Children are just lingual: the development of phonology in British Sign Language (BSL).*

Gary Morgan

City University, London

Address: ESRC Centre for Deafness, Cognition and Language

Dept. of Language and Communication Science

City University, London

Northampton Sq, London, EC1V0HB

Tel: (020) 7040 8291

Fax: (020) 7040 8577

Email: g.morgan@city.ac.uk

Abstract

This paper explores three universal tendencies in spoken language acquisition: consonant and vowel harmony, cluster reduction and systemic simplification, using a corpus of 1018 signs from a single child exposed to British Sign Language from birth. Child signs were recorded from naturalistic deaf parent-deaf child interaction between the ages of 19-24 months. Child errors were analysed by handshape, movement and location segments, as well as the accurate production of prosodic features, using an autosegmental phonology approach. Unadult like forms at this age were observed with 41% of handshapes, 45% of movements and 25% of locations. There were 47% of signs produced with unadult like prosodic features. Analysis of the results concludes that early child signing broadly follows proposed universal tendencies in language acquisition.

Key words: Sign language, phonology, development

1. Introduction

In many aspects of linguistic development young children's use of words and signs reveals that they possess more knowledge of the rules of language than is visible from consideration only of their temporarily limited productions. For example, English-speaking children between ages 2;6 - 4;0 are reported to produce the different verb argument structures of their language with very few errors (Pinker, 1989). However, they do occasionally attribute argument structures from the adult language to verbs whose meanings and structures do not fit that pattern. When children say things like *Daddy go me round*, this reveals that they have correctly identified the semantic relations needed in their request (make something happen to me) but without *spin* in their lexicon at this point they choose the motion verb *go* and make it fit into a transitive verb frame (Bowerman, 1982). These overextensions suggest that children apply abstract linguistic representations in the form of linguistic knowledge to the new forms they encounter in every-day communication and come up with previously unheard creative constructions.

Early work on children's acquisition of the phonology of their language demonstrated that the non-adult properties of early performance in this domain are not random. Smith (1973, 1975/2004) outlined a series of realisation rules his son Amahl (aged 2) used in order to move between the representation of adult words in his phonology and the child versions of the same words in his own speech. After meticulous analysis of written and taped recordings of Amahl and other children's speech, Smith argued that there were common principles in the acquisition of phonology that could be formulated in rules that perform one of four functions. These were: (a) to effect consonant and vowel harmony; (b) to bring about an "ideal" CVCV… canonical form through cluster reduction; (c) to effect simplification in the

system of phonological elements used; (d) to effect grammatical simplification (Smith, 1975/2004: 303). In setting down these four functions, Smith highlighted the notion that children's linguistic competence is not fully reflected in their performance. Additionally, he went on to suggest that:

> 'in giving these rules (hopefully) language-free characterisation in terms of both their formal and functional properties, I suggest that they reflect in a reasonably direct way the strategies that children bring to bear in the acquisition of speech whatever the language they happen to be learning. In other words these constraints reflect universal tendencies in the acquisition of phonology'. (Smith, 1975/2004, p305).

The idea that there are such universal tendencies also appeared in later theories of the acquisition of phonology, especially in Natural Phonology (Stampe, 1979) and is still debated in the field (e.g. Hooper 1976; Menn, 1983; Grunwell, 1997; Bybee 2001). Probably Smith did not have the acquisition of sign languages in mind when he made his list of universals, but research on children's acquisition of signed languages as 'mother tongues' has made it increasingly clear that children face up to language (whether signed or spoken) in very similar ways (for an overview see Morgan & Woll, 2002).

The rest of this paper describes changes that a 2 year old child exposed to British Sign Language (BSL) makes to adult signs in her own productions and an analysis of these systematic child forms in terms of strategies. When children

produce non-adult forms in speech or sign it, is not the case that they always produce the same forms. However, it is the case that the quality of the child form has some characteristic which makes it more like one particular sound or handshape than another. In this way it is possible to label child forms as being a 'b' sound or a 'fist handshape', although in each case the child produces different approximations of these forms rather than an exact identical articulation each time. By the end of this paper I hope to have shown that the striking similarities in how children acquire signed and spoken language phonology strengthens further the hypothesis that there are universal tendencies in the way performance is affected in early language acquisition.

