What Counts?

A typological and descriptive analysis of

British Sign Language Number Variations

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Abstract

This MA study is the first of its kind since it brings together and analyses the types of variations found within the British Sign Language (BSL) cardinal number system. The study is not a complete representation of the various systems that exist in the UK as there are still many left undocumented. However, as an MA study it provides a starting point to understanding some of the variations that do exist and what appear to be the rules that govern these systems.

Overall, this research demonstrates that there is more to BSL numbers than mere handshapes. From analysing the different phonological parameters (movement, internal movement, location & orientation) one can appreciate the complex laws that are embedded in BSL cardinal numbers.

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1.0. Introduction

1.1. My Research:

The aims of this research are to 1) collect a range of BSL number variations within the timeframe available; 2) provide a typological and descriptive analysis of the various number systems; 3) describe common or distinctive laws that govern the number formations.

The study does not include sociolinguistic issues relating to these variations. This type of sociolinguistic research would require a different controlled methodological approach. A substantial amount of data would be needed from each city, town, village, and deaf school to adequately explain such variations. However, as an MA study it provides a starting point to understanding some of the variations that exist and what appear to be the rules that govern the logic of the BSL cardinal number systems.

1.2. The Rationale

The majority of typological sign language studies have focused on the established lexicon, productive lexicon, and classifier constructions. None of these sufficiently describe or capture the nature of BSL cardinal numbers. Nowhere can one find documentation that describes how to articulate "*thirty-six*" in BSL. Moreover, nowhere is there documentation that informs readers that there are four potential ways of expressing "*six*".

The documentation of number variations in this study is not only provided in written descriptive format but in video format as well. Sign Languages have no written equivalent and BSL historically has only been recorded through written English supported by pictures. This study has preserved the true features of the numbers by using video data collection techniques, which are attached in DVD format (two discs).

The intention of this study is to provide a description which makes sense of the internal structures of BSL number expressions as well as common generalisations that exist in all types of variations.

2.0 Literature Review

This literature review covers the definitions of numbers, number systems and the internal structures of signs. Since this is the first piece of academic research which provides a typological corpus of BSL numbers there is no real scope for debate or review of alternative theories or definitions.

2.1. Numbers:

A world without numbers is simply impossible since it is ingrained in everything we do as humans. As Brian Butterworth (1999) clearly explains in '*The Mathematical Brain*', numbers are an intrinsic part of human thinking. They are not only used for counting in trade but also in record-keeping, dates, measuring, money, telling the time, sports, plural forms, naming, and in spiritual connotations such as "lucky 7" and "unlucky 13". Even the concept of 'nothing' is equally as valuable as the concept of 'more'.

Numbers have a unique flexibility to be applied to different contexts and are broken down into three distinct categories: *cardinal*; *ordinal*; and *nominal.*

20 dogs, £20, 20cm (*Cardinal*)

2nd place, Henry the 8th, the 5th runner (*Ordinal*)

Player number 11, bus number 343, 0208-112233 (*Nominal*)

Cardinal numbers are easily identifiable as the numbers we use when counting. This can include simple rote counting or counting the quantity of a set (1 computer, 10 CDs, 30 children, 100 volts, £150,000). *This number assignment works for any objects, imagined or existent, no matter what qualities they have otherwise; the only criteria is that the objects must be distinct in order to be counted* (Wiese, 2003: 10). A cardinal number such as '20' can only occupy one space in the chain of numbers and remains fixed in this place. The number '20' is expressed differently in languages across the world but its place value remains the same. The number '20' can be traced back to the same spot each time, for example '20' will always come after '19' and before '21', it is twice the size of '10' and a fifth of a '100' (Butterworth, 1999; Wiese, 2003). With this agreed concept users can refer to any countable object such £20, 20 children, 20 books, 20 litres, and know that it is twice as much as 10, one more than 19 but one less than 21. It is this definition of numbers that will be used within this study of BSL regional number systems.

