Profiling SLI in Deaf children who are sign language users.

In Multilingual Aspects of Signed Language Communication and Disorder

Editor: David Quinto-Pozos, University of Texas at Austin

Authors: Rosalind Herman, Katherine Rowley, Chloë Marshall, Kathryn Mason, Joanna Atkinson, Bencie Woll & Gary Morgan

Introduction

Specific language impairment (SLI) is traditionally defined as a deficit in language acquisition, which occurs in the absence of any cognitive, social or neurological difficulty (Leonard, 1998) in approximately 7% of children (Tomblin, Records, Bookwalter, Zhang, Smith and O'Brien, 1997). While there is some debate as to how specific to language development the problems are (e.g. Botting, 2005), it is still the case that language is relatively more impaired than other cognitive domains in children diagnosed with SLI. Deficits have been identified in syntax, morphology, phonology, the lexicon and pragmatics, and in receptive and expressive language. However currently there is widespread disagreement as to the underlying cause of SLI.

Crosslinguistic studies (reviewed by Leonard, 2009) have added to our knowledge of how SLI may present across different spoken languages. However, until recently, there has been almost no research determining whether or not SLI occurs in deaf children acquiring signed languages. One reason for this is that hearing loss is specifically excluded when diagnosing SLI, meaning that deaf children are not identified or included in studies of SLI in spoken languages. The rationale is obvious -

a hearing impairment would be expected to affect spoken language development. In contrast, there is no reason to expect a hearing impairment to impact on the acquisition of a language in the visuo-gestural modality. Furthermore, if genetic contributions to SLI hold true for all children then the incidence of SLI should be at least the same in children who are born deaf (or are the hearing offspring of deaf signing parents) as in the general population, if not higher due to neural predispositions caused by organic etiologies of deafness (e.g. conditions related to prematurity). SLI should therefore be identifiable in deaf children acquiring a signed language and if so, may provide insights moving beyond the immediate population of deaf children to theories about the nature of the deficit underlying SLI in the general population.

One problem for identification of SLI is that 90-95% of deaf children are from hearing families (Mitchell and Karchmer, 2004). Although many such children eventually become proficient users of sign language, they frequently experience delayed and impoverished sign language exposure at the crucial early stages of language development and throughout their school years, since parents and professionals are often unable to provide fluent sign language models. Thus, distinguishing the consequence of language delay from SLI is challenging.

A further complexity arises when distinguishing signs from gestures. While a linguistic description is available for BSL in its fully formed adult model (Sutton-Spence and Woll, 1999) young deaf children (especially those from hearing non-signing parents) are adept at using the visual modality creatively to communicate. For example many iconic signs for actions resemble same meaning gestures used by hearing children. However, lexical signs differ from gestures on many levels. Like words, signs have a phonological structure, and minimal pairs can be found which contrast in handshape, location, movement. For example, the signs AFTERNOON and NAME in BSL differ only in location (chin and forehead respectively). There are phonotactic constraints (for example, if both hands move, signs must have identical handshapes and symmetrical movements), and sign languages differ in their phonological inventories (for example, some handshapes which occur in BSL are not found in ASL). Although signs may enter the language via gesture, there is no distinction between iconic and non-iconic signs in phonological structure, and there is also evidence that signs and gestures dissociate in neurological conditions, with evidence of spared gesture use in adults with sign language aphasia (Marshall, Atkinson, Smulovitch, Thacker and Woll, 2004).

At the syntactic level, some linguists have suggested that sign languages incorporate both language and gesture. Signers mark person by modifying the direction the sign moves, either towards present referents or towards abstract locations in the signing space in front of the signer. Signers also describe the location and movement of persons and objects through devices termed ‘classifiers’ in sign space (see Sandler and Lillo-Martin, 2006). Liddell (2003) has argued that such visual-spatial devices in sign languages have a semi-gestural status, similar to pointing and co-speech gesture.

We did consider the possibility that a child with a language impairment in sign acquisition may be more reliant on gesture to communicate because they lacked models of sign language. To rule out this possibility, the involvement from the beginning of the research of both trained sign language linguists and native signers was crucial. In addition, in our studies we focused on children exposed to good models of BSL for several years before diagnosing SLI.

As we gain greater knowledge about native and non-native sign language acquisition, differences between sign languages, gesture, and artificial sign based communication systems, and with the availability of standardised sign language assessments (Herman, Holmes & Woll, 1999; Herman, Grove, Holmes, Morgan, Sutherland & Woll, 2004), we are in a stronger position to investigate SLI among deaf children who sign. Indeed, a small number of studies in recent years have reported SLI in deaf children who are learning BSL (Mason, Rowley, Marshall, Atkinson, Herman, Woll and Morgan 2010; Morgan, Herman & Woll, 2007) and ASL (Quinto-Pozos, Forber-Pratt and Singleton, 2011). This chapter presents a detailed overview of findings from our work documenting the sign language comprehension and production abilities of the same group of children with SLI initially identified by Mason et al. (2010) and in particular, describes how new measures were developed to further investigate and characterise SLI in sign language users.

Theories of the origins of Specific Language Impairment

There are a number of theories that attempt to explain the specific difficulty with phonology, syntax and morphology found in SLI. Each differs in their view on where the underlying deficit lies. One early framework attributed the language learning problem to a difficulty with underlying low-level auditory processing (Tallal and Piercy, 1973). Following this argument, children with SLI have difficulty processing the temporal characteristics of rapidly changing acoustic signals (at around 60 ms) for both speech and non-verbal auditory signals. This difficulty leads to the child forming unstable phonological representations of speech sounds and so interferes with the encoding and production of speech (Tallal, 2000, but see Bishop, Carlyon, Deeks and Bishop, 1999). Since this theory is specific to the auditory modality, it excludes the possibility of language impairment in a child exposed to a non-auditory language, i.e. a signed language, which in any event has slower temporal contrasts (Klima and Bellugi, 1979).

However, other processing accounts can encompass sign language impairments (e.g. Kail, 1994; Leonard, 1998). One theory focuses on a reduced ability to store information in the cognitive system that deals with phonological short term memory (Gathercole and Baddeley, 1990), with consequences for the development of speech, which depends heavily on phonological storage capacity. Given that phonological short term memory is also involved in the processing of visuo-spatial languages (Hall & Bavelier, 2010; Marshall, Mann & Morgan, 2011), it is possible that impaired phonological short term memory is involved in SLI in this modality too.

Leonard (1998) makes a distinction between perceptually salient and non-salient morphemes with children with SLI predicted to have difficulties with non-salient ones. Because this approach is cross-linguistic it can be applied to both spoken and sign languages. Saliency in spoken language is defined differently in each spoken language (e.g. Dromi, Leonard, Adam and Zadoneisky-Ehrlich, 1999). Limited processing capacity affects those morphological targets that involve several co-occurring underlying operations. According to Kail's (1994) 'Generalized Slowing Hypothesis', children with SLI process linguistic and non-linguistic input at a slower rate than typically developing children, and it is this which affects the acquisition process. There are several candidate linguistic construction types in British Sign Language (BSL) grammar, specifically complex sentences involving verb agreement and classifier constructions, non-manual scope that stretches across multiple manual signs in negations or questions and also the coherent use of discourse markers such as role shift across sentences.

