23

Sign language acquisition studies

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23.1 Introduction

In this chapter, I review aspects of sign language acquisition studies conducted over the past twenty-five years, and speculate on the future directions for such studies. I have organized the research into five themes, according to some of the stated or implicit goals of these works. The overview provided here is not meant to be exhaustive, but selects examples of studies falling into each theme in order to give the reader an idea of research directions. However, many studies fall into more than one of the five categories, and others may not have been specifically directed at any of these topics. The five themes discussed are as follows.

1. Exploring the parallels between sign and spoken language acquisition
2. Explaining potential differences between sign and spoken language acquisition
3. The reciprocal relationship between sign language grammar and acquisition
   a. Using sign language acquisition data to inform us about sign language grammar
   b. Using sign language grammar to inform us about sign language acquisition
4. Using sign language acquisition data to inform us about theories of language acquisition

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5. Using sign language acquisition data to tell us about the nature of language acquisition

Before discussing these five themes I provide a brief background.

23.2 Background

Any study of the acquisition of sign languages must begin with information regarding the participants and their language-learning situation. Unlike the vast majority of children, deaf children typically do not receive (accessible) linguistic input from birth. Only about 5 per cent of deaf children are born to deaf, signing parents (Mitchell & Karchmer 2004). These children are the focus of much research on sign language acquisition, since their input conditions are relatively comparable to that for children learning a spoken language. Most of the studies described here have been conducted with children in this condition, unless otherwise specified. Other deaf children can be, and have been, studied to gain a better understanding of the effects of delayed or 'imperfect' input on the course of language acquisition (see Chapter 9 for some discussion of the 'homesign' sometimes produced by deaf children afforded no sign language model).

The sign languages reported on in this chapter are natural languages, distinct from the spoken languages of the surrounding hearing communities. Most of the examples discussed come from American Sign Language (ASL), Brazilian Sign Language (Libras), British Sign Language (BSL), Hong Kong Sign Language (HKSL), Langue des Signes Québécoise (LSQ) and Sign Language of the Netherlands (SLN).

It will be useful for the reader to understand that individual signs are typically described in terms of their distinctive handshape, location and movement. Minimal pairs can be formed by the substitution of a different handshape, location or movement within a sign. For example, the signs CANDY and APPLE are distinguished by handshape alone; the signs APPLE and ONION are distinguished by location alone; and the signs CHAIR and TRAIN are distinguished by movement alone. Thus, handshape, location and movement are among the (sublexical) building blocks that are used to form words.

The sublexical elements combine in ways that are largely analogous to spoken language phonology, and are subject to phonological processes such as assimilation. For this reason, sign linguists consider it appropriate to use the term 'phonology' even though there are many differences between signed and spoken words due to the differences between the articulators (roughly, hands versus mouth). (For overviews of how sign language phonology is both similar to and different from spoken language phonology, see Brentari 2012, Sandler & Lillo-Martin 2006).

Some signs are referred to as iconically motivated, as opposed to strictly arbitrary. It has long been held that in language, as opposed to

nonlinguistic symbol systems, arbitrariness between the sign and referent is the norm (e.g. Hockett 1960). In contrast, iconic signs bear some visual resemblance to their denotation. For example, in the ASL sign TREE, the upright forearm bears resemblance to a tree trunk, and the outstretched fingers call to mind the branches of a tree. Despite the iconic motivation of many signs, Klima & Bellugi (1979) reported that non-signers are unable to guess the meaning of signs, supporting the conclusion that limited iconicity of sign languages does not contradict the assumption that linguistic elements are largely arbitrary.

In the area of morphology, sign languages tend to have rich structures, particularly in verbal morphology. Many sign languages display what is generally analysed as a kind of verb agreement, where the movement of a verb sign agrees with both grammatical subject and object using spatial loci (see Lillo-Martin & Meier 2011). Sign languages also usually have what are known as classifier constructions. Some researchers consider these to be morphologically complex predicates of motion in which the handshape is a morphological marker for the semantic category of an argument (e.g. theme, instrument), and the movement of the sign indicates the motion the sign describes (Supalla 1982). However, other researchers reject a morphological analysis in favour of calling these structures 'depiction', claiming that the representations used have both linguistic and gestural components (Liddell 2003). For some discussion, see Emmorey (2003).

Studies of the syntax of different sign languages have found that they typically use order-changing operations to reflect information structure rather than following a strict word order, although a pragmatically neutral basic word order can be identified (e.g. Subject–Verb–Object (SVO) for ASL, but SOV for some other sign languages). Sign languages frequently use the sentence-initial position for topics (as spoken languages do for the most part); a number of them also use the sentence-final position for repeated elements (referred to here as 'doubling'). Most sign languages mark certain grammatical functions through non-manual means: particular facial expressions may be used with different types of questions, for example; and head position may indicate negation. The details do vary considerably from one sign language to the next. More detail about syntax in sign languages can be found in Sandler & Lillo-Martin (2006) and Pfau, Steinbach & Woll (2012).

In the research literature, signs are glossed using upper-case words from a spoken language with approximately the same meaning, with additional notational devices to indicate relevant modifications such as agreement and reduplication. Non-manual markers (facial expressions and body position) are usually noted on a line above the glosses which indicate their extent. These conventions are illustrated in example (1) below. Each upper-case word stands for a sign with approximately the same meaning (note, for example, that ASL does not distinguish nominative from accusative pronouns). The line above the words 'EAT ICE-CREAM' indicates that the negative headshake signalled by 'neg' co-occurs throughout the articulation of both signs.

(1) _____neg
ME EAT ICE-CREAM
'I don't eat ice cream.'

23.2.1 Exploring the parallels between sign and spoken language acquisition

In this category I include a variety of studies which show that sign language acquisition takes a similar path to spoken language acquisition, under comparable input conditions (i.e. children whose parents sign to them fluently from birth). Such studies serve to demonstrate convincingly that sign languages are fully natural languages and, by implication, are deserving of the status associated with full natural languages (see Chen Pichler 2012, Lillo-Martin 1999 and Newport & Meier 1985 for reviews of some of this research).

Why is it important to demonstrate that deaf children with native signing input acquire sign languages along an 'identical' – or even parallel – time-course to that of children learning spoken languages? For Petitto (2000), the implication of this finding is that the human propensity for language is not modality-dependent. Rather, the mechanisms that make language development possible apply equally well to a visual–gestural language as to an auditory–vocal language. Thus theories of language acquisition need to accommodate such modality-independence.