Ordinal numbers do not make use of numbers in their fixed cardinal continuum; instead numbers are applied to individuals within a set (Wiese, 2003: 10). The logic for assigning numbers depends on the purpose, for example; Henry the 8^{th} was not the 8^{th} King to rule Britain but he was the 8^{th} Henry in the long line of ruling British Kings. This method of counting gives details about the item in terms of rank order.

Finally nominal numbers are used as a tool for naming objects (real or abstract) and can be used in a non-numerical context (Wiese, 2003: 11). Instead of using names such as

‘Peter’ or ‘the High Street bus’ as a method for identifying objects, a number can be used in its place to offer an alternative systematic approach (e.g. Player number 11, bus route 343, or phone and reference numbers). This type of number usage is in fact common in our daily lives.

2.2. Spoken Language Number Typology:

The typology of spoken language cardinal number systems has given ground for interesting discussion on cross-linguistic and cross-cultural comparison. This is neatly captured in the work of Joseph Greenberg (1978) ‘*Numeral systems*’. Greenberg’s article brings together the different types of known number systems used around the world and describes differences as well as universal features. One significant observation from a sign linguistic perspective is spoken languages do not all conform to the same arithmetical formulations for expressing numbers. Communities form number systems based on a range of principles: using additions (*with, of, and*); subtractions (*of, from, to*); multiplications; division; grammatical items (‘*teen*’, ‘*-ty*’); and/or bodily parts. Different arithmetical methods of counting can be combined into one number system.

Greenberg’s paper (1978) offers a comprehensive analysis, listing fifty-four universal generalisations, to the laws behind natural spoken number systems and encapsulating these variations. Not all these universal will apply to BSL in the same fashion that they do not all apply to English. The purpose of this study was to group and define various number systems.

Table.2.1: Number systems of the World[1].

Number	Reading	Meaning
7	*mer abo sas* (Ndom; Frederik Hendrik Island)	6 and 1
11	*Kito wodo* (Aghu; New Guinea)	Big toe (2 hands + 1 toe)
16	*Kuusitoista* (Finish)	6 of the 2nd
18	*Deunaw* (Welsh)	2 x 9
19	*Ūndēvīgintī* (Latin)	One from twenty
22	*Ua ua* (Tongan)	2, 2
33	*Otsdatsamet'*	20 and (3 more than 10)
74	*arba'ata wa sab'ûn* (Arabic)	4 and (7 x 10)
79	*sinepesanpe ikasma wanpe eine hotnep* (Ainu; Japan)	(1 obj. to 10 obj.) and (10 obj. to 4 × 20 obj.)
93	*Ngui waraga, ngui kane-gonaga tebira* (Huli; Papua New Guinea)	(15 × 6) + (3 obj. of the 7th 15)

As Chapters 4 and 5 demonstrate, the BSL number system resembles the English numbers system in many ways; therefore, generalisations which describe a number system involving subtraction or division bear no value to BSL (as well as English). Furthermore, these so-called "*Universal rules*" have only been tested on spoken

[1] Examples found from Number systems of the World: www.sf.airnet.ne.jp/~ts/language/number.html

languages and not against signed languages. Many more questions exist and it is time that sign languages are brought into the "Universal" equation.

2.3. Laws governing Spoken Numbers:

This broad mix of number systems (which rely on adding, subtracting, multiplication & division) presents some pertinent questions. For example, how does one remember the logic of using a number system? Numbers are not recorded in the same way as general vocabulary words are; '*ninety-seven*' cannot be retraced and found in the dictionary. Therefore, what are the laws that govern number systems that enable it to be widely used?

> *Number words had to be combined, of course, unless an impossibly large quantity of them were to be invented. The combination of number words have not followed any thought-out, clearly recognized plan, but quite often have had to be put together awkwardly from words already at hand.* (Karl Menninger, 1969: 86).

Number words have been combined to allow the speaker to reach a higher cardinal ranking. As demonstrated in the last section, counting is not a straightforward process.