In contrast to the previous framework, some researchers claim that SLI is caused by a deficit that is specific to the computation of language rules (Rice & Wexler, 1996; Ullman & Gopnik, 1999; van der Lely & Ullman, 2001), and therefore would also predict that SLI is not unique to one modality. There are a number of models within this approach and they vary as to where in the linguistic system the deficit is purported to exist. One of the most thoroughly articulated, the Computational Grammatical Complexity (CGC) Hypothesis (Marshall, 2006; van der Lely, 2005; van der Lely & Marshall, 2011), claims that the core components of grammar, that rely on the computation of rules (syntax, morphology and phonology) are most affected in SLI. The deficit in each component of grammar lies in the formation of complex structural representations. The CGC would predict SLI in signed languages, with children manifesting particular difficulties in constructions that are complex across components of grammar, such as classifiers.

In considering competing theories, most researchers acknowledge that because SLI is a heterogeneous disorder, no one account could explain all cases of language disorder. Identification of SLI in a visuomotor language presents a unique opportunity to challenge and shed further light on current theories of SLI.

Initial identification of deaf children with SLI: Developing a sample through a screening questionnaire

For several years prior to the systematic study we carried out, professionals working with deaf children reported to us that they suspected they had signing deaf children with SLI on their clinical caseloads. During our work conducting assessments of sign language development at the Compass Centre clinic at City University London, it became obvious to us that deaf children, even those with native or high quality sign language exposure early in development, could display language impairments above and beyond typical language delays. During that time we reported on a deaf child of deaf parents who had sign language SLI despite native input (Morgan, Herman and Woll, 2007). Because this child had deaf parents, his delayed language development in sign language could not be explained by late or inadequate exposure. The number of both deaf and hearing children of deaf parents who we saw in our clinic began to grow and so we planned a group study to ascertain what SLI might look like in a sign language, and to estimate the incidence of SLI in the school age deaf signing population.

Initial identification of deaf children with suspected SLI for inclusion in the study was carried out using a questionnaire sent to schools and speech and language therapists working with deaf children (Mason et al., 2010). The questionnaire contained a screening checklist of characteristics associated with SLI (see Table 1). As there was no precedent for sign language, a list of transferable characteristics of SLI were taken from studies of spoken languages (as reviewed by Leonard, 1988; Leonard, 2009).

Although SLI in spoken languages is typically characterised by grammatical deficits, it was not felt appropriate to include them in the checklist since we were concerned that teachers and speech and language therapists might not have sufficient knowledge of BSL grammar or BSL acquisition to be able to comment on this area reliably. The intention was to identify children based on teacher or clinician concern and then follow this up with assessments of performance on a range of standardised and newly developed measures, similar to approaches uses with bilingual children suspected of having language impairments in spoken languages (Paradis, Crago & Genesee 2005; Sheng, Peña, Bedore & Fiestas, 2012).

Table 1: SLI screening checklist

When compared to their signing peers of the same age, does the child:

	Yes	**No**	**Unsure**	**Comments**
Have difficulty following instructions in sign language?				
Often misunderstand what is signed?				
Have difficulty understanding what is being signed?				
Often ask for repetition?				
Often use gesture rather than signs?				
Have poor memory for language information?				
Become easily distracted in busy or noisy environments?				

Get labelled as a daydreamer or in their own world?				
Have social difficulties with friendships, being left out, withdrawing from conversation, being bullied or bullying others?				
Benefit less from hearing aids or CI than expected for their degree of hearing loss?				
Show strengths in maths ability, which is noticeably superior to language ability?				
Show strengths in visuospatial ability (e.g. sports, puzzles computer games etc), which is noticeably superior to language ability?				
Respond best to visual aids and non-language cues?				
Is the child reading at a lower level than expected, compared with their deaf peers of the same age?				
Have problems thinking of right word/sign?				
Show hesitation during signing?				
Show frustration during signing?				
Have a noticeably poor sense of rhythm?				

Further background information was collected as follows:

- Degree of hearing loss.
- Use of cochlear implant and/or hearing aids
- Age of first exposure to signing.

- Means of communication – BSL, SSE, and other spoken languages used at home and at school.
- Exposure to fluent signers at home and/or at school.
- Medical history that might exclude the child from our sample (e.g. neurological impairments or head injury)

In addition, where a child was identified as a possible SLI case, teachers and speech and language therapists were asked to report the number of deaf children attending the same school in order to gauge the proportion of children identified across the educational settings from which the SLI sample was drawn. Questionnaires were sent out to 72 mainstream schools, schools for deaf children and units for hearing impaired children around the UK and 50 completed questionnaires were returned, each identifying a potential participant. Of the 50 children referred, 1 child was excluded based on a prior diagnosis of autism and 5 others because of failure to obtain consent. A further 5 children were excluded following discussion with teachers where it emerged that only reading and not language was affected; 7 children could not be tested due to difficulties arranging visits within the time frame of the study; 1 child refused to take part, and data from 1 child could not be included due to corruption of video data. This left a final sample size of 30 children (16 male) ranging in age from 5 to15 years (mean age 11 years 5 months)

Initial identification of the sample: Use of standardised measures

The next phase of the study involved the use of standardised measures to eliminate children with low non-verbal cognitive abilities or impaired motor difficulties that might contribute to their communication difficulties, thereby excluding a possible diagnosis of language specific impairment. In addition, standardised measures of BSL development were used to confirm that the children's language development was below that expected for their age. Worldwide very few standardised measures of sign language exist. This is due to difficulties obtaining a sufficiently large sample given the size and nature of the deaf population and also because of the limited research on sign language and sign language acquisition in many countries (for a discussion of this and other issues, see Rowley, Herman, Mann and Haug, submitted). We were fortunate in having two available measures. For each, the standardisation was based on a sample comprising native signers, deaf children in hearing families on bilingual (sign language/English) educational programmes, and deaf children in hearing families on Total Communication programmes (using a range of communication approaches including sign language and English-based sign systems). Since these assessments are based in the main on children in optimal language learning environments, performance on these tests were used as an initial guideline. In subsequent testing, children's scores were compared with those of children from similar language learning backgrounds.

The measures used and the corresponding cut offs are described below. All testing was carried out in schools by a deaf native signer (second author) and a hearing researcher with a good level of fluency in BSL (fourth author).

Non-verbal cognitive abilities

Children were tested on three subtests of the British Ability Scales (BAS, Elliot, Smith and McCullough, 1996) to determine their non-verbal abilities: Matrices, Pattern Construction and Recall of Design. The BAS has been used successfully with British deaf children in recent studies (e.g. Kyle and Harris, 2006). Our criterion for inclusion in the SLI group was a combined z score of -1.2 or below. Nine of the 30 children were excluded on the basis of low non-verbal abilities.

Motor dexterity

To establish whether language production difficulties might be related to poor fine motor skills affecting hand and eye coordination, a timed standardised bead threading task (White, Fisher, Geschwind, Scharff and Holy, 2006) was used. Children were timed twice as they threaded 15 large coloured beads on to a piece of string and the faster time was recorded. This was then compared to data collected for typically developing deaf and hearing children aged 3-11 years, reported in Mann, Marshall, Mason and Morgan (2010). One child obtained a low score relative to age related norms for motor dexterity, and was subsequently excluded.

BSL development

Two standardized tests of BSL development were used: the BSL Receptive Skills Test (Herman et al., 1999) and the BSL Production Test (Herman et al., 2004).

The BSL Receptive Skills Test is a video-based test of comprehension of morphosyntax with norms derived from deaf children acquiring BSL aged 3–11 years. The child watches pre-recorded signed sentences presented individually in order of difficulty and after each has to select the picture representing the target sentence from a choice of three/four closely related alternatives. The test allows information to be derived about a child's strengths and weaknesses in different areas of BSL grammar such as negation, spatial verbs, and number agreement. The cut-off for impaired performance on this task was set at a z score of -1.3 or below based on previous research on SLI in spoken language.