2. Sign phonology and the Prosodic model

2.1 Decomposition

The discovery that sign languages, despite being soundless, have a linguistic organisation at the level of phonological representation stems from the first analyses of American Sign Language (ASL) by Stokoe (1960) and Stokoe et al. (1965). Stokoe showed that signs in ASL could be broken down into minimal, meaningless components of which the major parts were: the handshape, the movement, and the sign's start and end location. Signs also have different hand orientations and an important nonmanual component (specific facial actions, head movements and mouth patterns) which can co-occur with the manual part of the sign (see Reilly & Anderson, 2002).

Words in spoken languages are made up of sounds which on their own have no meaning. The words *coat* and *goat* differ only in their initial sounds, yet have very different meanings despite the /k/ and /g/ on their own being meaningless. These two

words are judged to be minimal phonological pairs in English. The same decompositional analysis also applies to all sign languages documented so far. For example in the BSL sign PENGUIN the hands each form horizontally flat surfaces (the handshape), they move up and down (the movement) and are positioned at waist height (the location). Each of these contrastive components taken on their own contains no meaning, it is only in their combination that the sign becomes symbolic.

By changing how sign components are combined, sign language users articulate different signs with different meanings. The signs NAME and AFTERNOON have identical handshapes and movements but differ in the location the signs are articulated at (forehead and chin respectively). This sign language minimal pair is shown in figure 1. Thus, within cognition and the language faculty, sign languages are structured as phonological systems, with their individual components organised, constrained and represented in ways similar to spoken languages (Corina & Sandler, 1993).

--insert figure 1 about here--

2.1. Nonlinear and hierarchical components of the sign

Spoken languages contain linear sequences of consonants, vowels and unstressed elements bound together in constituents. These sequencesh have defining characteristics for each segment (e.g. Chomsky & Halle, 1968). In spoken languages relevant characteristics of a segment could be whether it is the oral or nasal cavity that is used to make the sound. The different features that define segments get grouped together and organised into a hierarchical structure in a feature geometry (e.g. Clements & Hume, 1995).

Mirroring these advances in spoken language research, modern theories of sign language phonology show how different signs are represented by sets of branching features. In a similar fashion to consonant and vowel categories in spoken languages, the linear structure of signs can be represented as a sequence of phonological categories such as handshape, movement and location. Furthermore, each of these components can be thought of as having particular features that function together as a unit.

In the first linguistic studies of sign language it was thought that all contrastive components of the sign were expressed simultaneously and so differently to sequentially segmented words in spoken languages (e.g. Klima & Bellugi, 1979). While there is some degree of simultaneity in sign, many elements also have a clear sequential ordering for when each of the phonological components, including 'holds', get expressed. Holds are pauses in the articulation of the handshape and movement, or extensions in the timeframe a handshape remains in a particular location.

In autosegmental phonology (Goldsmith, 1976) a new type of phonological representation was proposed based on the appearance of nonlinear phonological features in words, for example tones, which spread across more than one segment. The feature does not make up a part of one particular segment. This same approach is used in theories of sign language phonology such as the Hand tier model of Sandler (1989) and the Prosodic Model (Brentari, 1998). In the Prosodic Model the sign splits into two sets of features (inherent and prosodic) which are organised hierarchically using feature geometry. The sets of features within handshape and location are classed as inherent, which Brentari compares directly to consonants in spoken languages. These parts of the sign do not undergo change during a sign's production

but spread across all segments in the phonological structure, in a similar way to the autosegmental features in words in spoken language.

The sign's movement (including any hand-internal movements) represent the Prosodic features, akin to vowels in spoken language as they are dynamic, have a temporal quality and undergo change during the unfolding of the sign's articulation. Part of the Prosodic Model is shown in figure 2.

--Insert figure 2 about here- -

2.2. Markedness and complexity in signs

A relevant part of the Prosodic Model for sign language acquisition is 'selection'. Different signs select their features at different points in the feature geometry. The number of features selected to represent a sign, in general underlies how 'markedness' is determined. In spoken language phonological models, how markedness is defined is not completely clear, although most frameworks state that it is directly related to phonological representations and their complexity (Calabrese, 1995, Steriade, 1995). The unmarked phonological components of signs and words are the basic, simple and most frequently occurring contrastive features, while marked handshapes are more complex and less frequently occurring in the language. The set of unmarked handshapes and some marked handshapes in BSL are shown in table 1.

--Insert table 1 here--

This is further illustrated by an analysis of different handshapes.

2.3. Inherent features

2.3.1. Handshape

In Brentari (1998) different handshapes are formed based on the selection and non-selection of parts of the hand during articulation. This way of representing different handshapes is characterised as a feature geometry approach, whereby different handshapes are made up of constituents of similar features (for example whether the thumb is selected or whether the non-selected fingers are flexed or not). In this way a basic set of frequently occurring handshapes with the fewest number of selected features can be derived and classed as the unmarked handshapes.