> *... counting is a matter of competence rather than performance, since presumably nobody will ever count to some very large number. As long as there is a*

> *procedure such that given a numeral expression for any number, speakers can produce the next highest number, this is sufficient.* (Greenberg, 1978: 254)

There are two key reasons for this recursive logic to numbers. Firstly, it avoids having to count your interlocutor through every individual number till you reach your desired point of reference. Secondly, without a recursive mechanism, each individual number would require a unique name. Imagine having to devise and remember unique names for each cardinal number up to a Centillion. It would be an impractical and highly inefficient system for people to use. Number systems need a recursive mechanism that can be tracked through a logical progression for it to be received and understood when communicating. Languages have, therefore, developed systems using a concept known as 'base'. Number systems around the world have mainly been found to use a base system of five, ten (decimal) (10) or twenty (vegistmental) (Comrie, 2005; *in press*). 'Base' can be defined as the *numerical value to which various arithmetical operations are applied* (Comrie, *in press*: 4).

Table 2.2 demonstrates many different types of numeral bases in existence. Number systems are known to use more than one numerical base, such as the Supyire (Niger-Congo), and/or exponentiation, raising the base to various powers (Comrie, 2005). An example of an exponentiation is the English *hundred* (10^2) and *thousand* (10^3). Unlike the Chukchi example, where two-hundred is expressed using a transparent process (40 x 40), English uses the special and opaque expressions, '*hundred*', and '*thousand*'. Nowhere in the expression does it denote second or third power of the base (Comrie,

2005). The value of both meanings is shared in an implicit way between users of the English language as to be the next base level and divisible by 10.

Table.2.2

Base #	**Reading**	**Meaning**
5	*Five times five times another five times five, and four times five, one upon* (Luiseno; Uto-Aztecan, USA) [2]	$(2 \times 5^2) + (4 \times 5) + 1$
10	*Èr-shi-qī* (Mandarin;Chinese)	Two-ten-seven
20	*qliq-qlikkin* (Chukchi; Russian)[3]	20 x 20
60	*ena ma gait daimita muto* (Ekari; Trans-New Guinea ; Papua; Indonesia)	1 + 10 + 60
(Mix) 80, 40, 20, 10 & 5	*kàmpwóò ŋ̀kwuu sicyɛɛré 'ná béé-tàànre ná kɛ́ 'ná báár-cyɛ̀ɛ̀rè* (Supyire; Niger-Congo)[4]	400 + (4 x 80) + (3 x 20) + {10 + 5 + 4)}

2.4. Finger counting:

Finger counting, and its closeness to the formation of numeral systems, is reported in many of the spoken language typological studies (Eells, 1913; Menninger, 1969;

[2] English gloss only, found by Kroeber and Grace (1960) cited in Comrie, *in press*: 6
[3] Found in Comrie, *in press*: 3
[4] Found in Comrie, *in press*: 4

Greenberg, 1978; Mallory & Adams, 1997). The Yuki of Northern California used the spaces between the fingers to count (Mallory & Adams, 1997); this led to a base-8 system (octal) being used. It is also reported that the Babylonians used a base-12 system that originated from the number of knuckles on the four fingers of a hand (excluding the thumb). A highly common base is the base-10 system (decimal) which corresponds to the number of fingers and thumbs found on the human hands. Many other civilizations, such as the native American Indians, continued the counting from the hands down to the feet and used a base-20 system (vigesimal), where one person equates to 20 (Eells, 1913). The venerable Bede's devised a complex finger counting system which is reportedly a concept based on a Roman invention (Menninger, 1969). One other unique example is the Oksapmin in Papa New Guinea (Saxe 1999), see fig.1 below:

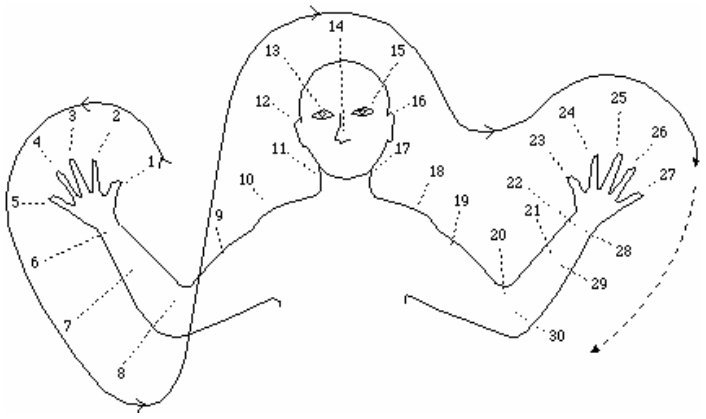


Fig.2.1. The Oksapmin counting sequence (Saxe 1999)