The BSL Production Test uses a story recall technique to elicit a narrative. The child watches a short story acted out by two deaf children, presented on a DVD. The child is then asked to tell the story in BSL, and is video-recorded for subsequent scoring. The assessment is scored in three parts: (1) the propositional content of the story (i.e. how much information children include in their narrative); (2) structural components of the narrative, i.e. introducing the participants and the setting, reporting the key events leading up to the climax of the story, and telling how the story ends; and (3) aspects of BSL grammar, including use of spatial location, person and object classifiers and role shift (see Sutton-Spence and Woll, 1999, for details of these aspects of BSL linguistics). The test is standardized on deaf children aged 4–11 years with early BSL exposure, and percentile scores can be calculated for each of the three parts individually.

Two raters independently scored all children and subsequently compared scores. There was over 90% agreement and for the small number of disagreements, the raters arrived at a consensus after discussion. The cut-off for impaired performance on each of the three parts of this task was set at a score at or below 10th percentile.

Using the standardised language measures, 3 children were found to have language within the normal range and were therefore excluded from the sample.

Identification of a group of children with sign language SLI

A final sample of 17 children (11 male) with a mean age of 10 years achieved scores within the normal range on the non-verbal and motor dexterity measures but fell outside the expected range on the two BSL development measures. Cognitive and language profiles showing relative strengths and weaknesses for these individuals are presented in Table 2.

Table 2: Non-verbal IQ and language test scores for children with SLI

Child	BAS z-score	BSL Receptive Test z-score	BSL Production Test percentile scores		
			Narrative Content	Narrative Structure	BSL Grammar
1	-0.6	0.3*	25*	50*	10*
2	-0.6	<-2.1	<10	<10	<10
3	-0.1	1.1*	10*	10*	25*
4	-0.9	-1.5	10*	10*	10*
5	0.6	-2.1	<10	<10	<10
6	-0.7	0.1	25	10	50
7	-1.2	<-2.1	<10	10	25
8	-1.2	0.6	<10	<10	25
9	-0.6	-2.3	10	25	10
10	0.3	-1.5	<10	<10	<10

11	-0.5	<-2.1	<10	<10	<10
12	0.7	1.1	<10	10	<10
13	-1.0	-0.7	10	50	10
14	0.2	-1.0	10	10	10
15	-0.9	-0.3	10	10	10
16	-1	-0.7	10	50e	10
17	0.7	0.8	10	75	25
Range	-1.2 – 0.6	-2.1 – 1.1	<10 - 25	<10 – 50	<10 - 50

Cells shaded in grey represent performance below our pre-set cut-offs.

*Indicates children who are older than the standardisation sample. Their performance was compared to the oldest norms available, thus the magnitude of their poor performance is in fact worse than it appears here.

At this point we were able to say that our original suspicion that deaf children who use sign language could present with SLI was borne out. We were able to demonstrate that this was not an anecdotal or isolated occurrence. Our recruitment process identified 17 out of 50 children initially referred who fitted the profile of SLI. We assert that SLI is a developmental disorder not restricted to spoken languages or the auditory modality. Just as language acquisition proceeds in largely the same manner across modalities (Chamberlain, Morford & Mayberry, 2000; Morgan & Woll, 2002; Schick, Marshark & Spencer, 2006), it would appear that developmental breakdowns specific to language comprehension and production are equally possible within the visuomotor modality. An understanding of the exact ways in which SLI in sign language manifests itself will require far more specific testing and profiling. This finding has far reaching consequences for how we view language impairments. At a general level we can say that BSL does not offer a way for deaf children with SLI to compensate for their linguistic deficits. BSL offers just as much of challenge for a child with a language impairment as acquiring English or any other spoken language.

Profiling language skills and impairment: developing new tests

In the second stage of our project, the 17 children identified with SLI underwent further testing using a series of measures designed to explore their language difficulties. Our aim was to further characterise areas of sign language acquisition that were fragile or robust in the face of language impairment. There are relatively few BSL assessments in the UK, therefore in addition to one available measure, four new tests were created for this study based on previous research into SLI in hearing children:

1. Nonsense Sign Repetition Test (Mann et al., 2010; Marshall et al., 2011)
2. Semantic Fluency Task (Marshall, Rowley, Mason, Herman & Morgan, 2013)
3. Lexical Development Test
4. Sign Sentence Repetition Test (Marshall, Rowley, Mason, Herman & Morgan, submitted)
5. Narrative Details Test (Herman, Rowley, Mason & Morgan, submitted)

Where existing norms were not available for the new measures, comparison data were collected from a control group of deaf children for whom there were no concerns about language acquisition or cognitive abilities, and who were matched for age, gender, parental hearing status and quality of BSL exposure. The last factor is perhaps the most crucial and to achieve this in as many cases as possible, children came from the same schools as the SLI participants. Next we describe the characteristics of the new tests, how they were developed and, as analysis is ongoing, findings for our sample where these are available.

1. Nonsense Sign Repetition Task (NSRT)

The ability to repeat nonsense or non-words (i.e. spoken forms that follow the phonotactics of a particular language but have no meaning) is a robust measure of SLI and of general language development in spoken languages (Gathercole and Baddeley, 1990). Children learning new words use short term working memory to rehearse sounds they hear in order to locate meanings, as well as to lay down their first phonological representations in long term memory. Marshall, Denmark and Morgan (2006) created a test of non-sign repetition developed along similar lines to published and experimental spoken tests of non-word repetition (e.g. Gathercole and Baddeley, 1990). The task consists of 40 non-signs that are plausible BSL signs, in that they do not violate phonological rules, but they are made up and do not exist in the in BSL lexicon (see Marshall et al., 2006; Mann et al., 2010 for more details). The nonsense signs within the test are graded for complexity linked to markedness of handshape and movement. In the test, signs are presented one by one on a computer screen and the child is required to copy them as accurately as possible. After every 10 signs, there is a brief cartoon break before the test continues (i.e. a total of 3 breaks). Responses are filmed and are subsequently coded according to accuracy of handshape, internal hand movement and path of movement.

Age norms are available based on 91 typically developing deaf children aged 3-11 years (Mann et al., 2010) and a significant correlation has been found between the ability to repeat non-signs and comprehension of BSL grammar (ibid).

Inter-rater reliability was established at 96.6% for overall score. The cut-off for impaired performance on this task is set at a z score of -1.3 or below. Of the 17 children identified initially as having SLI, 5 performed at or below this level. Thus it appears that repeating non-signs is a weak skill in only a subset of our sample of sign language users as opposed to being a defining feature as has been reported for spoken language SLI. It is an empirical question whether with more complex non-signs we would see a difference between SLI and controls (Marshall, Mann and Morgan, 2011). We present some possible explanations for this somewhat unexpected finding in the following general discussion section.

2. Semantic Fluency Task

In a semantic fluency task, participants are asked to produce as many words as they can from a specific semantic category, such as ‘animals’ or ‘food’, within a limited time period. As the child produces each item, the assumption is that other semantically related items will be activated. The order of item generation is an indication of the proximity of items to each other in the lexicon. Although the time limit does not allow the child to produce an exhaustive list of the words they know, the test does reveal the items that come most readily to mind. In this way, the test gives an indication of semantic organisation and the child’s ability to use different language processing strategies to generate items within the specified category.