For example the handshape labelled 'G' has only two features: a value for which of the fingers are selected (one index finger) and a value for the flexion of the non-selected fingers (fist flexed). This is shown in figure 3.

--Insert figure 3 about here--

In contrast the '8' handshape (an index finger point with an extended thumb), which occurs less frequently in the BSL lexicon, is more marked, as it requires more selection of features in its phonological representation. This is shown in figure 4. The two handshapes stem from a phonologically related form as the 8 is an extension of the phonological representation of the 'G' hand.

--Insert figure 4 about here--

2.3.2. Location

The second inherent feature of the sign is its location value. Many signs are produced in a neutral location in front of the signer but signs also contrast with each other in where they are located on the body, such as in the minimal pair NAME and AFTERNOON (figure 1). In the Prosodic Model a sign is specified first for one of three planes in sign space, then its region on or around the body and finally for eight place distinctions at each region. A feature geometry for the phonological representation of location is shown in figure 5.

--Insert figure 5 about here --

2.4. Prosodic Features – Movement

Signs differ in their path of primary movement. For example, MINE has a straight movement towards the chest, while FARM has a curved path from chest to waist. Some signs have no path movement but a hand-internal movement (for example, the finger flick in the sign UNDERSTAND or the finger wiggle in MIRROR). There may also be a hand-internal movement simultaneously produced as the sign moves along a path. For example, the sign FIRE (figure 6) moves up and down and the fingers make a rapid back and forward movement (wiggle) as they move.

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In this last example, the movement component of the sign is a complex one; there is both path and hand-internal movement information produced simultaneously. In an abstract sense several pieces of phonological material packed closely together like this

resembles groups of sounds in spoken words where phonemic units are expressed in sequential clusters e.g. **'spl**ash'. In signs like FIRE the two movement components are packed together so much that they show partial or total overlap (Brentari, 1998).

In the Prosodic Model different movements are made up of a combination of features on a hierarchy. The degree of phonological markedness of particular movements depends on the number of features selected in the representation of the sign. Curved or circular paths or paths with simultaneous hand-internal movements are the most marked as they select the most features in the feature geometry, while straight paths with no hand-internal movements are the least complex.

2.5. Prosodic properties of the sign

In an autosegmental approach to phonology some features operate across rather than within segments. A sign's movement, especially in a string of connected signs, is based on both the timing of the sign's complete articulation from beginning to end – including signs which have repetitions or holds in their prosody – and the timing of hand-internal movements across different segments of the sign's articulation. In the Prosodic model, prosody is defined as the manipulation of feature groups, where sign parts have specified timing slots in the overall prosody. The temporal relationship between the articulation of the handshape, movement and location parameters creates units or prosodic phrases. These temporal properties can be located on a separate phonological tier to the segmental constituents e.g. finger selection or body region (Brentari, 1998).

3. Developmental studies of native sign language acquisition

During development children exposed to consistent models of language begin to speak or sign at about the same age – around 11 months (Meier, 2000; Petitto, et al 2001). From the outset the task for the child in beginning to use a sign language is the same as for all children: the mastery of the phonetics of sign articulation, as well as the acquisition of rules for the combination of a finite set of meaningless units. In spoken language development, when children start speaking, the range of sounds they can produce and thus their ability to make phonological contrasts is limited. Nevertheless, the ways in which children simplify the adult model is based on their knowledge of language structure (Smith, 1973). Similarly, when children exposed to consistent adult models of sign language from birth start signing, they are unable to produce all the units of the sign. They also do not immediately use all the rules for combining these units (McIntire, 1977; Meier in press). However, their language acquisition clearly follows patterns. For example, developmental studies concur that getting the location correct on first signs is less problematic for young children than the correct specification of handshape and movement (Siedlecki & Bonvillian, 1993; Karnopp, 2002).

Compared with the hundreds of studies of spoken language development (see MacWhinney, 2000) there are far fewer studies of native sign language acquisition. One major reason for this is that 90% of deaf children have hearing parents who might not sign themselves at all when the baby is born (see Morgan & Woll, 2002). This means that many deaf children might not learn to sign until later in childhood or even in adolescence (Mayberry & Eichen, 1991). The data reported on in this paper come from a child who was fortunate to experience early and consistent models of BSL from birth.