Based on her research with ASL, Petitto (2000) argues that developmental milestones are 'identical' in signing and speaking children; these include babbling (occurring at 7–12 months of age); the first word stage (starting at 11–14 months); and the first two-word stage (starting at 16–22 months). Furthermore, Petitto reports that the acquisition of sign languages continues to follow the same path as acquisition of spoken language in age-matched hearing children. Similar reports that the general path of language acquisition is parallel for signed and spoken languages can be found in studies of sign languages other than ASL; for example, Italian Sign Language (Caselli & Volterra 1990), Brazilian Sign Language (Quadros 1997) and Sign Language of the Netherlands (Van den Bogaerde 2000).

Research on the babbling of hearing children shows that vocal babbling (repetitive, syllabic sounds such as 'baba') emerges around 6 to 8 months of age, and continues (with certain changes) until it disappears as words come in (see also Chapter 10). Petitto and Marentette (1991) observed that deaf children exposed to sign language produced 'manual babbles' during this same period. They found manual babble activities occurring as 32–71 per cent of the manual activity produced by two deaf children studied at 10, 12 and 14 months of age. Petitto and Marentette argued that manual babbling is like vocal babbling in satisfying three conditions. First, the babbles employed a restricted set of phonetic units (handshapes, locations and movements), which were described as a reduced subset of

those used in signing; second, they showed four types of syllabic organization also found in adult signing ((i) path movement; (ii) secondary movement – handshape change; (iii) secondary movement – orientation change; (iv) path and secondary movement combined); and third, they were used non-communicatively. This similarity suggests that babbling represents a critical and distinct stage in the ontogeny of human language.

Meier and Willerman (1995) and Cheek *et al.* (2001) have also reported similarities in babbling between children learning a sign language and children learning a spoken language, although they view the similarity as a consequence of motor development rather than an expression specifically of the linguistic faculty. Meier and Willerman and Cheek *et al.* observed manual babbling in five deaf children at approximately 7, 10 and 13 months. The children were all exposed to sign language. Manual babbling comprised between 25 per cent and 93 per cent of all gestures produced. However, while Petitto and Marantette reported that manual babbling was much less frequent in the three hearing subjects they studied (about 20 per cent of gestures), Meier and Willerman and Cheek *et al.* found that the five hearing children they studied, who were not exposed to sign language, produced manual babbles at a similar rate to the deaf children (44–100 per cent of all gestures). These authors connect their findings to theoretical explanations which stress similarities in the development of sign and spoken languages, although their theories differ.

Research such as the studies summarized here is important in illustrating that sign languages are natural human languages with the same biological foundations as spoken languages, as well as similar social environments. Babbling might well have been thought to be specific to spoken language, and dependent on experience with spoken language. The observation of manual babbling helps to drive home the point that babbling is a natural function of language acquisition, no matter whether the language is spoken or signed. The linguistic status of sign languages is well recognized in many academic areas. However, there are still people including doctors and educators who are not well informed on this subject and they are sometimes in positions which allow them to make decisions regarding the welfare of (potential) sign language users (see Humphries *et al.* 2014). For this reason, the point cannot be stressed too much.

23.2.2 Explaining potential differences between sign and spoken language acquisition

In this category are studies which have observed differences in the path of acquisition of sign and spoken languages, and which attempt to account for them, often by appealing to influences of modality. In some cases the differences are quite straightforwardly due to modality (e.g. although sign phonology and spoken phonology have abstract principles in common,

they are each deeply rooted in their specific modalities); in others, a good argument has been made that ties the difference to a particular aspect of the modality (see Lillo-Martin & Gajewski 2014 for discussion of some modality effects in the adult grammar of ASL). Modality effects may include iconicity, the use of space and motor/articulatory development.

Numerous authors have claimed that first signs appear before first words by as much as six months, and the current enthusiasm for 'baby signing' in the hearing population is based on this idea (see Chen Pichler 2015). Meier and Newport (1990), in a comprehensive review of the literature documenting acquisition milestones for sign versus speech, came to several important conclusions about the similarities and differences. First, the 'advantage' for signs seems to be about 1.5 to 2.5 months (roughly age 8.5 months for first signs versus age 10–11 months for first words), and this difference is seen only with the earliest context-bound signs (e.g. the word 'dog' applied only to the family pet and not to other dogs), not purely symbolic ones, which display flexible, adult-like usage. Second, the sign advantage exists only for first words, not for first word/sign combinations (early syntax). Third, a possible explanation for the sign advantage is based on 'peripheral' mechanisms – that is, the mechanisms used in the production and/or perception of signs versus words; it takes longer for speaking children to develop sufficient articulatory control to produce utterances which can be recognized as words than for signing children to develop comparable control. Thus there is a disadvantage for spoken language at the earliest stages of lexical development.

A 'noun bias', that is a predisposition to learn first the names of objects (Gentner 1982 et seq.), has been reported in a number of studies investigating the composition of early vocabulary of children learning a spoken language. This 'bias' may be the result of a universal cognitive/linguistic bias, or a reflection of structural properties of the input to children. Hoiting (2006) studied the early vocabulary composition of children acquiring Sign Language of the Netherlands (abbreviated SLN). The data were from 17 children aged 1;03–3;00; 4 had deaf, signing parents and 13 had hearing parents and early exposure to SLN. Hoiting's study used an adaptation of the MacArthur-Bates Communicative Development Inventory (CDI; Fenson *et al.* 1993), and compared children learning SLN with English-speaking children previously studied using the CDI by Bates *et al.* (1994). In order to consider the nature of the potential noun bias across groups, Hoiting presented results as a proportion of total vocabulary, grouping responses for children with vocabulary sizes of 0–50 words, 51–100 words, 101–200 words, 201–300 words and 301–400 words. She found that the children learning SLN had nearly five times as many predicates (25 per cent of total vocabulary) as the English-speaking children (who had just over 5 per cent) at the earliest stage of language acquisition (total vocabulary of 0–50 words). While the proportion of predicates steadily increased over the period observed at a faster rate for the English-learning children than for the SLN-learning children, the latter

still had many more predicates (approximately 32 vs 21 per cent) in a total vocabulary of 301–400 words.