Only a few research studies have used a semantic fluency task with hearing children who have SLI. Henry, Messer and Nash (2012) reported scores for English-speaking children with SLI below those of their chronological age-matched controls on both verbal and non-verbal fluency tasks. In a slightly different test probing lexical organisation, children with SLI performed more poorly than typically developing peers matched for expressive vocabulary ability (Sheng and McGregor, 2010). However, the SLI group as a whole was characterised by variable performance, and some children performed age-appropriately.

We decided to use a semantic fluency task to investigate lexical organisation in our SLI participants in comparison to a control group. Two semantic categories were used: "food" and "animals". Children were instructed to name animal/food items in BSL as quickly as possible and timed for one minute. "Colours" was used as a practice category. Responses were video-recorded and subsequently glossed into English for counting and coding. Inter-rater reliability was established at 90%.

Our findings indicated no differences between the SLI and control groups in terms of overall numbers or types of responses (Marshall et al., 2013). However, subtle differences were observed: the SLI group produced fewer signs in the first 15 seconds than the control participants and there was also some evidence of word-finding difficulty in the SLI group, suggesting that their access to signs was poorer (ibid).

3. Lexical Development Test

Our semantic fluency findings support findings based on hearing children that those with SLI may have the slower lexical access (see Messer and Dockrell, 2006 for a review). We included a further measure of lexical knowledge in our test battery in the form of a picture naming task.

Initially, the adaptation of existing English vocabulary tests such as the British Picture Vocabulary Scale (Dunn, Dunn, Whetton and Burley, 1997) was considered. However, problems were presented by the iconicity of some signs and difficulties with the exact translation of some items. An iconic sign is one with a visual motivation that links the meaning of the referent to its form, e.g. WORLD in BSL, where the sign is represented by two hands outlining a large sphere. Indeed, iconic signs such as TOOTHBRUSH in BSL are readily recognised by non-signers since this sign depicts the action of brushing one's teeth (Sutton-Spence and Woll, 1999). Body part vocabulary in BSL often just requires pointing to specific parts of the body, e.g. NOSE is shown by pointing to the nose (ibid.) These and other highly iconic signs are likely to be less challenging to acquire in a sign language than the equivalent lexical items would be in English.

As well as these issues, there are also words in English vocabulary tests that do not have an exact equivalent sign in BSL: either the same sign can be used for two different meanings or the same English word can be represented by two different signs. For these reasons it was decided to develop a measure specifically for BSL.

A key challenge in developing a lexical test in BSL is the lack of information about lexical development among children who are acquiring BSL normally. Fortunately, a norming study (Vinson, Cormier, Denmark, Schembri, and Vigliocco, 2008) was being conducted with adult signers at the time with the specific purpose of collecting normative data about BSL for use in language processing studies. The norming study looked at age of acquisition of vocabulary by asking deaf adult participants to recall when they learned particular signs. Although this is appears to be relatively subjective, the data does correlate with data collected on native child signers' lexical acquisition (Thompson, Vinson, Woll and Vigliocco, 2012) using the BSL version of the MacArthur Communicative Development Inventory (Woolfe, Herman, Roy and Woll, 2009). In addition, the Vinson et al. (2008) norming study collected data about the familiarity of signs by asking adult participants to score how often the sign was seen in everyday conversation using a Likert scale of 1-7.

Picturable items from the age of acquisition and familiarity data sets were used in the creation of the BSL vocabulary development measure. Items identified as too iconic, easily gestured or with high regional variation were excluded. The aim was to create a test that ranged from easy to difficult signs. The signs that were rated as being highly familiar and to have been acquired at a young age by Vinson et al. (2008) were included as easier vocabulary items and conversely signs that had a low familiarity rating and were acquired at a later age comprised the more difficult items on the vocabulary development measure. In addition, in order to arrive at an ecologically valid test, staff at two deaf schools were asked to suggest vocabulary that was used within the classroom environment and these items were also included.

A pilot version of the test was developed using a picture naming procedure and stimuli were presented to children on a laptop. As there were some items that were not possible to depict (abstract items such as MAYBE, NEVER), an extension to the vocabulary test was developed in the form of a definitions test. For this part of the assessment, children watched a video of 22 signs presented individually by deaf adults and were asked to explain the meaning of each sign and the context in which it would be used.

Pilot versions of the vocabulary and definitions tests were trialled on 6 deaf adults and 6 deaf children who used BSL to eliminate problematic items. Changes were made to pictures from the vocabulary test which did not effectively elicit the target response. Items from the definitions test were also removed where none of the pilot participants could give an appropriate definition or where the sign had more than one meaning.

The final version of the vocabulary test included 84 pictures to be named and 50 signs which had to be defined. A score of 1 point was given for an appropriate sign (vocabulary test) or description of the meaning of each sign (definitions test). An additional point was awarded for a correct example of the context in which the sign would be used (definitions test). Criteria for what constituted a correct response were compiled. For both parts of the assessments, instructions on how to do the test were pre-recorded by a deaf native signer so all children saw the same set of instructions. Responses were filmed and subsequently scored. Inter-rater reliability was established at 95.6% for this measure. The data analysis for the vocabulary test is still ongoing.

4. Sign Sentence Repetition Test

Sentence repetition is a component of many different spoken language tests devised to diagnose SLI (Gardner, Froud, McClelland & van der Lely, 2006; Seeff-Gabriel, Chiat & Roy, 2008; Semel, Wiig & Secord, 2003). The task requires the child to repeat back a recorded or spoken sentence as accurately as they can. This type of test has been used across a range of spoken languages, such as Italian (Volterra, Caselli, Capirci, Tonucci and Vicari, 2003), German (Snow and Höfnagel-Höhle, 1978), French (Maillart and Parisse, 2008), Cantonese, (Stokes and Fletcher, 2003) and Dutch (Rispens, 2004). A sign repetition test has also developed been for adult signers of American Sign Language (Hauser, Paludnevičiene, Supalla and Bavelier, 2008). Hauser et al. have shown this test to be sensitive to language proficiency with respect to language acquisition experience, with native signers performing more accurately than non-natives. However, the ASL test has not to date been used to differentiate typically developing from language-impaired signers.

The child BSL sentence repetition test required children to repeat 20 signed sentences (including 3 practice items). All sentences were developed and recorded by a native BSL signer. The sentences were presented in order of complexity, as defined by the number of signs and clauses in the sentence. A glossed example from the start of the test is BOY WAIT (the boy is waiting), and one of the last and most demanding sentences is GIRL WALK SUDDENLY RAIN AWFUL WET (the girl was walking, when suddenly there was a downpour and she became awfully wet).

Many standardised sentence repetition tests are scored simply as 'correct' or 'incorrect' regardless of the nature of the error. In order to make more detailed comparisons between the SLI and control groups, we devised an in-depth scoring system that allowed investigation of error patterns. Participants' repetition accuracy was scored for: 1) exact replication of the lexical items used by the model in the target sentence; 2) accurate reproduction of the overall meaning of the sentence even where different lexical items were used; 3) accurate and consistent use of spatial placement;

4) accurate reproduction of facial expression (for those sentences to which it applied); 5) order of items in the sentence, and 6) verbatim repetition, i.e. if the child reproduced the sentence exactly as it was signed, they would obtain an overall score of 5 or 6 (some items did not include facial expression or placement). If the child did not reproduce the sentence accurately, they would lose points where they made errors, e.g. wrong lexical item, altering the overall meaning, inaccurate placement, inaccurate facial expression and/or using a different sign order. Inter-rater reliability using this method of scoring was 96.4%.