4. Method

4.1. Subjects

The child reported on in this study, known by the pseudonym Gemma, is a deaf child of deaf parents and at the time of data collection had no other siblings. She was identified as deaf in the first weeks of life through targeted screening. This meant that her parents knew from the outset that their child was deaf and used BSL with her from birth onwards.

4.2 Data collection and transcription

Gemma's signing between the ages 19 – 24 months was recorded in the family home with 19 recordings each of 50 minutes. The language sample consisted of a total of 1018 sign tokens. All of this data was based on naturalistic interaction between the child and her mother. If the child's sign differed from the adult target but was still recognisable, it was transcribed with respect to the three main phonological parameters outlined above (handshape, location and movement), as well as the sign's prosodic structure, through a recording of the sign's timing and repetition. As mentioned previously, across the data there was inconsistency in the production of different signs. For example, sometimes a handshape was more clearly a 5 hand than other times, but in order to code the sign, the handshape had to be produced clearly enough to decide whether it was flexed or not (see Morgan, 2003 for procedure on sign language transcription).

5. Results: Patterns in child sign language acquisition

In this section an analysis of Gemma's signing in terms of the first three strategies proposed in Smith (1973; 1975/2004) is presented: consonant harmony, cluster reduction and systemic simplification. During the data collection period there were minimal occurrences of two-word combinations or grammatical morphemes and so Smith's fourth strategy, grammatical simplification, will not discussed.

Overall, the relative occurrence of childlike productions of phonological features and alterations to the sign prosody was consistent with previous research on sign language acquisition. See table 2. The accurate productions of handshapes and movements were more divergent than those of locations.

--Insert table 2 here--

In producing these errors, the child uniformly simplified the articulation of the sign by changing the sign's structure. The nature of these simplifications is now described and compared with strategies commonly reported in spoken language acquisition. It is worth noting, as Smith (1975/2004) pointed out with Amahl's approximations, although Gemma made many errors in her signing she did not accept the same simplified signs from her mother, indicating her competence exceeded her performance.

5.1. Consonant and vowel harmony

In the process of harmony in speech development, segments which have different places of articulation end up with the same places of articulation e.g. *bag* gets

changed to *bab*, or *lorry* to *lolly*. In a similar fashion, phonological features in signs can adapt by assimilating into neighbouring linguistic environments. A concrete example in BSL is in lexical compounding, where two signs fuse to make one meaning (e.g. SEE + MAYBE = CHECK). In these examples one component, for example the handshape in SEE, assimilates into the following segment (Sutton-Spence & Woll, 1999:103).

In a very big proportion of the data (482 tokens - 47% of corpus) Gemma produced signs with the non-adultlike addition of a repetition during articulation. For example, the sign TABLE in the adult input moves once from a centre point in front of the body outwards to shoulder distance and stops. In Gemma's signing this movement was reduplicated several times. Children of 7-10 months may reduplicate parts of words e.g. CV syllables but not whole words (Bernhardt & Stemberger, 1998).

These reduplication examples do not directly fall into a category of consonant or vowel harmony. Reduplication of a sign means the whole unit is being repeated rather than a feature spreading across to alter another target component (as in the CHECK compound example described previously). However reduplication did seem to be functioning to spread the prosodic contour of the sign further across the sign span. This is explained with a further example.

In adult signs with identical repetition of movement, for example the sign DOG, the hands bounce up and down twice. Gemma extended the repetition to several bounces. During these repetitions she was not omitting parts of the sign (as in weak syllable deletion in speech development), but was reduplicating the whole sign two or more times. The reduplications however were not identical copies, rather in each sign Gemma was reducing the size of the movement but keeping the handshape

and location constant. The repetitions meant the sign took longer to complete with the effect on the prosodic features being elongation and spreading between the start and end of the articulation.

5.2. Cluster reduction

A second developmental strategy commonly reported in speech development is children's tendency to arrive at canonical CVCV form (Smith 1975/2004). This is achieved mainly through cluster reduction, whereby clusters of consonants are reduced and altered by separation e.g. *pink* (CVCC) becomes *pik* (CVC). Avoidance of clusters is also seen in the epenthetic insertion of a schwa inside a consonant cluster e.g. *black* is articulated as *b**e**lack*. As outlined previously, clusters of phonological features are also common in complex signs where components can show partial or total time overlap, for example when both path and hand-internal movement information are produced simultaneously, as in the sign FIRE.