Hoiting (2006) proposed a modality-specific explanation: the modality of sign languages makes action and motion salient and thus draws attention to verbs. Another explanation, proposed by Hoiting (2006) and by Slobin (2006), relates to language typology rather than modality. They classify SLN (and other sign languages) as 'head-marking'. One characteristic associated with head-marking is that arguments do not need to be expressed in every sentence. This characteristic would lead to an overall higher proportion of predicates being used in head-marking languages in comparison to languages like English, where subjects and objects are overtly expressed.

Some support for the idea that languages in which arguments may be unexpressed are expected to have a higher percentage of verbs in early vocabulary comes from the study of Mandarin conducted by Tardif *et al.* (1999). In a direct comparison, Tardif *et al.* did find that Mandarin-speaking children used relatively more verbs and fewer nouns than English-speaking children. However, they also observed that a variety of factors influences the appearance of a noun bias, including the nature of the input and sampling techniques used. In fact, although the study by Hoiting and the comparison data from English both used CDI data, it is not clear that the sampling was equivalent, since the adaptation of the CDI for SLN did not contain all of the word categories used for English. Furthermore, Anderson & Reilly (2002), using an ASL version of the CDI, found 17 per cent predicates for 12 signing children at the 0–50-word stage. Clearly further study is needed to identify if sign language acquisition is different from the acquisition of spoken languages in the area of vocabulary development. In particular, the use of comparable methodology across languages is crucial.

Another body of research which examines effects of modality on sign language acquisition concerns early sign phonology, specifically, looking at effects stemming from development of the articulators. Children learning a sign language or a spoken language may produce some non-target forms due to difficulties with articulatory control, while other patterns may come from non-target phonological systems. Because the articulatory systems for spoken languages and sign languages are different, acquisition effects that can be traced to articulation are a kind of modality effect. Meier (2006) argues that studying articulatory factors in the development of sign phonology is important for at least two reasons. First, knowing which effects come from articulation helps identify those which require other explanations. Second, he suggests that articulatory factors may promote particular kinds of linguistic organization – especially for children – which might lead us to think that these effects may reflect different levels of performance (for signing and speaking children), and also different representations. Articulatory factors may well explain some aspects of early phonological development in spoken languages as well (e.g. MacNeilage & Davis 1990). Modality effects are present in both modalities, and in this sense attending to modality is not only a way

of explaining how sign language development and spoken language development are different, but also how they are alike.

Researchers have studied which components of signs children produce more or less accurately, and found that in many cases children's developmental errors can be explained by appealing to the development of motor or perceptual mechanisms. For example, several researchers find more errors on handshape than on location in early signs. Young children's first signs tend to use a handshape with all fingers extended, whether spread or lax (), or with the fingers all in a fist (), or with just the index finger extended (). These handshapes will often be substituted for others in target signs which use more complex handshapes. However, the location of signs is much more frequently produced correctly. A possible explanation offered for this pattern is that fine motor control is needed for handshape, but this develops later than gross motor control, which is needed for location (Cheek *et al.* 2001, Conlin *et al.* 2000, Marentette & Mayberry 2000). However, some researchers suggest that it may be easier for children to perceive differences in location as compared with different handshapes, also contributing to the earlier accuracy with the former.

Meier (2006) reported that children's earliest signing often involves movement repetition. This can be directly related to repeated movements in motoric development such as the stereotypes of repeated kicking or arm waving. Meier also observed that children sometimes produce certain two-handed signs with incorrect movement. In these signs, the target form has one hand acting on the other as a base. However, children may erroneously use identical movements on both hands. Meier proposes that such errors may be explainable by reference to a phenomenon known as 'sympathy', whereby children have difficulty inhibiting the action of one hand when the other is active.

Identifying whether children's production of signs reflects their developing knowledge or performance errors is difficult, but there are some cases for which an articulatory/perceptual explanation is probably unwarranted. For example, Conlin *et al.* (2000) and Marentette and Mayberry (2000) discuss different types of location errors. Some may be attributable to articulatory control (e.g. replacing the target location with an anatomical neighbor). However, other location errors are not consistent with a motoric explanation, but rather some other kind of grammatical process. For example, Marentette & Mayberry identify location errors which may be attributable to the child's attempting to satisfy morpheme structure constraints (Battison 1978), turning a two-handed sign with [trunk] location to a one-handed sign using the other hand as its location (see also Section 23.3.3.1). Thus, as suggested by Meier, understanding articulatory factors helps to identify those aspects of the development of signs which require alternative explanations.

Discussions of how sign languages seem to be 'different' from spoken languages typically include iconically motivated aspects of sign languages,

including iconic lexical items, and the so-called classifier constructions. Below I summarize recent studies looking at the acquisition of each of these important areas of sign languages.

Orlansky & Bonvillian (1984) argued that children's early signs are not typically iconic. Thompson *et al.* (2012) proposed, however, that testing comprehension might be more revealing of iconicity than production, due to effects of motoric development. They looked at parental reports of children's early BSL comprehension and production using the BSL adaptation of the MacArthur Bates Communicative Development Inventory (Woolfe *et al.* 2010). Thompson *et al.* referred to independent ratings of iconicity for 89 signs, which categorized signs such as AEROPLANE (depicting perceptual features of an airplane's wings) and DRINK (depicting the action of drinking) as iconic (Vinson, Cormier, Denmark, Schembri & Vigliocco 2008). The researchers found a significant main effect of iconicity for both younger (11- to 20-month-old) and older (21- to 30-month-old) children, with a stronger benefit of iconicity for the older children. Their analysis also took into account factors including phonological complexity (more complex handshapes, locations and movements were determined based on Mann, Marshall, Mason and Morgan 2010), and adult ratings of familiarity of the signs and imageability of the concept from corresponding English words. The effect of iconicity remained after comparing their results to early acquired words in spoken British English. Thompson *et al.* (2012) pointed out that it is easier to see how iconicity assists in learning sign languages because of the greater potential for visual than auditory iconicity, but they point to research suggesting it also assists in learning spoken languages, such as a study by Imai, Kita, Nagumo and Okada (2008) finding that 3-year-old Japanese learning children acquire novel action words more readily when the sound of the word matched the sound of the action.