The test is presented on a laptop. First, participants view instructions in BSL presented by a native signer directing them to repeat each sentence exactly immediately after the screen fades to black. Three practice sentences are shown and participants are encouraged to repeat each one as accurately as possible. If the child does not copy the practice sentence exactly, it is demonstrated by the tester. Once it is established that the child understands what is required, the 17 test sentences follow. Each sentence is viewed once. The child's responses are video recorded for later scoring and analysis. Participant performance in comparison to our control group is reported in Marshall et al. (submitted).

5. Narrative Details Test

Narrative skills develop over a protracted period, beginning with early word combinations and reaching peak complexity at around the ages of 10-12 years (Berman and Slobin, 1994). Development involves coordinating cohesion at the local (sentence) level, through grammatical morphology and reference and at the global (hierarchical) level with connectives, anaphora and pragmatics.

Because of the challenges posed to young children in constructing a coherent narrative, narrative tasks have been used to investigate different aspects of language development and also patterns of SLI in spoken languages (e.g. Botting, 2002; Wetherell, Botting & Conti-Ramsden, 2007). English speaking children and adolescents with SLI have been reported to produce narratives similar to those of younger typically developing children (Merritt & Liles 1987; Wetherell et al., 2007) with delays reported at the local and global levels. In a study of Italian-speaking children, Marini, Tavano and Fabbro (2008) found that those with SLI produced narratives with less developed sentence structure and use of verb morphology and also displayed problems with anaphoric use of pronouns.

Rathmann, Mann and Morgan (2007) provide a useful review of the structure of signed narratives and the process of acquisition based on the available research. The main linguistic devices in BSL grammar important for narrative are spatial verbs, morphological markers of verb agreement, aspect, manner, classifiers and role shift or referential shift (Sutton-Spence and Woll, 1999). Although there is some research on how these devices develop at sentence level (e.g. for basic verb agreement, see Meier, 2002; Morgan, Herman & Woll, 2002; Morgan, Barrière & Woll, 2006), information is generally lacking on how they are used by developing children within a narrative context, other than for role shift (see Morgan & Woll, 2003 for BSL and Loew, 1984 for ASL).

There is no previous research on narrative skills in deaf signers with SLI. Because narrative provides a rich source of data on how language is used in a real life context compared with a more formal testing context, it was decided to subject the narrative samples collected for the BSL Production Test (Herman et al., 2004) to a more detailed analysis in addition to the analysis that is part of the assessment protocol. Children's stories were analysed for semantic content, narrative structure, number of clauses, number of anaphoric references and the following aspects of BSL grammar: spatial verbs, e.g. PERSON-GO-TABLE; agreement verbs, e.g. SHE-GIVES-HIM; handling classifiers, e.g. TAKE-SMALL-ROUND-OBJECT; manner inflections, e.g. PUT-REPEATEDLY; role shift.

Data collected from the SLI group were compared to equivalent narrative samples collected from a control group. Findings are reported in Herman et al. (submitted).

General discussion

The work reported in this chapter demonstrates that it is possible to identify children with specific language impairment in the deaf population where language delay is often the norm. Teachers of the deaf and specialist speech and language therapists were able to identify children with suspected sign language impairments using our screening checklist (see also Quinto Pozos et al., 2011 for ASL). Following initial teacher or clinician concerns, children were followed up using standardised measures of nonverbal abilities, motor skills and sign language proficiency and a set of more detailed language tests were developed. A distinct and measurable profile of severe language difficulties on the standardised sign language tests in contrast with good non-verbal and fine motor abilities allows us to be confident about identifying SLI in deaf children. Further analysis of findings from our new measures will allow us to say more about areas of sign language that are particularly vulnerable. This approach can lead to a confirmed diagnosis and a profile of relative strengths and weaknesses, with positive implications for targeting language interventions.

Seventeen of the 30 children tested in the first phase of our research were subsequently identified as having SLI; in many of the excluded cases, other needs were apparent such as reading, motor or learning difficulties. The tendency of teachers and clinicians to over-report the number of children in their class whom they consider to have language-learning difficulties is not surprising given the high level of comorbidity and the profile of delayed sign language acquisition that so many deaf children experience. Based on our findings to date, the SLI screening questionnaire may be a useful tool for teachers of the deaf and speech and language therapists to use to screen deaf children in their care. Further analysis of the prevalence of the specific SLI characteristics listed in the questionnaire among our final sample and the addition of further characteristics based on findings from our new tests is needed in order to finalise this.

We estimated a prevalence rate for SLI in BSL of 6.4% (Mason et al., 2010) based on the 13 children we had identified with SLI at that stage out of a total of 203 deaf children attending the schools who responded to our initial questionnaire. Despite this finding being based on a relatively small sample compared to studies of hearing children, the prevalence is similar to that reported by Tomblin et al. (1997) for the hearing population. Although epidemiological studies are needed, at a theoretical level, this comparability allows us to speculate that similar genetic and neurobiological causes may underlie SLI in both auditory and visual-manual language modalities (although as mentioned above, other causes can also be assumed), and this warrants further investigation.

It is important to stress that the systematic evaluation of language disorder in deaf children in our work was made possible by two main factors: 1) A team of native Deaf and hearing sign bilingual researchers, working closely with psychologists, linguists and clinicians with skills in sign language linguistics, language and cognitive assessments and knowledge of language acquisition in deaf and hearing populations. 2) A set of language assessments with norms or control group scores for age matched children. We were fortunate that two standardised language assessments already existed for BSL when we started this project. Such instruments do not exist for many other signed languages. Even so, we are still a long way from having the range of language assessments for BSL employed for SLI research in spoken languages and further work is needed. Test development across a wide range of signed languages is a crucial pre-requisite to cross-linguistic diagnosis and profiling of SLI in deaf sign language users around the world. Further work in this area will allow new theoretical advances in our understanding of SLI generally, and the development of therapeutic interventions in sign language.

The picture that emerges from our findings to date is that SLI in a signed language looks very similar to SLI in spoken languages, in that both comprehension and expressive language may be affected, and in some cases, both are compromised. Analysis of data collected from the new measures indicates varying difficulties with sentence and discourse level language, including morphology and co-reference (Marshall et al., submitted; Herman et al., submitted). Importantly, our preliminary observations suggest that most children with sign language SLI do not sign in a deviant or unusual way but instead, features of their language performance appear to be characteristic of children at a significantly younger age. Further analysis is needed to confirm this and to describe individual cases which eschew this pattern.

Perhaps contrary to popular belief, our research suggests that there is nothing inherently 'easy' about signed language acquisition and that it is not the case that signing protects deaf signing children from developing language impairment. Language displays complexities and difficulties in whichever modality it is crafted. This has important implications for our understanding of the underlying causes of SLI. A deficit in rapid auditory processing, of the type proposed by Tallal (Tallal & Piercy, 1973; Tallal, 2000), cannot account for SLI in a signed language. Because the visual system does not process change as rapidly as the auditory system, sign languages do not make use of rapidly changing signals equivalent to the formant transitions of speech in the auditory system (the locus of the proposed impairment in spoken languages, according to Tallal's theory). A deficit in the perception of rapid temporal transitions is therefore not relevant to a visual language which has slower temporal contrasts (Klima and Bellugi, 1979). Some hearing children with SLI acquiring spoken language might plausibly have a rapid auditory processing deficit, but the fact that this cannot explain sign impairment suggests that they are other pathways to impairment in both spoken and signed languages.

