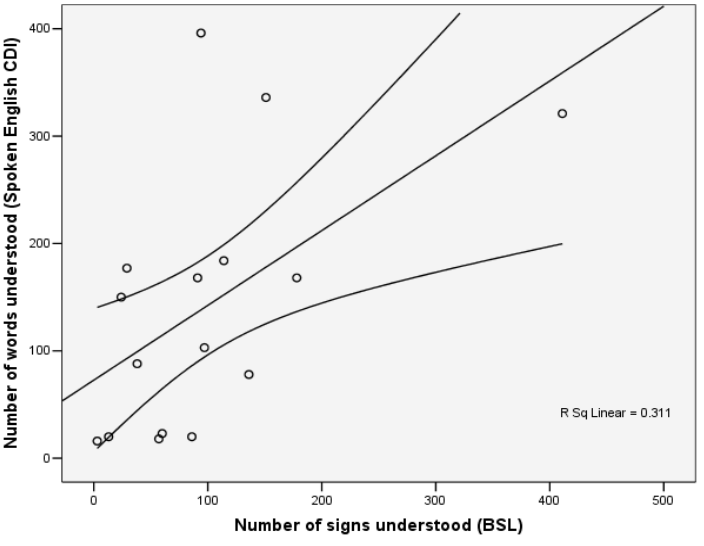


Figure 6. Comparison of BSL development in deaf native signers and deaf children from hearing families

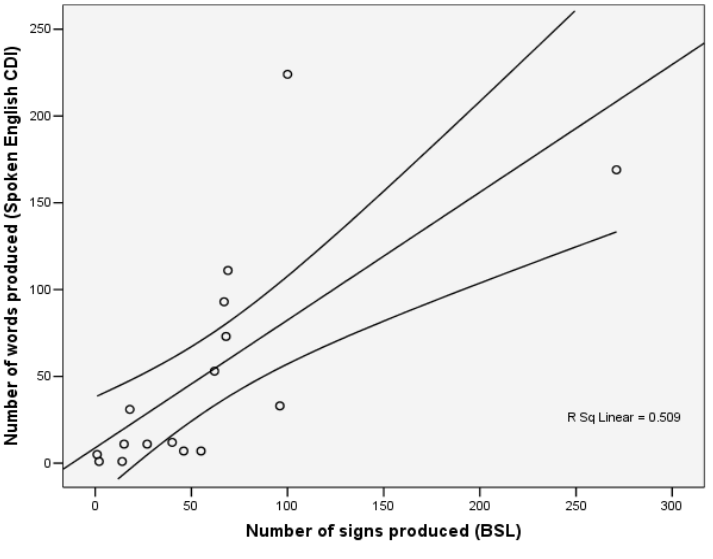
There are several possible reasons for the difference in sign vocabulary size between deaf children with hearing parents and those with deaf parents: 1) they have poorer input from their parents as hearing parents are less likely to be fluent in BSL than deaf parents; 2) they are more likely to receive spoken language input than deaf children in deaf families; 3) they are developing as bilinguals and as such are likely to display the slower language development often found in early bilingualism as compared to monolingualism. This third possibility was explored by examining the overlap in English and BSL vocabulary, comparing the vocabulary size in English of the deaf children in hearing families exposed only to English with those deaf children in hearing families who are receiving bilingual input. The monolingual children have a larger English lexicon than the bilingual children; this difference however, is not significant ($z = 0.876$, $p = 0.381$, two-tailed). The cumulative lexicon in the bilingual children – the size of vocabulary in English and BSL combined – is the same as the size of the English lexicon in the monolingual children.

In the first 50 signs + 50 words used by the children in this study, 71 different words/signs occur. In other words, the first words in English do not entirely overlap with the first signs in BSL. Some of this difference is because some lexical items are more likely to be produced in one modality than the other. For example, names of family members serve an important vocative function in spoken language, but not in sign language. There is also a tendency for items in the CDI category of "action words" to appear earlier in BSL than in English. Of the overlapping items, the bilingual children produce 29 out of these 71 items (41%) in both languages. The remaining 42 (59%) are produced only in one of the two languages. The bilingual children, like spoken language bilingual children in early stages of bilingual development, prefer to learn new words/signs (this enlarges their total vocabulary) instead of learning a translation into a second language of the words/signs that they already know. In other words, bilingual children are efficient in their language learning: they are learning different lexical items in BSL and English, rather than duplicating meanings across both languages.

Comparisons were also undertaken of the relationship between vocabulary size in the two languages for the children learning BSL and English. Figure 7 plots individual children's English and BSL comprehension (Fig. 7a) and production (7b). For both comprehension ($r = +.56$; $p < .05$) and production ($r = +.71$; $p < .01$), children with larger vocabularies in BSL had larger vocabularies in English. These data suggest that bilingual development has no adverse effect on language development and provide support for bilingual approaches to language development for deaf children in both hearing and deaf families.



7a. Size of vocabulary comprehended by individual children acquiring both BSL and English



7b. Size of vocabulary produced by individual children acquiring both BSL and English

Figure 7. Relationship between English and BSL development in deaf children with hearing parents

8. Conclusions

Studies of cross-modal bilingualism indicate that patterns of language development are generally comparable to those found in unimodal bilingualism in hearing children. However, there are significant differences between language development in deaf and hearing children, even in contexts where they are developing as native signers with deaf parents. These differences are probably related to the contexts in which young children learn to label referents and point to a need for intervention programmes for deaf children to address the task of building the attention-switching required for deaf children to learn vocabulary.

At a time when bilingualism for deaf children is under increasing challenge (cf. Knoors and Marschark, 2012), these studies provide important data confirming the benefits of bilingualism. Although the deaf children in hearing families lag behind native signers in vocabulary development, early diagnosis appears to provide hearing parents with the opportunity to learn and use signing with their deaf children, and development of BSL is strongly correlated with development of English for these bilingual children. Additionally, the use of the CDI enables hearing and deaf parents to take an active part in assessing their deaf child's communication, alongside other instruments administered by appropriately trained professionals, to provide an accurate description of a child's developmental profile. In turn, this contributes to the development and evaluation of intervention strategies designed to meet individual deaf children's needs, and to the assessment of deaf children's achievements in language rather than their deficiencies.

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