Classifier constructions involve multi-componential signs in which the handshape comes from a limited set representing specific semantic classes (e.g. one handshape for vehicles; another handshape for cylindrical objects). The movement of one set of classifier signs is said to depict the movement of the object being represented (e.g. a vehicle going from point A to point B); in other signs, movement is used to represent the extent of an object (e.g. a tall versus short cylinder). There has been extensive debate regarding the analysis of these elements (see Emmorey 2003, Sandler & Lillo-Martin 2006).

A number of studies have examined children's acquisition of classifier constructions in different sign languages, looking at the role of iconicity or morphological analysis in their development. For the most part, researchers have stressed the relatively protracted developmental period, with some reporting early beginnings (e.g. de Beuzeville 2006 for Auslan, Schick 2006 for ASL, Slobin *et al.* 2003 for SLN), but all noting that mastery of a classifier system and its discourse requirements is quite late (e.g. Morgan *et al.* 2008 for BSL, Tang *et al.* 2007 for HKSL).

Brentari *et al.* (2013) looked specifically at ASL signing children's use of the appropriate handshapes for classifier signs. They focused on the fact that different types of classifier predicates (object vs handling) require different types of handshapes, with nouns varying between the two types. All of the handshapes can be considered iconically motivated: for example, a handshape with the thumb and index finger touching in a circle represents holding a lollipop, while an extended index finger represents the lollipop itself. However, the different handshapes are distributed according to grammatical structure. When the predicate is used with an agent ('someone puts the lollipop on the table'), the former, handling handshape is used; but when the predicate is used in a phrase with no agent ('the lollipop is on the table'), the latter, object handshape is used.

Brentari *et al.* found that children's development follows a morphological course. In particular, they found that even 4- to 6-year-old children are adult-like in their use of nouns and predicates with handling handshapes, but that children develop over time in their use of object handshapes in classifier predicates. In other words, children's choices were based on grammatical contexts, even when their productions differed from those of adults. Brentari *et al.* take this as strong evidence that children are attending to grammatical contexts since they are sensitive to the phonological and morphological properties of their language.

23.2.3 The reciprocal relationship between sign language grammar and acquisition

Two categories are grouped together to emphasize the importance of a strong, reciprocal relationship between studies of grammar and studies of acquisition. Studies in this category show how acquisition research can bear on theoretical questions in grammatical analysis, and how new grammatical analyses can lead to new questions or reanalysis in acquisition studies. Such relationships between acquisition and grammar are not unique to sign language studies, of course, but sign language researchers can and do profitably participate in these kinds of works.

23.2.3.1 Using sign language acquisition data to inform us about sign language grammar

When competing grammatical models make different acquisition predictions, developmental data can be used to test the models. This is a principle of spoken language research as well as sign language research, although it has only been applied in sign language research relatively recently. Here I will discuss two examples.

Conlin *et al.* (2000: 52) proposed that studying early sign development may help us decide between models proposed for the adult language. For example, children's early signs may help in the determination of canonical signs;

that is, those employing phonological features that should be considered unmarked. Linguistically, marked features have a more limited distribution. This concept has been considered in detail with respect to handshapes. Signs that are made with two hands can either be symmetrical, or one hand may act on the other as a base hand. When the sign is symmetrical, the two hands use the same handshape; when one hand forms a base for the other to act on, the base hand must adopt one of the linguistically unmarked handshapes (Battison 1978). Sign language acquisition is relevant to this idea in that children's earliest occurring handshapes come from the set of unmarked ones in the adult language (Boyes Braem 1990).

In her investigation of the development of phonology in Brazilian Sign Language, Karnopp (2002) adopted the Dependency Model of van der Hulst (1993). In this model, the finger selection aspect of handshape is identified as a 'head', and the finger configuration aspect (e.g. whether the fingers are open or bent) is a 'dependent'; the model thus predicts that finger configuration will be acquired only after finger selection. Karnopp found support for this in the data analysed from one deaf signing child.

A second example comes from the area of syntax. Lillo-Martin and Quadros (2005, 2006) investigated the acquisition of topic, focus and wh-questions in ASL and Libras. ASL and Libras both follow Subject–Verb–Object as their pragmatically neutral, basic word order, but in both languages certain signs can appear in a sentence twice, once in their usual position and again at the end of the sentence, to indicate emphasis on that sign. These constructions are often called 'doubling'. Some examples are given in (2) (examples in this section are grammatical in both ASL and Libras; they are reproduced from Lillo-Martin & Quadros 2008).

(2) a. JOHN CAN READ CAN
John really CAN read.'

b. MARY FINISH GO SPAIN FINISH
Mary ALREADY went to Spain.'

c. I LOSE BOOK LOSE
I did LOSE the book indeed.'

In the examples in (2), an element which would appear only in the sentence-internal position in the neutral context (CAN, FINISH, LOSE) appears in its base position and in the final position. In both languages, the same category of signs which can occur in doubling constructions can occur in the sentence-final position only. These sentences can be referred to as 'final constructions'. Examples are given in (3).

(3) a. JOHN READ CAN
b. MARY GO SPAIN FINISH
c. I BOOK LOSE

According to one type of grammatical analysis, doubling and final constructions are related. Both are used for emphatic focus, and according to these theories, their derivations are related (Nunes & Quadros 2006, 2007, Petronio 1993, Wilbur 1997). However, there is another kind of focus, known as new information focus ('I-focus'). Unlike the emphatic focus, this places the focused material in the sentence-initial position (Lillo-Martin & Quadros 2008, Neidle 2002). Such new information focus is used, for example, in the context of answering a question, as in example (4). The basic word order (SVO for both ASL and Libras) is also permitted in such contexts.

(4) S1: WHAT YOU READ?
'What did you read?'

I-focus
S2: BOOK STOKOE I READ
or I READ BOOK STOKOE
'I read *Stokoe's book.*'

According to the proposals of Lillo-Martin and Quadros, I-focus is derived syntactically through a completely different mechanism from that of emphatic focus. They predicted that if their analyses are correct, children would acquire doubling and final constructions together, since these are both instances of emphatic focus, but these might be acquired independently from I-focus, since it is derived differently. Lillo-Martin and Quadros (2005) tested their prediction by looking at the longitudinal spontaneous production data from two deaf children acquiring ASL as a native language (Aby, Sal), and two deaf children acquiring Libras as a native language (Ana, Leo). All four children have deaf, signing parents. They were videotaped regularly starting before the age of 2. Their utterances were examined to determine when they started productively using I-focus, doubling and final constructions. The results of this study are summarized in Table 23.1.