The main way in which Gemma achieved reduction of sign clusters was through the separation of the path of movement and hand-internal changes. The data contained 118 attempted signs that required combined path and hand-internal movement. In 100 of these (85%) Gemma changed the form of the target by pulling apart or deleting the clustered features. For example, in the adult sign PIG the fist hand should twist during movement to the nose location, but in Gemma's approximation the twisting movement was articulated first and then the hand arrived at the nose. The handshape was articulated and then moved.

An alternative method of cluster reduction was illustrated by deletion of the finger wiggle on the 5 hand in the sign FIRE, with retention of the up-and-down path. Similarly in the adult sign THROW the hand moves outwards from the shoulder as

the hand opens. In Gemma's version, shown in figure 7, the final open movement was deleted altogether.

--insert figure 7 about here--

In the child's version of these signs (PIG, FIRE and THROW) the handshapes are articulated first but do not change during the sign's movement.

The other means used by the child to reduce clusters was through changing the prosodic timing of the sign at the point where a transition between a handshape and a movement occurred. There were 193 signs (19% of the corpus) with a marked change in the timing of the articulation, of which the most common type was through the insertion of holds into the sign. The hold insertion in these signs resembles the insertion of the unstressed schwa in speech development.

The adult sign CAKE is normally signed with a continuous, double repetition of an up-and-down movement of the moving hand on the back of the non-dominant hand. Gemma's production of this sign inserted a hold between the first and second up-down movements, essentially in the middle of the sign, thereby extending the timing of the sign's articulation. In another, similar, example the mother signed THANK-YOU by moving the hand downwards from the chin in one smooth movement. Gemma, by contrast, inserted holds at the start and end position and shortened the movement in between these locations. As before, this lengthens the timing of the handshape articulation in the sign's prosodic structure. In these last two examples the movement part of the sign is altered, as a result of which the handshape articulation spreads further across the sign.

5.3. Systemic simplification

The third of Smith's tendencies revolves around the child applying systemic simplification or general rules across classes of sounds, for example removing a contrast between alveolars and plato-alveolars ('brush/bus' becomes 'but'). Simplification can also be achieved in speech through substitution of features e.g. 'tar' instead of 'car'. Here the 'k' sound in car is replaced by a 't', presumably because the 't' location (+ dental) is simpler than the velar location. The other features (- voice, + plosive) are retained.

A clear example of systemic simplification in early sign language development was observed in handshape substitutions. Across Gemma's repertoire, errors through substitution of the unmarked handshapes were low (28-58%) compared with higher error rates with attempted adult signs using marked handshapes (93-100%). When Gemma used an inappropriate handshape in all cases (systemically), she substituted the sign's target handshape with an unmarked handshape (this included unmarked substitutions for unmarked targets) while retaining the other features of the sign. An example is shown in figure 8 where the marked handshape 'V' (two fingers extended) in the adult sign CHERRY is changed by the child to an umarked G hand. The movement and location features are retained.

Insert figure 8 about here --

Gemma also used systemic phonological simplification strategies with signs involving various types of movement. Signs with complex, circular movement, for example in the signs BLUE or BOAT, were produced least accurately. From 189 tokens there were 158 errors (83%). In all cases these types of complex movements were

substituted with simpler movements such as side-to-side or forward-and-back. For example, the circular movement in the adult sign for BOAT was produced with a simpler up-and-down movement by the child. Another example from the data is shown in figure 9, where the circular movement in SHEEP is changed to a forward-and-back movement by the child. In all of these examples, elements of the adult phonology are retained (especially location), but other parts of the sign get simplified. This maintenance of some features, as well as the contingent context, ensures that the signs continue to be recognisable by the adult who is interacting with the child.

---Insert figure 9 about here---

In other aspects of Gemma's signing systemic simplification was common through consistent changes to the location parameter of signs due to enlargement. Attempted signs whose target location in the adult input were on or in front of small locations (for example, the head, face or neck) were assimilated and enlarged into nearby but larger regions of the body (for example, the body, neutral sign space in front of the trunk, and the non-dominant or passive hand). The number of attempted productions in the data which had small target locations was 412 tokens with childlike productions in 180 cases (44%). In contrast to problems with small and specific locations, Gemma attempted 606 signs with large target locations with childlike productions in only 74 cases (12%).

Some examples of childlike productions of signs with a small specified target location were FROG, which is articulated at the neck by the mother and was signed onto the chest by the child, and COW, which was signed at the temple by the mother and at the cheek by the child. The sign HOT moves from in front of the mouth in the

adult input but was assimilated into a larger location by the child, who placed the hand over the bottom part of the face (see figure 10).