At first glance, the performance of our group of SLI children on the non-sign repetition task, on which the majority performed comparably to typically developing deaf controls, might appear to challenge the hypothesis that SLI is caused by a phonological short term memory deficit (Gathercole and Baddeley, 1990). However, as we have argued elsewhere (Marshall et al., 2011), the repetition of non-signs appears to be a difficult task even for typically developing deaf children. Our current explanation is that the phonological content of a non-sign is less predictable than the phonological content of a spoken non-word, and therefore its retention in short term memory is more costly. The basic idea here is that signs in BSL may have less limiting constraints than spoken language words in how their sub-lexical components can be combined. In a sense there are more degrees of freedom for how sub-components combine in a sign than a word and this makes processing demands higher (Marshall et al., 2011). Because performance of the norming sample on this task was low and had such a large standard deviation, children had to perform particularly poorly in order to fall more than -1.3 SD below the mean for their age group (see Mann et al., 2010). However, the fact that five children did so poorly suggests that weakness in phonological short term memory may be part of the profile for at least some deaf children with SLI. This pattern of findings supports the notion that there may be subgroups of SLI with different aetiologies in both hearing and deaf populations.

We are not yet able, on the basis of data collected, to test the other theories discussed previously, namely the generalised slowing hypothesis (Kail, 1994), and one of the linguistic hypotheses of SLI such as the computational grammatical complexity hypothesis (van der Lely and Marshall, 2011). This would make for a fruitful line of future enquiry. We can say that any universal explanations of SLI will need to account not only for cross-linguistic data, but also cross-modality data of the type we have presented here. We have not explored this in our work up to now, but there are important implications of diagnoses of sign SLI for deaf children's acquisition of spoken or written English. It is generally the case that SLI affects both languages in hearing bilingual children (e.g. Gutiérrez-Clellen, Simon-Cereijido & Wagner, 2008; Paradis, 2010) and the same would be expected for a deaf child. Indeed, a hearing child who was a native signer found to have SLI in English also had difficulties with language development in BSL (Morgan, 2005). It should therefore be expected that a deaf child with SLI in sign language might experience additional difficulties with the acquisition of English.

Further issues following a diagnosis of SLI concern the long-term outlook and implications for intervention. Many hearing children with language impairments have difficulties that persist over time (Conti-Ramsden, Botting, Simkin and Knox, 2001) and although there is not yet any longitudinal research to confirm this, the same is likely to be the case for deaf children with SLI.

It is often suggested that a deaf child who does not sign well would be best placed in a signing environment where they would have more opportunities to see sign language, rather than being placed in a school where only oral communication is used. However, if the child has SLI, they will also require specialist sign language therapy, since clinical experience and research based on hearing children with SLI suggests that language enrichment interventions alone are insufficient. Specific interventions for hearing children with SLI in spoken languages have been developed to target a range of areas: vocabulary (e.g. Hyde Wright, 1993; McGregor & Leonard, 1989; Parsons, Law & Gascoigne, 2005); morphology (Leonard, 1975; Ebbels, 2007); pronouns (Courtwright and Courtwright, 1976), various syntactic structures such as questions (e.g. Ebbels, 2007; Ebbels & van der Lely, 2001; Wilcox & Leonard, 1978) and narrative (Swanson, Fey, Mills and Hood, 2005), among others. The development of guidelines for specific interventions in a sign language remain to be addressed in future work.

A first step in this direction for deaf children with SLI might use existing therapies as possible templates. However, for staff working with deaf children, there is also the issue of the knowledge and skills needed to deliver language interventions in a sign language. Although interventionists such as speech and language therapists are often native speakers of the languages they are working with and have extensive knowledge and experience of spoken language development and interventions, many lack fluency in sign language, knowledge of sign linguistics and sign language acquisition. In contrast, Deaf staff working in educational contexts generally have high levels of sign language fluency but require training in developing, delivering and evaluating language interventions. One way to address this mismatch in key skills is for staff to work collaboratively in order to achieve the necessary skill mix. This is the principle behind a training course that has been established at City University London for Deaf and hearing professionals learning to use the BSL Production Test (Herman et al., 2004). Professionals attend a four day training course in pairs with colleagues from their service. Training is delivered by Deaf and hearing researchers and practitioners, often directly in BSL. The course seeks to develop an understanding of sign linguistics and sign language acquisition, alongside principles of assessment and practice in using the BSL Production Test. On the final training day, an afternoon is set aside to discuss approaches to intervention. Participants work in small groups sharing their ideas, experience, knowledge of resources, etc., based on the children with whom they have worked. Feedback from several cohorts of course participants confirms the value of working in teams and sharing working practices in this way, the relevance of the course content, and the feelings of empowerment following such training.

Finally, there is a need to develop centres of excellence where a diagnosis of SLI can be confirmed using a set of instruments designed for this purpose. One such centre is the Sign Language Assessment Clinic at the Compass Centre, City University London. This clinic has an open referral system, allowing families and professionals throughout the UK to refer deaf individuals for whom there are concerns about their communication in sign language. Deaf and hearing staff carry out individualised assessments, using available standardised and experimental measures along with collection of background information and observations of the person's communication in different contexts and with different people. Based on the assessment, a report is written that profiles the individual's strengths and difficulties and recommendations are made for local services which include the optimal communication environment, suggested intervention targets and appropriate intervention strategies.

Practical implications/recommendations

Our preliminary work has confirmed the existence of SLI among deaf children. This has theoretical consequences and also practical implications for professionals who work with deaf children:

- Professionals should be aware that a proportion of deaf children may have SLI.
- Our screening checklist may, with further refinement, prove to be a useful preliminary tool for initial identification of deaf signing children with SLI.

- Further language assessments are needed for deaf children who sign in order to confirm a diagnosis of SLI.
- There is a need for centres of excellence to be set up which offer specialist assessments for deaf children who sign and advice for professionals working with such children.

Acknowledgements

The research was funded by the Economic and Social Research Council of Great Britain (Grant 620-28-600 Deafness, Cognition and Language Research Centre) and a Leverhulme Trust Early Career Fellowship to Chloë Marshall.

We would like to express our thanks to the children, their families and staff in participating schools, without whom this research would not have been possible. We would also like to thank a group of specialist speech and language therapists working in bilingualism and deafness in the UK (SALTIBAD), and in particular Jane Thomas, Katie Martin and Katy Persse, for their contributions at various stages of the study.

References

Berman, R. and Slobin, D. I. (eds.) (1994). *Relating events in narrative: a crosslinguistic development study*. Mahwah, NJ: Lawrence Erlbaum.

Bishop, D.V.M. Carlyon R.P., Deeks, J.M. and Bishop S.J. (1999). Auditory temporal processing impairment: Neither necessary nor sufficient for causing language impairment in children. *Journal of Speech, Language and Hearing Research*, 42: 1295-1310.

Botting, N. (2002) Narrative as a tool for the assessment of linguistic and pragmatic impairments. *Child Language Teaching and Therapy*, 18(1), 1-22.

Botting, N. (2005) Non-verbal cognitive development and language impairment. *Journal of Child Psychology and Psychiatry*, 46, 317-326.

Chamberlain, C., Morford, J. P., and Mayberry, R. I. (2000) *Language acquisition by eye.* Mahwah, NJ: Erlbaum.

Conti-Ramsden, G., Botting, N., Simkin, Z. and Knox, E. (2001) Follow-up of children attending infant language units: outcomes at 11 years of age. *International Journal of Language & Communication Disorders,* 36, 207-219.

Courtright, J. A. and Courtright, I. C. (1976) Imitative modelling as a theoretical base for instructing language- disordered children. *Journal of Speech and Hearing Research,* 19, 655–663.