It is clear that the children acquired doubling and final constructions together, but these two constructions were acquired later than I-focus (highly significant by Binomial Exact Probability). These results can be taken to support theoretical analyses which relate doubling and final constructions in ASL and Libras over analyses which give them distinct derivations.

The two examples presented have shown areas in which data from sign language acquisition can bear on theoretical questions of grammatical analyses. For both sign and spoken languages, there are many cases in which different theoretical proposals do not obviously make different predictions for acquisition, so acquisition data may not bear on such issues. However, other cases lead to expectations of ordering, such that phenomena that are related in the adult grammar can be expected to be acquired together; or phenomena that are separated are expected to be acquired separately. In some cases, specific ordering predictions can be

Table 23.1 *Age of acquisition of each structure (Lillo-Martin & Quadros 2005)*

Child	I-focus	Doubling	Final
Aby	1;9 ***	2;1	2;0
Sal	1;7 ***	1;9	1;9
Ana	1;6 **	2;0	2;1
Leo	1;10 ***	2;1	2;2

** $p < .005$
*** $p < .001$

made, such as when a particular construction has others as prerequisites (for discussion of examples, see Snyder & Lillo-Martin 2011). In these cases, language acquisition data can provide important support – or disconfirmation – of theoretical proposals.

23.2.3.2 Using sign language grammar to inform us about sign language acquisition

The previous section looked at ways in which acquisition studies can inform studies of grammar. The present category of studies goes in the opposite direction, using new developments in grammar to inform acquisition studies. These two categories are closely related, since both show the close relationship between acquisition studies and linguistic theory, and in fact there is often a spiral effect such that both fields benefit from and influence each other in the same domain.

An example of this category comes from studies of children's development of word order. Coerts and Mills (1994) undertook a study of two deaf children's development of the subject–object–verb word order in the Sign Language of the Netherlands (SLN), between the ages of about one-and-a-half years to two-and-a-half years. They found that children showed a great deal of variability in their ordering of subjects and verbs. An explanation for the variability was proposed by Bos (1995), who identified SLN as having a process known as Subject Pronoun Copy (SPC) (see Padden 1988). According to SPC, the subject of a sentence (glossed INDEX) can be repeated as a pronoun in the sentence-final position, as shown in (5a). However, it is also possible for the sentence-initial subject to be unexpressed (this is a general process found in SLN as well as in other sign languages). When the sentence-initial subject is left unexpressed, but the sentence-final subject pronoun is present, the surface order is verb–subject, as in (5)b) (examples from Coerts 2000).

(5) a. $\text{INDEX}_{\text{beppie}}$ FILM $\text{INDEX}_{\text{beppie}}$
'Beppie is filming.'

b. CRY $\text{INDEX}_{\text{dolls}}$
'The dolls are crying.'

Coerts (2000) reanalysed the child data previously studied by Coerts and Mills. It was clear that the children knew that SLN permits null subjects, as they used them appropriately and frequently. Coerts employed a fairly strict criterion for acquisition of the SPC process: the child must use a sentence-final subject pronoun in a sentence with an overt subject to show that they had acquired SPC. Once the children showed they had acquired SPC, at around two years, any later instances of verb–subject order in which the postverbal subject is a pronoun were considered instances of SPC. Using this reanalysis, Coerts found that the majority of the previously 'unexplained' word order examples were in fact explainable, and children's acquisition of word order was more in line with expectations.

Research by Chen Pichler (2001a, 2001b) resulted in similar findings for ASL; her study goes beyond consideration of SPC alone to include other instances of word order variability in the adult grammar. Although there had been early claims that children strictly followed the adult basic SVO word order, Schick (2002) found no evidence for this strategy in 2-year-olds, concluding instead that children's word order was 'random'. Chen Pichler used a similar approach to Coerts's and determined when children's use of verb–subject order could be considered cases of SPC, and when their use of object–verb order could be considered as following from adult-like word-order-changing operations such as object shift. Object shift is an operation that may occur with verbs marked for spatial location, aspect, or handling classifier, as illustrated in (6) (Chen Pichler 2001a: 147).

(6) a. BALL THROW-INTO-CORNER
b. SALLY PAPER TYPE-asp
c. BABY FEED-WITH-SPOON

Chen Pichler established clear criteria for counting utterances as legal order changes. For example, postverbal subjects must be pronouns to be considered SPC; preverbal objects occurring with verbs marked for aspect, spatial location, or handling classifier were considered instances of object shift. Using these criteria, Chen Pichler found that children's word-order use demonstrates regularity in following grammatical options much earlier than previously thought. She studied four children longitudinally, and found that all four of the children followed adult-like word order SV or SPC virtually always at 21–23 months (three children) or 25 months (earliest available transcript for one child). In addition, for three of the four, adult-like word order VO or OV with object shifting verbs was at ceiling by 22 months (two children) to 28 months (one child). Most of the instances of OV order that were not so explained for the fourth child could be analysed as topic structures, also an adult-like option. Thus, taking into consideration such developments in the syntactic analyses leads to more reliable acquisition studies.

Both of the examples provided illustrate the importance of considering the target adult grammar when studying language development. The goal

of studying language acquisition is to understand how children become adult-like in their knowledge of language. When children differ from adults, an explanation for this difference must be sought. But sometimes researchers examining child development overlook the adult input.

23.2.4 Using sign language acquisition data to inform us about theories of language acquisition

Sign language research is not alone in pursuing the goal of developing and testing explicit theories of how language acquisition proceeds, but it has much to contribute to such goals. It is particularly important to include sign languages in the database of language acquisition facts which theories strive to explain, because any such theory would have as its goal to provide an explanation of the ability of *any* child to learn the natural language she is exposed to.

In the previous section, we considered theories of adult grammar and their relationship to studies of language acquisition. Here, we turn to theories of the process of acquisition. Alternative theories of how language develops can be tested and refined using real-time acquisition data from sign languages just as they are tested using data from spoken languages. These theories are general theories about language acquisition, not particular to sign languages (and in general, not developed on the basis of sign language data).

As an example, consider the Verb Island Hypothesis of Tomasello (1992, see also Chapter 5). According to this model of language development, children go through an early period in which verbs are individual 'islands' of organization. It predicts that certain patterns (such as word order or inflections) will be found with individual verbs, although there will not be evidence that a whole class of verbs behaves in the same way. This early period of verb islands would begin when children are starting to use two-word combinations, but generalizations would be apparent some months later (say, around the age of 2 years for most children).