The Oksapmin counting pattern can progress on to a second and third run, running back and forth around the body, to denote higher cardinal values. It is interesting to note that as humans our manual digits are instinctively used to support the counting process and this ultimately leads to defining a base system. These are examples of hearing cultures and communities using visual means to represent numbers. Despite the same human physical endowments, the manual counting mechanism can be devised in different ways using the fingers, knuckles, feet, and other bodily parts.

2.5. Research on Sign Language numbers:

As mentioned in the introductory chapters, this is the first typological and descriptive study of regional BSL numbers. Existing research on BSL numbers are limited and can be broken down into Cognition and Numbers (Bull, Marschank & Blatto-Vallee 2005; Bull 2006) and general British Sign Language teaching tools (including the BSL Dictionary). These materials aspire to a different goal and provide limited data and explanation of BSL numbers. The BSL Dictionary described two of the most common variations including pictures on the following numbers: 1-20, 30, 40, 50, 60, 70, 80, 90, 100. The University of Central Lancashire produced a DVD which covers a broad range of regional numbers; however, this DVD only displays a random and limited set. The numbers expressed in the DVD are based on stories told by deaf individuals, 'going to the bank', 'what I did on my birthday' etc. None of these materials provide an in-depth typological or descriptive analysis of BSL numbers, they types of variations and rules that govern their usage.

2.6. The internal structure of signs:

This final section provides some understanding of the phonological parameters and properties that exist within a sign. Sign Languages are natural languages and depend on different articulators from spoken languages; the hands, body and face. Research on sign languages since the 1960s have found three main phonological parameters (phonological is used to refer to properties of the form of a sign): Handshape, Movement, and Location. The pioneering work by William Stokoe (1960) demonstrated that the signs used by the American Deaf community were not mere unanalysable gestures but in fact had properties that could be broken down into small, recurring segments. A change in one parameter can often lead to a minimal pair. Since Stokoe's work other minor phonological features within the established lexicon have been found to come into play such as internal movements, orientation of the palm and non-manual features.

2.6.1. Handshape:

The shape of the hand for any sign is commonly known as 'handshape' or 'hand configuration'. Handshape refers to the configuration of the fingers in a sign as it is articulated (Ann, J 2006); for example, the extension of the index finger and thumb for *BIRD* or the extension of four fingers and one thumb for *DUCK* (see fig.2.3). These extended fingers are defined as 'selected fingers'.

Selected fingers are the fingers that are able to move or contact the body during the course of executing a sign (Brentari & Padden, 2001). Unselected fingers remain closed

within the fist or if extended are passive in comparison to the active and moving selected finger/s.

Fig.2.3: Minimal pair distinguished by select fingers:

BIRD *DUCK*

Research has shown that once fingers have been selected they then remain selected until the completion of the sign. Within the established lexicon a finger cannot change status from being selected to unselected finger mid-way through a sign. It is only the position of the fingers that may change not the selection of fingers.

Within handshape there are other parameters of lexical contrast like the selection fingers such as internal movement (Brennan et al, 1990; Brentari, 2000; Sandler & Lillo-Martin, 2006). These internal movements are a sub-phonological parameter and can be defined as a change in finger position (e.g. flickering movement or an extension of the selected fingers) or a change in palm orientation (e.g. a repeated twist at the wrist).