--Insert figure 10 about here—

Gemma does not accept the sign HOT being signed on the face by her mother, showing she is capable of processing fine grained phonological contrasts but she consistently chooses to move signs into larger areas as a simplification strategy in her own signing.

6. Discussion

Signs are made up of basic separable properties, which interact with each other in a hierarchical organisation (Clements & Hume, 1995; Pulleyblank, 1995). Signs also have a separate level of representation for the prosodic component, which spreads across the sign. Both parts of the phonological structure of signs are explained in the Prosodic Model (Brentari, 1998).

Smith (1973; 1975/2004) proposed that in learning English and other spoken languages children manage the performance demands of articulation by systematically changing the realisation of the adult phonological form by following rules. This seminal work provided a catalyst for many follow up studies and provided the field with a list of predictions based on a clearly testable Theory (e.g. Bernhardt & Stemberger, 1998). Furthermore he proposed a set of universal tendencies children follow during the acquisition of phonology. The present case study describes observational data from the earliest period of sign language acquisition and

investigates commonalities between phonological development in spoken and signed first language acquisition.

The role of consonant and vowel harmony was not as obvious in Gemma's signing as other strategies for simplification. When reduplication was observed (in almost half of the corpus) the first part of the sign was shortened and carried over into the repetition. Within Brentari's Prosodic model, segmental elements of the sign (handshapes, movements and locations) need to be coordinated with the overall timing and prosodic pattern of the sign's start and finish. This coordination issue may lie at the origin of the high number of reduplications in the data, which may be functioning to increase the time between starting and completing the sign. In Gemma's signing, for example, the final downwards movement of the hands in the sign DOG needs to coincide with the hold in the movement that signals the end of the prosodic envelope of the sign. Extending the sign's articulation may allow more time for the initiation and coordination of the segmental and prosodic parts of the sign's production.

As regards the avoidance of clusters as a common tendency in early language acquisition, several parts of Gemma's data support the existence of this tendency in the acquisition of sign language. In general, cluster reduction in speech involves the deletion of more marked members in a cluster group. By analysing the sign structure within a feature geometry, we see that avoidance of markedness is also the case in sign acquisition. Phonological markedness relates to complexity: in a hierarchical structure, more marked representations have more selected features in the representation. In Brentari's feature geometry for the sign, movement features are on the prosodic branch and build up from simple path movements to signs which involve both path and hand-internal changes e.g. FIRE, PIG and BAG.

Gemma reduces the number of selected features in the sign by deleting hand-internal changes. However clusters can also be altered by separation. Gemma achieved this in two ways:

1. By changing simultaneously articulated path and hand internal components into sequentially ordered elements through changes to the sign's timing.
2. By inserting holds between path and hand internal elements.

Both strategies reduce the complexity of the sign and move the sign towards a canonical or more unmarked form. The insertion of a hold in a sign and the prolongation of the handshape or location articulation all function to change a sign's simultaneous realisation of more than one phonological parameter in the adult input to a sequence of articulated features in the child's own output. They stretch the sign's prosody out and linearize the individual phonological parameters.

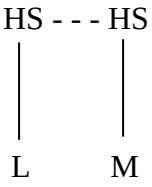
This tendency can also be captured and accounted for by an autosegmental approach to the sign's phonological representation as in (1). In the adult production of the sign PIG, the handshape (HS) articulation is carried out across the movement (M) and location (L) parts of the sign. As the hand moves towards the location at the nose, it is simultaneously forming the fist handshape. Thus, the handshape spreads across the sign.

(1)

By contrast, in the child's signing, the cluster reduction effected in the PIG and FIRE cases described previously means that the handshape element gets expressed earlier in

the sign and then is held during the articulation of the movement and location features as represented in (2), where the hold is indicated by ---.

(2)



The final universal tendency in child language acquisition considered in the present study was systemic simplification. The most obvious realisation of this constraint in Gemma's signing was through a series of substitutions. Gemma's attempts at producing marked handshapes were only 0-7% accurate, compared with 42-72% accuracy with unmarked handshapes and all substitutions featured unmarked handshapes. Previous studies of children aged between 12 –24 months learning different sign languages have reported that the first handshapes to appear in children's signs are the unmarked kind (e.g. Siedlecki & Bonvillian, 1993; Clibbens & Harris 1993; Marentette & Mayberry, 2000; Cheek et al, 2001).

In the Prosodic model, marked handshapes are those with the most selected features for the child to express in production. Gemma responded to this demand by choosing unmarked handshapes that were paired down versions of the target marked forms. A similar explanation based on simplification can also account for her preference for simple over circular movements in signs such as BOAT and SHEEP.