In support of this proposal, Morgan and Woll (2002) found no evidence for an abstract set of verb frames before the age of 3;2. Rather, the children studied appeared to build argument structure for each verb and the verbs were uniquely tied to their communicative function. Only later did the children build rules which held over multiple verbs. Schick (2002) also examined the verb island hypothesis in her study of early sign combinations. She found only limited evidence in support of the hypothesis, in that some of the children she studied showed consistent ordering patterns with some verbs. However, she found that in many cases, word order was quite varied even for individual verbs. This would appear to show neither verb islands, where individual verbs behave alike, nor evidence of word order rules which apply across the board to all different verbs.

In this context, we can return to the findings of Coerts (2000) and Chen Pichler (2001a, 2001b), reported in Section 23.3.3.2. These authors reported systematic use of word order by young signing children when grammatical alternations allowed by the adult grammar were considered (see examples (5–6)). According to their results, children's signing is neither random nor organized into verb-specific islands. Rather, the rules which characterize the adult grammar are also found in this domain of children's language. Whether the data analysed by Morgan and Woll (BSL) and by Schick (ASL) are amenable to the same conclusion has not yet been determined, since these authors did not take into consideration the possibility of children using order-changing operations such as SPC and object shift.

Another example can be taken from Reilly's study of the development of non-manual marking (as summarized in Reilly 2006). Reilly and colleagues were interested in children's development of the use of linguistic non-manual markings versus affective and communicative facial expressions, which are often similar. Reilly identified this project as, in part, a test of the longstanding question about the degree to which language is an innately specified independent cognitive function (see Elman *et al.* 1996, Pinker 1994; Chapters 2 and 5), because it assessed the separability of language from other cognitive functions. She suggested that an approach to language acquisition in which language is seen as a general cognitive system would predict that children would readily recruit their prelinguistic affective and communicative abilities in the service of linguistic functions, and thus acquire non-manual markings together with their co-occurring manual components. On the other hand, in a more modular approach 'children would approach each linguistic structure and its morphology de novo' (Reilly 2006: 268).

This question is clearly addressed with data from the development of non-manual marking of negation. The negative non-manual marker used in adult ASL (indicated with 'neg' on the line above the sign glosses) is essentially like the negative headshake used communicatively by very young children, whether exposed to sign language or not. Negation can be expressed in adult ASL by a negative sign co-occurring with this negative headshake, or even by the negative headshake alone, as in the examples in (7) (examples from Reilly 2006; the notation 't' indicates a topic non-manual marker with the sign BOOK in (7a), while the 'neg' non-manual occurs with 'CAN'T' in (7a) and the verb phrase 'EAT ICE-CREAM' in (7b)).

(7) t neg
a. BOOK READ ME CAN'T
'I can't read the book.'

neg
b. ME EAT ICE-CREAM
'I don't eat ice cream.'

Reilly and her colleagues studied naturalistic videotaped sessions between fifty-one Deaf children ages 1;00 to 4;11 and their Deaf mothers (Anderson & Reilly 1997). They found that deaf children acquiring sign languages, like hearing, non-signing children, produce communicative negative headshakes by about 12 months of age. The first negative signs, NO and DON'T-WANT, emerged at 18–20 months, followed by other negative signs up to age 3;6. For seven of the eight negative signs investigated, Reilly found that the manual sign first appeared without the required co-occurring headshake. Several months later, the negative headshake was combined with the negative signs. This separation occurred despite the fact that the negative headshake was used prelinguistically by these children to mean essentially the same thing. Reilly concluded that children treat the negative headshake as it is used in ASL as a linguistic element which must be analysed independently. This would not be expected under the theory of language as a more general cognitive system, but only by the modular approach.

23.2.5 Using sign language acquisition data to tell us about the nature of language

Sign languages and deaf communities allow us to understand in more detail the nature of language since, due to experiments of nature, they sometimes reveal what happens to language in extreme circumstances which are not found elsewhere. As previously mentioned, most children who are born deaf are not born into families who already use a sign language. If speech is inaccessible, and no sign language is used, such children spend at least some part of their crucial early developmental period without linguistic input. Whether, and if so, when, they are exposed to a sign language and in particular to native signers, varies considerably depending on individual circumstances. What is the linguistic situation for such children in the meanwhile? Once they begin to acquire a sign language, how does the delay in accessible input affect the language acquisition process? After years of using a sign language, are effects still present? Information about what happens in these circumstances is of great significance to theories of language in providing a unique contribution to our understanding of the nature of language and the mechanisms which make language acquisition possible. Researchers studying such circumstances have a very special role to play in advancing scientific knowledge.

Examples of such contributions come from the study of late first language learners of sign languages (e.g. Mayberry *et al.* 2002), learners with degraded input (Singleton & Newport 2004), learners of invented sign systems (Supalla 1991), homesigners (Goldin-Meadow 2003b, Chapter 9) and recently developed sign languages (Senghas *et al.* 2004). These studies tell us about the ranges of possible languages, the path and properties of

language emergence, 'resilient' properties of language which appear in the absence of evidence, critical period effects in language acquisition, how the learner modifies the input she or he receives. The range of outcomes from such studies is so broad and important that there is no way to give it justice here. However, I will give one example to whet the reader's appetite; for more details please see the original works in this area.

Late first-language learners are virtually unheard of in spoken language communities, but this is not so in signers. Since about 95 per cent of deaf children have hearing parents (Mitchell & Karchmer 2004), it is not surprising that the vast majority are not exposed to sign language from birth. Sometimes, parents decide to educate their children orally (without sign language); some of these children are later exposed to a sign language after having learned only a portion of spoken language (often, not enough to communicate effectively). In other cases, children experience late exposure to sign language simply because the resources for exposing the child earlier were not available to the family. For various reasons, children may be exposed to sign language only after the age of 2 years, or 5 years, or 12 years. It is not well understood exactly how such delayed linguistic exposure affects language development, but it is clear that there are such effects.

Morford and Mayberry (2000) provide an overview of some of the research investigating effects of delayed input on (first) language acquisition and processing. Most of this research has been conducted with adults whose exposure to sign language began at different times. By studying adults, researchers investigate the outcome of the language-development process, after years of experience have made the use of sign language a well-practised, familiar skill.