Fig.2.4. Minimal pair distinguished by internal movement:

DANGER

(no internal move)

PHILOSPOHY

(trilled movement of the fingers)

An important distinction of handshape is if the configuration is defined as marked or unmarked. The definition adopted here follows the criteria set out by Jakobson ((1986 [1941]) cited in Sandler & Lillo-Martin, 2006: 160) *less marked handshapes are easier to produce, aquired early by children, and resistant to loss in aphasia*. Jean Ann (2006) analysed the frequency of occurrence and ease of articulation of sign language handshape for Taiwanese Sign Language (TSL). Based on a physiological criteria Ann (2006) provided a detailed description of easy to difficult handshape ratings and collect frequency of occurrences data from a conversational setting and from the TSL dictionary. Ann (2006) found that ease of articulation did not necessarily dictate the frequency of occurrence (Anne.J, 2006: 181). Marked handshapes were just as likely to be found and used in as many lexical signs compared to unmarked handshapes.

2.6.2. Movement

All sign have movement in them, transitional moves, path movements made by the hand or hands as they go from one location to another, a change in handshape, a change in orientation, or a combination of these (Brennan et al, 1990; Schembri, 1998; Sandler & Lillo-Martin, 2006). Signs that are static and bear no phonological movement are equally as valuable and meaningful as any sign which does contain movement.

The types of movement can be broken in to two categories, path movements and internal movement. Path movement can include straight (up, down, towards, away, diagonal), arc, circle, spiral or ASL '7' (Brennan et al, 1990; Sandler & Lillo-Martin, 2006; Johnston & Schembri, 2007).

Fig.2.5. Straight path movement:

NEW

(movement up from behind the non-dominant hand)

Fig.2.6. Circle path movement:

PRAISE

(alternating circular move led by the dominant hand)

In the sign lexicon the inventory of path movements is far more limited, and the possibilities for their combination is strictly constrained compared to the classifier system (Sandler & Lillo-Martin, 2006: 196). For example, Brentari (1998) and Sandler (1993) both found that there are a maximum of two distinct movements per lexical sign.

Fig.2.7. Minimal pair distinguished by path movement

HOW

(symmetrical move in)

TECHNOLOGY

(symmetrical move down)

For internal movement there are; hooking, flattening, releasing, squeezing, rubbing, twisting, nodding, circling, swinging, oscillating, trilled (rapid repetition of handshape or orientation), or finger wiggle.

Fig.2.8. Flick internal move:

MAGIC

(Select fingers flick open)

Fig.2.9. Twisting internal move:

BARBEQUE

2.6.3. Location

The place of articulation can be located around the body in a number of ways. Brennan et al (1990) list the following locations, signing space (the neutral space in front of the signer's body), head, torso, arms, wrist and the non-dominant hand. Within these allocated domains there are known subcategories to exist. The head has multiple sub-areas for example, forehead, temple, eyes, ears, cheek, nose, lips, chin, and neck. This list is not complete and a further detailed list can be found in Johnston & Schembri (2007). The sign itself can either make contact with the specified location or articulated close to the designated area.

Fig.2.10. Minimal pair distinguished by location:

NAME

AFTERNOON

Research on Australian Sign Language (AUSLAN) shows signs are mostly distributed around the *'head, face, neck locations'* or *'trunk and arm locations'* (Schembri 1996: 37). Few signs will be produced around the back of the body, top of the head, below the waist due to the physical effort and visibility constraints. These are what Brennan et al (1990)

has called as atypical space. The location of a sign is not always fixed and can change during the production of a sign. It is known that signs do have contrasting start and end points.

2.6.4. Orientation:

Orientation was the fourth proposed major phonological parameter of a sign. Originally it fell in to the category of hand configuration; however, as the images show these are clear examples of minimal pairs distinguished by the orientation of the palm.

Fig.2.11. Minimal pair distinguished by palm orientation:

MEET

SAME

THING

The orientation of the palm can be directed in the following ways, up, down, left, right, in (toward the signer), out (away from the signer).

Orientation of the palm may have originally been discredited as a primary phonological characteristic since it is often guided by which handshape is being produced. Certain handshapes restrict the directionality of the palm and therefore not considered an essential feature. However, this old school of thought is beginning to change as current research redefines and reclassifies this phonological parameter to be of primary importance.