Dromi, E., Leonard, L.B., Adam, G. and Zadoneisky-Ehrlich, S. (1999) Verb agreement morphology in Hebrew speaking children with specific language impairment. *Journal of Speech, Language and Hearing Research*, 42 (6), 1414-1431.

Dunn, L. M., Dunn, D. M., Whetton, C., and Burley, J. (1997) *The British Picture Vocabulary Scale*. 2nd ed. Windsor: NFER-Nelson.

Ebbels, S. H. (2007) Teaching grammar to school-aged children with specific language impairment using Shape Coding. *Child Language Teaching and Therapy,* 23(1), 67–93.

Ebbels, S. H. and van der Lely, H. (2001) Meta-Syntactic Therapy Using Visual Coding for Children with Severe Persistent SLI. *International Journal of Language & Communication Disorders*, 36(1), 345–350.

Elliot, C. D., Smith, P. and McCulloch, K. (1996) *The British Ability Scales*. Windsor: NFER-Nelson.

Gardner, H., Froud, K., McClelland, A., and van der Lely, H. K. J. (2006) Development of the Grammar and Phonology Screening, GAPS, test to assess key markers of specific language and literacy difficulties in young children. *International Journal of Language and Communication Disorders*, 41, 513–540.

Gathercole, S. E. and Baddeley, A. D. (1990). Phonological memory deficits in language disordered children: is there a causal connection? *Journal of Memory and Language,* 29, 336 – 360.

Gutiérrez-Clellen, V. F., Simon-Cereijido, G., and Wagner, C. (2008) Bilingual children with language impairment: A comparison with monolinguals and second language learners. *Applied Psycholinguistics*, *29*, 3–19.

Hall, M. and Bavelier, D. (2010) Working memory, deafness and sign language in: Marschark, M. & Spencer, P. E. (eds.) *The Handbook of Deaf Studies, Language and Education*. Vol 2. Oxford: Oxford University Press, 458–472.

Hauser, P. C., Paludnevičiene, R., Supalla, T. and Bavelier, D. (2008) American Sign Language-Sentence Reproduction Test: Development and implications. In R. M. de Quadros (Ed.) *Sign Language: Spinning and unraveling the past, present and future* (pp. 160-172). Petropolis, Brazil: Editora Arara Azul.

Henry, L.A., Messer, D.J. and Nash, G. (2012) Executive functioning in children with specific language impairment*. Journal of Child Psychology and Psychiatry*. 53, 37-45.

Herman, R., Grove, N., Holmes, S., Morgan, G., Sutherland, H., and Woll, B. (2004) *Assessing British Sign Language Development: Production Test (Narrative Skills).* London: City University.

Herman, R., Holmes, S., and Woll, B. (1999) *Assessing British Sign Language Development: Receptive Skills Test.* Gloucestershire: Forest Bookshop.

Hyde Wright, S. (1993). Teaching word-finding strategies to severely language-impaired children. *International Journal of Language & Communication Disorders,* 28(2), 165–175.

Kail, R. (1994) A Method for Studying the Generalized Slowing Hypothesis of Children with Specific Language Impairment. *Journal of Speech and Hearing Research,* 37, 418-421.

Klima, E.S. and Bellugi, U. (1979) *The signs of language.* Mass: Harvard University Press.

Kyle, F. E. and Harris, M. (2006) Concurrent correlates and predictors of reading and spelling in deaf and hearing school children. *Journal of Deaf Studies & Deaf Education*, 11, 273-288

Leonard, L. B. (1975) Developmental considerations in the management of language disabled children*. Journal of Learning Disabilities*, 8, 44–49.

Leonard, L.B. (1998) *Children with Specific Language Impairment*. Cambridge, MA: MIT Press.

Leonard, L. (2009) Cross-linguistic studies of child language disorders. In R. Schwartz (Ed.), *Handbook of child language disorders* (pp. 308-324). New York, NY: Psychology Press.

S. Liddell (2003) *Grammar, gestures, and meaning in American Sign Language.* Cambridge: Cambridge University Press.

Loew, R. (1984) *Learning American Sign Language as a First Language: Roles and Reference.* Unpublished doctoral dissertation, University of Minnesota.

Maillart, C. and Parisse, C. (2008) Dislocations as a developmental marker in French language: A preliminary study. *Clinical Linguistics & Phonetics*, 22(4-5), 255-258.

Mann, W. and Marshall, C. R. (2010) Building an Assessment Use Argument for Sign Language: the BSL Nonsense Sign Repetition Test. *International Journal of Bilingual Education and Bilingualism,* 13, 243-258.

Mann, W., Marshall, C. R., Mason, K. and Morgan, G. (2010) The Acquisition of sign language: the interplay between phonology and phonetics. *Language and Learning Development*, 6, 60-86.

Marini, A., Tavano, A. and Fabbro, F. (2008) Assessment of linguistic abilities in Italian children with Specific Language Impairment. *Neuropsychologia*, 46(11), 2816-2823.

Marshall, C. R. (2006) The morpho-phonological interface in Specific Language Impairment. *Language Acquisition*, 13, 373-375. (Thesis synopsis).

Marshall, C.R., Denmark, T. and Morgan, G. (2006) Investigating the underlying causes of SLI: A non-sign repetition test in British Sign Language. *Advances in Speech–Language Pathology*, 8(4), 347 – 355.

Marshall, C. R., Mann, W. and Morgan, G. (2011) Short term memory in signed languages: Not just a disadvantage for serial recall. *Frontiers in Psychology*, 2:102. doi: 10.3389/ fpsyg.2011.00102.

Marshall, C. R., Rowley, K., Mason, K., Herman, R., & Morgan, G. (2013) Lexical organisation in deaf children who use British Sign Language: Evidence from a semantic fluency task. *Journal of Child Language* 40, 193-220.

Marshall, J., Atkinson, J., Smulovitch, E., Thacker, A. and Woll, B. (2004) Aphasia in a user of British Sign Language: Dissociation between Sign and Gesture. *Cognitive Neuropsychology*, 21 (5), 537 - 554.

Mason, K., Rowley, K., Marshall, C. R., Atkinson, J. R., Herman, R., Woll, B. and Morgan, G. (2010). Identifying SLI in Deaf children acquiring British Sign Language: Implications for theory and practice. *British Journal of Developmental Psychology*, 28, 33-49.

McGregor, K. K., and Leonard, L. B. (1989) Facilitating word-finding skills of language-impaired children. *Journal of Speech and Hearing Disorders*, 54, 141–147.

Meier, R. P., Cormier, K. and Quinto-Pozos, D. (Eds.) (2002) *Modality and Structure in Signed and Spoken Languages.* Cambridge: Cambridge University Press.

Merritt, D. D. and Liles, B. Z. (1987) Story Grammar Ability in Children with and without Language Disorder: Story Generation, Story Retelling, and Story Comprehension. *Journal of Speech and Hearing Research*, 30, 539-552.

Messer, D. and Dockrell, J. E. (2006) Children's Naming and Word-Finding Difficulties: Descriptions and Explanations. *Journal of Speech, Language and Hearing Research*, 49, 309-324.

Mitchell, R. E. and Karchmer, M. A. (2004) When Parents Are Deaf Versus Hard of Hearing: Patterns of Sign Use and School Placement of Deaf and Hard-of-Hearing Children. *Journal of Deaf Studies & Deaf Education*, 9(2), 133-152.