Overall, studies with adults whose age of first exposure to ASL was approximately 4 to 16 years, as compared to native signers (those with exposure from birth), have consistently reported lower performance in selected domains in both production and comprehension tests. Furthermore, studies looking at language processing have also found differences for different age-of-exposure groups. The degree of an effect is not uniform across different studies. For example, Newport (1990) found that later learners (those with exposure after age 12) scored lower than 'early' learners (those with exposure between 4 and 6), who in turn scored lower than native signers, on tests of ASL morphology production and comprehension. However, the three groups were not different on a test of basic word order. Similarly, Emmorey *et al.* (1995) found that late learners were different from native signers in a study of online processing of verb agreement, but not in aspect marking.

Mayberry *et al.* (2002) extended such findings by comparing late first-language learners of ASL with late *second*-language learners of ASL: late-deafened adults whose exposure to sign language began in the same period as the late first-language learners (9–13 years). Their study asked

participants to judge the grammaticality of complex sentences. The effects of late exposure were strongest for late first-language learners; late second-language learners performed close to natives.

These results reinforce the idea that early exposure to language is crucial for its normal acquisition. But what factor(s) will be most affected by delayed input when other factors are relatively spared? Newport (1990) hypothesized that young children have the ability to detect patterns of the correct grain size for the development of complex morphology, while the greater cognitive capabilities of older children or adults actually interfere with this type of analysis, thus leading to the differences in performance on syntactic versus morphological tests she observed.

An alternative proposal is put forth by Morford and Mayberry (2000), who emphasize the differences in phonological processing skills for native or early learners versus late learners. For example, Mayberry (1993) asked thirty-six adult participants to produce on immediate recall complex sentences of ASL. The late first-language learners produced a large number of phonological errors, unlike the other participant groups (despite no significant difference in the length of sign language experience). Morford and Mayberry speculate that difficulties with processing at the phonological level also underlie other observed differences between late learners and native signers, including lexical and morphological tasks. They suggest that what is missing for late learners is what is learned by those with native exposure in the first year of life. In particular, a great deal of phonological development takes place during this period, and studies show infants' sensitivities to phonological information from a very early age (see Chapters 7 and 8). This sensitivity may well be at work in early sign language development, although fewer studies have focused on this very early period (see Krentz & Corina 2008).

What Morford and Mayberry propose is that the early development of the phonological system prior to the development of lexical–semantic and morphosyntactic systems is an advantage for native signers. Perceptual changes over the first year of life may well mean that starting later prevents the development of appropriate neural mechanisms for processing native language contrasts. Problems in phonological processing can then have 'cascading' effects on other levels of language processing, showing up in the various areas of effects of language delay.

Support for the hypothesis that phonological processing is disrupted in late learners comes from a neuroimaging study by MacSweeney *et al.* (2008). MacSweeney *et al.* found that a very similar neural network is used in phonological similarity judgments in English and BSL, but that for the processing of BSL, the neural network is modulated by factors including age of first language acquisition (as well as hearing status). MacSweeney *et al.* consider their results in conjunction with those of Mayberry and colleagues, and conclude that early exposure to an accessible language (even sign) is important.

23.3 Research which cuts across themes

Many areas of sign language acquisition research touch on more than one of the themes discussed above. One area of research which touches on all five themes is the acquisition of verb agreement. In ASL and other sign languages, subject and object person agreement is expressed on a class of verbs (such as HELP and ASK) by modifying the initial and final locations of the verb (as also mentioned in Section 23.2). A sign so marked typically begins its path movement at a spatial location associated with the subject (either the actual physical location of the person or an abstract location associated with the person), and moves towards the location associated with the object. Agreement with source and goal location in another class of verbs (such as MOVE and GO) takes a similar form, but the endpoints represent location arguments rather than person. Thus, the verb will move from the location of the source, to the location of the goal. A third class of verbs (including LIKE and EAT) takes no agreement marking at all. Such verbs typically have a short path movement and are often articulated on the body.

Meier (1982) examined the acquisition of verb agreement in ASL in comparison to the acquisition of verbal morphology in spoken languages. He argued that sign language agreement is acquired in a similar fashion as is complex, unstressed verb agreement in some spoken languages. On the other hand, Morgan *et al.* (2006), in their study of the acquisition of verb agreement in British Sign Language (BSL), argue that 'spatial' aspects of verb agreement in sign language make it unlike that in spoken languages. The form of agreement is not an affix, but a modification of the root, which Morgan *et al.* argue involves a high degree of simultaneity, making segmentation difficult for the young child. Both of these research groups found that children make errors of omission and commission in marking verbs for agreement, until at least the age of three years. An omission error would mean that only a short movement is used – generally this movement is considered the citation form and moves slightly outward from a location near the signer's body. A commission error would mean having agreement on a verb that doesn't usually take agreement. For example, the ASL verb CRY is not an agreeing verb – it is made on the signer's face – but a child might sign the verb on the face of a doll, committing a commission error.

On the other hand, Quadros and Lillo-Martin (2007) found that verb agreement errors were extremely rare, for two children acquiring ASL and two children acquiring Libras. They found almost no errors of omission or commission for these children. They attributed the differential error rate to a different theoretical view of contexts for obligatory use of verb morphology, a view which is confirmed in studies with adult signers. It has become clear that some verbs do not require agreement, but can be modified by being signed in spatial loci similar to agreeing verbs. For example, the ASL verb BUY was previously considered to be an agreeing

verb, but it is now clear that producing the sign without agreement should not be considered an error. Similarly, the ASL sign LEAVE can be signed in a neutral location (to mean 'leave it'), or it can be signed in a locus (to mean 'leave it there'). Lillo-Martin and Quadros argue that the acquisition data support an approach which identifies verbs needing agreement in particular sentential contexts rather than lexically marking certain verbs as always requiring agreement.

Verb agreement has also been studied in late learners, as it seems to be an area of special problems. Adult late learners have been shown to err in using verbal morphology (Newport 1990), and they also have processing difficulties in this domain, failing to detect verb agreement errors in a sign monitoring task (Emmorey *et al.* 1995). Studies of verb agreement in late learners provide some evidence that there are specifically grammatical differences between early and later learners as well as proposed processing differences. Berk (2003) studied two children whose exposure to ASL began at the age of 6. She found that the later learners were particularly affected in their production of person-marking agreement on ASL verbs. They made numerous errors of both omission and commission, continuing without a decrease in error rate over four years of observation. Other verbal morphology, indicating location agreement, was not affected, as the late learners appropriately used such marking, although the form of location agreement is very similar to that of person agreement. A specifically grammatical deficit would seem to be implicated in order to explain such a difference.