2.6.5 Other phonological considerations:

Other phonological considerations include the use of hand arrangement and the non-dominant hand. Hand arrangement is concerned with features such as, is the sign produced with one or two hands? If the sign is produced using two hands, what is the relationship to each other? Sign are predominantly produced using the main articulator, which is known as the dominant hand. The dominant hand varies on an individual basis, it depends if the signer is a left handed or a right handed. The passive hand is defined as the non-dominant hand and is restricted with its range of usage. Battison (1978) provide a six fold classification describing these constraints and relationship between the dominant and non-dominant hand. These constraints have been tested against BSL and found to have general applicability (Brennan et al. 1990: 9). Brennan et al (1990) explain that hand arrangement is first concerned with how many sign are. Brennan et al. have shown that minimal pairs can be found in BSL that contrast only in hand arrangement.

Fig.2.12. Minimal pair distinguished by one hand vs two hands

PERHAPS

PARTY

Fig.2.13. Minimal pair distinguished by hand arrangement:

JOIN
(move in)

RELEASE
(move away)

3.0 Methodology

The aim of this study was to elicit a range of BSL number signs for a typological and descriptive analysis. Variation in number systems can transpire through the main phonological parameters handshape, movement and location, as well as other minor parameters such as internal movement features. The collection of data was completed and filmed in two separate stages. The first stage was a pilot merely focusing on numbers 1 – 36, this was to establish what types of differences may exist. The second stage covered a wider number of participants and comprehensive number range (including a selection within the hundreds, thousands and millions).

All participants gave written consent to being filmed for this study, see Appendix 3 for a copy of the 'Participant consent form'.

3.1. The experimenter

The collection of data and filming was carried out by a fluent hearing native user of BSL who uses a London South/East number dialect.

It is important to note that some Deaf participants may be conscious they are communicating with a hearing experimenter thus influencing their style or choice of number usage. Deaf people have been known to adopt a different style or lexical choice of BSL. These adapted items tend to be more widely know or highly transparent in its

iconicity rather than a particular abstract variation. This is a communication strategy used by many Deaf people to avoid misunderstandings.

3.2. Participants

In total fifty-one participants were filmed for this study. Nineteen participants were Deaf native users and came from a Deaf family; one participant was a hearing native user of BSL and came from a Deaf family; Thirty-one were Deaf and from a hearing family. Nine participants were filmed in the pilot study and forty-two participants were recorded in the comprehensive follow up study.

The aim of this research was to gather as much number variation as possible, therefore, no strict selection criteria was followed. The experimenter was unaware before the filming what type of variation would be produced by the participant. This approach left the possibility open of finding unique samples of number constructions. However, it has resulted in an unbalanced distribution of number variations within the data set.

Thirty participants gave written consent for their film clips to be shown as part of this MA thesis. The remaining twenty-one participants only gave the experimenter permission to view the footage for linguistic analysis purposes. Therefore, to retain their individual rights for anonymity these participants could not be included in the final DVD.

3.3. Stimuli

Participants in the pilot study were asked and filmed by the experimenter to produce their number signs from 1-36, followed by a brief demonstration of their sign for '*hundred*', '*thousand*' and '*million*'.

The second study used power-point stimuli to elicit the number variations (see Appendix 1). Each participant was filmed and asked to respond to the questions shown on the power-point slides (name, region from, age etc) and then demonstrate their BSL number for the Arabic numerals shown on the screen. The use of Arabic numerals was seen as a neutral option which avoided other BSL or English influence. Furthermore, the British Deaf community are familiar with Arabic numerals and come into contact with these features in their daily lives.

A third alternative method was used to elicit the number data which accommodated the ability of the participants. Four of the elderly participants in this study were over the age of seventy and another two were in their Eighties. Four of these elderly participants were not able to count in full up to one-hundred. Instead they were recorded informally explaining their number expressions and known variations. The remaining two who were able to count up to one hundred successfully were only asked to count a select few numbers in the hundreds, thousands and millions. In all these cases the experimenter referred to sets of Arabic number displayed either on a computer screen or paper copy of the power-point stimuli.