Overall the child's articulation of location was the most accurate part of her signing, although substitutions were observed when small distances between contrastive locations were required. In the Prosodic Model the selection of region and place features adds complexity to the representation of the sign's location. Smaller

target locations require more selection features and are therefore more marked. Hence, it would be predicted that children might omit fine-grain place features (e.g. the neck) and express only more general regions in their own signs (e.g. the body). Gemma effected such simplifications of location by reducing the fine-tuning of the articulator. By enlarging the sign to larger adjacent locations, the fine phonetic detail is reduced but the sign is still understandable.

6. Conclusions

Data from the study of deaf children acquiring sign as first languages combined with models of the phonological structure of signs such presented in as Brentari 1998 provide additional evidence for the claim that children know more about linguistic structure than their immature signs suggest. In particular, in this study, there is evidence that Gemma has a well-developed set of rules for her sign phonology that is not transparently reflected in her linguistic performance. Furthermore, she appears to go about simplifying signs by adopting the same broad strategies Smith proposed for speech development (Smith, 1975/2004).

How then does early sign language development display these universal tendencies? The difficulty in coordinating the handshape and movement components of the sign, with the prosodic timing of transitions and completions is dealt with by harmoniously repeating segments. When inserting holds into signs by separating out simultaneously articulated path and hand-internal movements, Gemma increases a sign's canonical form by reducing clusters of closely or simultaneously articulated segments. In reducing the number of selected features that she expresses in her own signing, she chooses to systematically make substitutions with phonemes that are unmarked, already a common part of her output phonology and related phonologically

to the target handshape or movement. Similarly, when attempting fine-grain locations on the temple or cheek, Gemma's tendency is to systematically move the sign out into adjacent larger locations, thus keeping the sign intelligible while changing the representation by omitting more marked parts of the feature geometry of the sign.

The patterns in which particular biases in acquisition are realised, is similar or different across languages, due to the phonetic details of the language the child is exposed to (Pye et al, 1987). This is no more radically the case than with toddlers' acquisition of signed languages. The articulation and perception of the units of natural languages differ completely between modalities, yet strikingly similar tendencies emerge in young lingual children.

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Table 1 Handshapes in BSL

Unmarked handshapes	**Some marked handshapes**
LAX 5 	8 
A 	CLAW5 
5 	C 
G 	I 
B 	F 

Table 2 Rates of occurrence of childlike productions across different parts of the sign (errors and tokens)

Handshape	Movement	Location	Prosody
41% (416)	45% (462)	25% (255)	47% (481)

Figure captions

Figure 1 A minimal pair in BSL - NAME (forehead) and AFTERNOON (chin). All other parts of the sign are identical.

Figure 2 Prosodic Model of the sign (Brentari, 1998)

Figure 3 Unmarked handshape

Figure 4 Marked handshape

Figure 5 Hierarchy of location features in the Prosodic model

Figure 6 An example of a combined hand-internal and path movement in the sign FIRE. The sign is shown during its movement across two photos. The hands move up and down and the fingers wiggle.

Figure 7 An example of a phonological simplification through hand-internal movement omission in THROW. Two versions of the same sign are illustrated. The adult target on the left has an open-close and forward path movement. On the right the signer shows how the child omitted hand opening.

Figure 8 An example of a handshape substitution in the sign CHERRY. The adult target on the left has a V handshape and is replaced in the child form on the right with a G hand.

Figure 9 An example of a movement simplification in the adults sign SHEEP. The adult target on the left involves a circular movement at the temple. This is replaced in the child form with a forward-back movement in the sign on the right.