Morgan, G. (2005). Biology and Behaviour: Insights from the acquisition of sign language. In A. Cutler (ed). Twenty-First Century Psycholinguistics: Four Cornerstones. Lawrence Erlbaum Press.

Morgan, G., Barriere, I. and Woll, B. (2006). The influence of typology and modality in the acquisition of verb agreement in British Sign Language. *First Language*, 26(1), 19-43.

Morgan, G., Herman, R. and Woll, B. (2002) The development of complex verb constructions in BSL. *Journal of Child Language*, 29(3), 655-675.

Morgan, G., Herman, R. and Woll, B. (2007) Language impairments in Sign Language: Breakthroughs and Puzzles. *International Journal for Language and Communication Disorders,* 42, 97-105.

Morgan, G., and Woll, B. (Eds.) (2002) *Directions in sign language acquisition*. Amsterdam: John Benjamins.

Morgan, G. and Woll, B. (2003) The development of reference switching encoded through body classifiers in BSL. In K, Emmorey (ed.) *Perspectives on classifier constructions in sign languages*. Mahwah, NJ: Lawrence Erlbaum Press pp 297-310.

Paradis, J. (2010) The interface between bilingual development and specific language impairment. *Applied Psycholinguistics*, 31, 227–252.

Paradis, J., Crago, M. and Genesee, F. (2005) Domain-general versus domain-specific accounts of Specific Language Impairment: Evidence from bilingual children' acquisition of object pronouns. Language Acquisition, 13(1), 33-62.

Parsons, S., Law, J., and Gascoigne, M. (2005) Teaching receptive vocabulary to children with specific language impairment: A curriculum-based approach. *Child Language Teaching and Therapy*, 21(1), 39–59.

Quinto-Pozos, D., Forber-Pratt, A., and Singleton, J.L. (2011) Do developmental communication disorders exist in the signed modality? Perspectives from professionals. *Language, Speech and Hearing Services in Schools*, 42, 423-443.

Rathmann, C., Mann, W. and Morgan, G. (2007) Narrative Structure and Narrative Development in Deaf Children. *Deafness and Education International*, 9(4), 187-196.

Rice, M. and Wexler, K. (1996) Toward tense as a clinical marker of specific language impairment in English-speaking children. *Journal of Speech and Hearing Research*, 39, 1239-1257.

Rispens, J. E. (2004) *Syntactic and phonological processing in developmental dyslexia.* Groningen: Grodil.

Sandler, W. and Lillo-Martin, D. (2006) *Sign Language and Linguistic Universals.* Cambridge: Cambridge University Press.

Schick, B., Marschark, M., and Spencer, P. E. (Eds.) (2006) *Advances in the sign language development of deaf children.* New York: Oxford University Press.

Seeff-Gabriel, B., Chiat, S. and Roy, P. (2008) *Early Repetition Battery.* London: Pearson Education, Inc.

Semel, E., Wiig, E. H., and Secord, W. A. (2003) *Clinical Evaluation of Language Fundamentals*, Fourth edition. San Antonio, TX: The Psychological Corporation.

Sheng, L. and McGregor, K. K. (2010) Lexical-semantic organization in children with specific language impairment. *Journal of Speech, Language, and Hearing Research,* 53, 146-159.

Sheng, L., Peña, E.D., Bedore, L.M. and Fiestas, C.E. (2012) Semantic Deficits in Spanish–English Bilingual Children with Language Impairment. *Journal of Speech, Language, and Hearing Research,* 55, 1-15. doi:10.1044/1092-4388(2011/10-0254)

Snow, C.E. and Hoefnagel-Hohle, M. (1978) Critical period for language acquisition: Evidence from second language learning. *Child Development*, 49, 1263-1279. Reprinted in S. Krashen, R. Scarcella and M. Long (Eds.) (1982) *Child-adult differences in second language acquisition.* Rowley, MA: Newbury House, 93-111.

Stokes, S. and Fletcher, P. (2003) Aspectual forms in Cantonese children with specific language impairment. *Linguistics,* 41(2), 381-406.

Sutton-Spence, R. and Woll, B. (1999) *The Linguistics of British Sign Language: An Introduction*. Cambridge University Press.

Swanson, L.A., Fey, M.E., Mills, C.E. and Hood, L.S. (2005) Use of narrative-based language intervention with children who have specific language impairment. *American Journal of Speech-Language Pathology*, 14, 131-143.

Tallal, P. (2000) Experimental studies of language learning impairments: From research to remediation. In Bishop, D.V.M. and Leonard, L.B. (eds.) *Speech and Language Impairments in Children: Causes, Characteristics, Intervention and Outcome.* Hove, UK: Psychology Press, 131-155.

Tallal, P. and Piercy, M. (1973) Defects of non-verbal auditory perception in children with developmental aphasia. *Nature*, 241, 468-469.

Thompson, R.L., Vinson, D.P., Woll, B. and Vigliocco, G. (2012) The Road to Language Learning Is Iconic: Evidence From British Sign Language. *Psychological Science*, 23 (12), 1443-1448.

Tomblin, J. B., Records, N. L., Bookwalter, P., Zhang, X., Smith, E., and O'Brien, M. (1997) Prevalence of specific language impairment in kindergarten children. *Journal of Speech, Language, and Hearing Research,* 40, 1245–1260.

Ullman, M. T. and Gopnik, M. (1999) Inflectional morphology in a family with inherited specific language impairment. *Applied Psycholinguistics*, 20, 51-117.

van der Lely, H. K. J. (2005) Domain-specific cognitive systems: Insight from Grammatical-SLI. *Trends in Cognitive Sciences*, 9(2), 53–59.

van der Lely, H. K. J. and Marshall, C. R. (2011) Grammatical-Specific Language Impairment: A window onto domain-specificity. In Guendouzi, J., Loncke, F. and

Williams, M. (eds.) *The handbook of psycholinguistic and cognitive processes: Perspectives in communication disorders*. LEA, Taylor & Francis, 401-418.

van der Lely, H. K. J. and Ullman, M. T. (2001) Past tense morphology in specifically language impaired and normally developing children. *Language and Cognitive Processes*, 16(2-3), 177-217.

Vinson, D.V., Cormier, K.A., Denmark, T., Schembri, A. and Vigliocco, G (2008) The British Sign Language (BSL) Norms for Age of Acquisition, Familiarity and Iconicity. *Behavior Research Methods*, 40(4), 1079-1087.

Volterra, V., Caselli, M. C., Capirci, O., Tonucci, F. and Vicari, S. (2003) Early linguistic abilities of Italian children with Williams syndrome. *Developmental Neuropsychology*, 23(1-2), 33-58.

Wetherell, D., Botting, N. and Conti-Ramsden, G. (2007) Narrative in adolescent specific language impairment (SLI): A comparison with peers across two different narrative genres. *International Journal of Language & Communication Disorders*, 42, 583-605.

White, S.A., Fisher, S.E., Geschwind, D.H., Scharff, C. and Holy, T.E. (2006) Singing mice and songbirds: animal models for FOXP2 function and dysfunction in human speech. *Journal of Neuroscience,* 26, 10376-10379

Wilcox, J. M. and Leonard, L. B. (1978) Experimental acquisition of Wh-questions in language-disordered children. *Journal of Speech and Hearing Research*, 21, 220–239.

Woolfe, T., Herman, R., Roy, P. and Woll, B. (2009) Early vocabulary development in deaf native signers: a British Sign Language adaptation of the communicative development inventories. *Journal of Child Psychology and Psychiatry*, 51 (3), 322 – 331. doi:10.1111/j.1469-7610.2009.02151