3.4. Type of Analysis

The analysis will describe the different phonological features such as handshape, movement and orientation. This descriptive analysis will be a stepping stone to defining the variation types. Since there is no written equivalent of British Sign Language (BSL) the signs will be glossed using English italic capital letters: *ONE, TWO, THREE* etc. Number variations will be broken down using the following labels NV1a, NV1b, NV1c, NV2, NV3, and NV4. The analysis overall will provide generalisations and descriptive patterns that exist across all categories.

The descriptive analysis (Chapter 4) has been segmented into five sections; numbers 1-5, 6-9, 10, 11 – 19, and finally 20 – 99. These segments capture specific phonological patterns at certain points of the number system and represent key stages of phonological changes. Numbers above one hundred could not be included due to the limitations of space in this study. Instead the data recorded for numbers above one hundred will be discussed separately to this work.

3.5. Considerations:

McKee & McKee (2006) study on New Zealand Sign Language (NZSL) cardinal numbers asked participants to sign numbers 1 – 20 in a random order. The purpose of using random numbers is to prevent any skewed rhythmic pattern and substitutions for preferred number signs. If participants were asked to sign the numbers in chronological

order some would be more prone to drop *NINE* with the extended thumb handshape for the four extended digits (fig.3.1.).

Fig.3.1. *NINE*

For this current MA study there were approximately 145 Arabic numbers in the stimuli and to randomise every one could cause a higher rate of confusion and slips of the hands. Potentially this research could be criticised for not randomising the numbers as the rhythm built in the sequence is priming the following number.

4.0 BSL Regional Variation Number Analysis

4.1. Background:

In total fifty-one participants were filmed as part of this study, thirty of these participants can be viewed on the DVD accompanying this thesis. Table.1 provides a breakdown of the geographical location, age, gender and background. There was a high male, London, South-East and Liverpool presence therefore not all categories were evenly distributed. The method of collecting the data was an open approach and blind to the types of variations that may exist. The purpose of this approach was to record as many possible variations in use. Often the experimenter did not know beforehand what variation would be produced by the participants. Due to this highly unbalanced distribution of region, age, and gender, sociolinguistic factors are not discussed. This study would be ill-equipped to respond to such issues. All the factors discussed in this chapter focuses on describing the phonological variations have and what the underlying laws that governing these systems.

Several variations were found within this study and are classified based on phonological differences (NV1, NV2, NV3, & NV4). The fist number variation category is NV1 which represents the largest and dominant group of cohorts found in this study. Twenty-eight participants fit in to this umbrella group. The second category is NV2 with eleven participants and represents the second largest group. Both NV1 and NV2 were the same categories described in the BSL dictionary and classed as the most common types in

current usage. NV3 was the third largest with three participants and the final two participants were labelled as NV4.

Table.4.1:

Region	Male / Female	DoD / DoH	Age
Scotland	4 / 1	2 / 3	20 – 29 = 2 30 – 39 = 2 40 – 49 = 1
North – East	2 / 0	1 / 1	30 – 39 = 1 60 + = 1
Manchester	2 / 0	1 / 1	50 -59 = 1 60 + = 1
Liverpool	4 / 3	2 / 5	20 – 29 = 2 40 – 49 = 1 60 + = 4
Midlands	6 / 2	3 / 5	20 – 29 = 2 30 – 39 = 3 40 – 49 = 3
Wales	1 /1	0 /2	60 + = 2
Bristol	1 / 1	1 / 1	20 – 29 = 1 50 – 59 = 1
Oxford	2 / 0	1 / 1	20 -29 = 1 40 – 49 = 1
London	4 / 6	4 / 6	20 – 29 = 2 30 – 39 = 2 50 – 59 = 3 60 + = 3
South-East Coast	3 / 4	3 (1 HoD) / 4	20 – 29 = 1 30 – 39 = 2 50 – 59 = 3 60 + = 1
South-West Coast	0 / 2	2 / 0	30 – 39 = 1 60 + 1
Northern Ireland	1 / 0	0 /1	30 – 40 = 1
Hertfordshire	1 / 0	0 /1	30 – 40 = 1
TOTAL	31 /20	20 /31	20 – 29 = 11 30 – 39 = 14 40 – 49 = 6 50 – 59 = 8 60 + = 12

The unbalanced sizes for each group (NV1, NV2, NV3 & NV4) was an incidental consequence of the methodology. Sub-variations as well as idiosyncratic variations were observed; some participants admitted to using a mixture of these variations. Four participants were identified, or suspected, as mixing and were excluded for some parts of this study. For the reader's own interest Appendix 2 explains which geographical regions have been grouped into the NV categories.