Figure 1

Figure 2

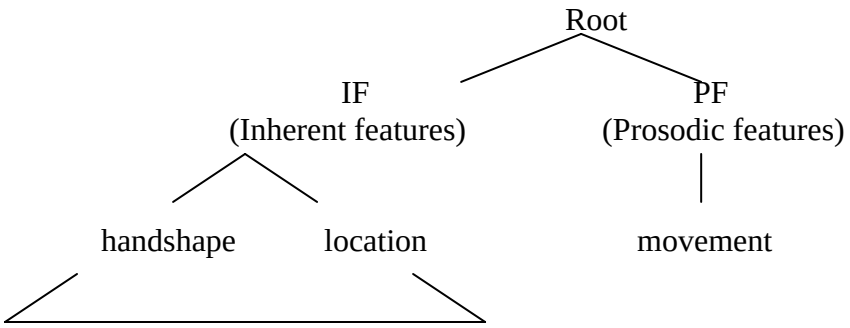

Root
IF
(Inherent features)
PF
(Prosodic features)
handshape
location
movement

Figure 3

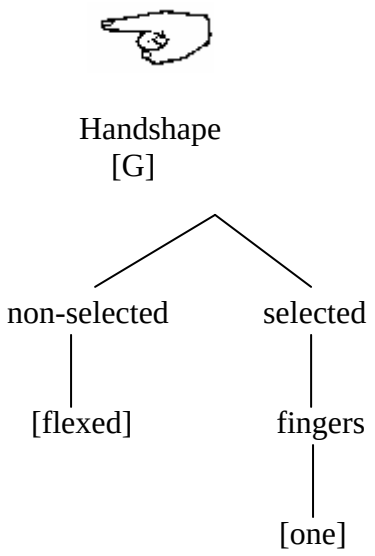


Figure 4

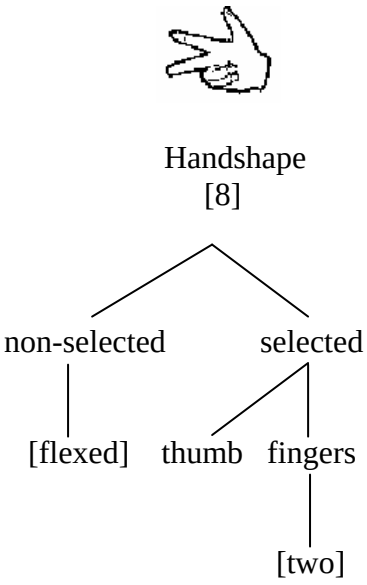
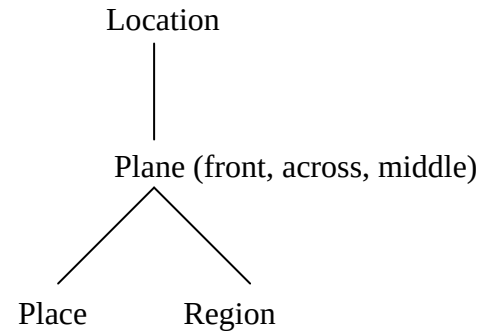

Handshape
[8]
non-selected
selected
[flexed]
thumb
fingers
[two]

Figure 5



[1] – [8] (head, arm, body, non-dominant hand, neutral space)

Figure 6

Figure 7

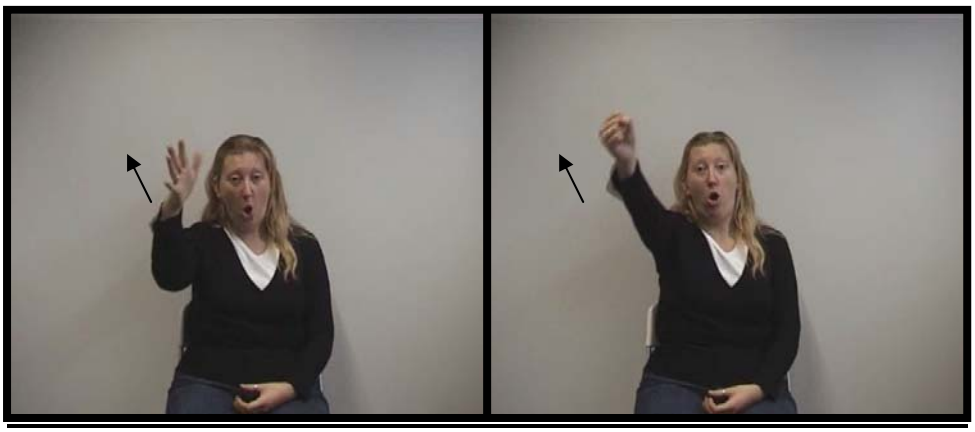


Figure 8

Figure 9

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Footnotes

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[*] Neil Smith taught me the importance of Theory in the study of any area of Psychology ('a light in the darkness'). If theory and data don't meet under the light as I hope they will in this paper it is solely because of my slow learning curve and not Neil's teaching which is always enlightening. One day after a discussion about sign language, bilingualism, the brain and language acquisition, we arrived at an impasse: what was the default language setting for the brain (one or several, signed or spoken language) and what would that mean for the onset of children's language learning? After humouring me for a while Neil came out with a sanguine: 'well in the end you know, children are just lingual'. Thank you Neil, for lighting the way.