Another cross-cutting area that has been receiving more research attention in recent years is bilingualism (see also Chapter 22), particularly bilingualism between a sign language and some version of a spoken language (oral or written), often referred to as *cross-modal* or *bimodal bilingualism* (bilingualism between two sign languages is virtually unstudied). One group of bimodal bilinguals includes Deaf people who use a sign language and typically the written version of a spoken language; a second group consists of hearing people who have been raised in deaf, signing households – often known as Children of Deaf Adults (codas), whether adult or child (sometimes called kodas) in age.

Until recently, most research on literacy in Deaf signers has focused on the relatively low overall reading level achieved by deaf students, and how better literacy could be achieved (for an overview see, e.g., Power & Leigh 2000). Others have considered the development of the written language within the context of bilingualism and study deaf signers as bilinguals, either through consideration of a bilingual approach to education, or by looking at psycholinguistic processes common in bilingualism (e.g. Chamberlain & Mayberry 2000, Kuntze 1998, Morford *et al.* 2011, Padden & Ramsey 1998, Plaza-Pust 2012).

Ormel *et al.* (2012) took the latter approach in their study of Dutch deaf children bilingual in SLN and Dutch. It is widely known from studies of

bilinguals that during cross-language activation, written words in one language activate their translations in the other language. Morford *et al.* (2011) came to the same conclusion in their study of ASL/English deaf bilinguals from the US. Ormel *et al.* used this finding and employed a word–picture verification task with children in grades 3–6. Evidence for crosslanguage activation was found in that the participants responded more slowly/less accurately when mismatched word–picture pairs had phonologically related signed translation equivalents. In addition, Ormel *et al.* found that participants responded faster/more accurately when matching word–picture pairs had strongly iconic signed translation equivalents. The results of this study indicate that like oral language bilinguals, deaf bilinguals read with activation of both of their languages, not just the language of the text. This is a common effect of bilingualism.

Hearing children raised in signing deaf families can become bimodal bilinguals, using a sign language and the oral language. Such cases can be of particular interest for questions regarding how simultaneous bilingualism proceeds, since the different modality of the two languages leads to unique possibilities. For example, Petitto *et al.* (2001) considered the question to what extent bilingual children separate versus 'fuse' their vocabularies at a very young age. They compared children acquiring LSQ and French with children acquiring two spoken languages, English and French. While a number of early spoken words were difficult to code as English vs French (e.g. 'ba' could be interpreted as Eng. *ball* or Fr. *balle*), such 'neutral' forms are not an issue for the bimodal bilinguals. Petitto *et al.* concluded that both groups of children had comparable numbers of translation equivalents, indicating separation of the languages from early on.

Another topic of interest for studies in simultaneous bilingual development concerns crosslinguistic interaction: the use of morphosyntactic elements from one language while speaking the other. Hulk and Müller (2000) proposed that such interaction is strictly limited to particular types of structural conditions. However, Lillo-Martin *et al.* (2010) examined data on crosslinguistic influence from hearing children acquiring ASL and English, as well as children acquiring Libras and Brazilian Portuguese. They found – consistent with a number of other studies of unimodal bilinguals – that crosslinguistic influence can be observed in unexpected domains. A characteristic of bimodal bilingualism that is unique to that situation is *code-blending* – production of some parts of the message in both speech and sign (see Emmorey *et al.* 2008 on this phenomenon in adult codas). Lillo-Martin *et al.* argue that code-blending is an illustration of the flexibility of the bilingual language architecture – rather than being tightly constrained in ways unique to bilinguals, language 'mixing' phenomena are only constrained by the principles that govern language use more generally.

One final bilingual situation that is quite recent and rare is the case of deaf children in deaf, signing households, who receive a cochlear

implant and learn the spoken language with auditory input. While much remains to be seen about bilingual development in this context, Davidson *et al.* (2014) conducted a series of standardized (spoken) English language tests, and compared the results of six children with CIs (CCIs) to a group of kodas (the use of 'k' indicates that the participants are 'kids'). They found that the CCIs were not different from the kodas, and that both performed at or above monolingual norms for each standardized test. This study is one indication that sign bilingualism with children using CIs is not only possible, but may well be beneficial for overall language development.

23.4 The future of sign language acquisition research

What does the future of sign language acquisition research look like? Our hope is that future research on sign languages will continue to enhance connections with the questions asked of spoken language acquisition. Theories of language, and of language acquisition, need to accommodate sign language data, so sign language research that informs and benefits from studies of spoken languages is desirable. Additional studies of an enhanced range of populations are encouraged; for example, cross-sign language comparisons, studies of the effects of differences in input quality and timing, bilingualism. Such studies have much to offer, both scientifically and practically.

Suggestions for further reading

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24

Children with Specific Language Impairment (SLI)

J. Bruce Tomblin

24.1 Introduction

During the past thirty years there has been an increasing amount of literature concerning one form of developmental language disorder that has come to be known as Specific Language Impairment (SLI). Within this chapter, I will be focusing on the conceptual and empirical issues concerned with who these children are in relation to other children with or without language impairment and what is known about the course and etiology of SLI. In Chapter 25, Leonard surveys what we know about the language-particular features of SLI and the cognitive explanations offered for these features, and in Chapter 26 Archibald and Noonan discuss processing deficits in children with language impairment.

24.1.1 Conceptualizing SLI

Much of the research concerning child language development has focused on mechanisms and characteristics that generalize across children. In such research, individual differences in language development are acknowledged, but often set aside. In contrast, these individual differences in language development are the central focus of those who study developmental language disorders. Consequently, developmental language disorders may be viewed as a particular region in a multidimensional space of individual differences among children with regard to language development and use. Conceptualizing Specific Language Impairment as a domain within a broader region of individual differences in language development helps highlight key issues that surround our conception of its nature and the manner in which it is similar or contrastive with other typically and atypically developing children who are not considered to present with SLI. In this regard, a part of understanding the concept of SLI involves