4.2. Numbers 1 – 5:

Figs.4.2 – 4.4 demonstrate the various handshapes found to represent numbers *ONE* – *FIVE* in BSL. Differences between NV1, NV2 and NV3 occur at the sign *THREE*. From this point onwards the three number systems depart and differ in many other phonological ways. NV4 is temporarily housed within the NV1 category as no difference could be found. Phonological difference were not detect until the number *SIX* which is discussed in the next section (4.3).

Fig.4.1: NV1

ONE *TWO* *THREE* *FOUR* *FIVE*

Fig.4.2: NV2

ONE *TWO* *THREE* *FOUR* *FIVE*

Fig.4.3: NV3

ONE *TWO* *THREE* *FOUR* *FIVE*

Of the fifty-one participants filmed NV2 and NV3 *THREE* variant (three fingers and one thumb) was only found in five participants while the NV3 *FOUR* variant only occurred in four participants. There are two possible explanations for this imbalance. This first is undoubtedly linked to the low number of people filmed using the NV3 dialect. The second is several participants from the NV2 category appear to be using a hybrid of two variations. Evidence presented in Chapter 5.2 suggests that latter point is true. Possible diachronic changes have occurred to some of the NV2 number expressions.

The pictures above demonstrate that there is a linear process of counting which resembles a tally format. Each manual digit represents one cardinal value. There is a conventionalised mode of progression which starts from the index finger and moves through the neighbouring digits. With exception of NV2 *FOUR* (fig.4.3), once a select finger comes in play it remains selected for all higher numbers. Each finger is designated a specified cardinal ranking: the index finger is the 1st cardinal number, the middle finger is the 2nd, the ring finger or thumb is 3rd, the 4th digit is either the little or ring finger, and the final expandable digit is allocated the 5th cardinal ranking. NV2 does not conform to this observation since the thumb disappears (unselected) for *FOUR* and reappears for *FIVE* (reselected) (fig.4.3). The disappearance and reappearance of a select finger interferes with an expected and established flow along neighbouring digits. This is the first suspected evidence of a hybrid between two number systems and is discussed further in sections 4.5, 4.6 and Chapter 5.4-5.5.

It is important to note that handshape is the critical phonological feature for all number expressions. The dominant hand is the main and only articulator and is capable of operating alone. The orientation of the palm has been conventionalised and inverts inwards towards the signer's body. Neither movement nor the non-dominant hand has any significant or phonological role. Movement can only be found as transitional, a means of moving on to the next cardinal number.

Place of articulation appears to be specifically allocated to neutral space, the signing space in front of the body. This observation is not complete as Chapter 5.1 explains the location of the sign can be manipulated for spatial and semantic meaning.

4.3. Numbers 6 – 9:

Four number variations were observed and four of the fifty-one participants demonstrated a mixing of regions. Participants were deemed to be mixing if they did not perform a linear progression of select fingers as described in section 4.2. NV1 has been divided into two sub-categories N1 and NV1b since there was a partial digression in phonological features.

As observed with *ONE – FIVE*, where *SIX* begins defines how the progression through to *NINE* is completed. NV1 and NV1b participants began counting *SIX* from the thumb, and progressed along neighbouring digits which ended at the ring finger[5]. NV2 and NV3 participants provided an alternative spreading from the little finger through to the index finger[6]. Finally NV4 participants began the sequence from the index finger down to the little finger. This method of counting reinforces the concept of a tally counting system. Each manual digit bears the weight of one cardinal value.

[5] Note that mathematically the little finger is beyond the reach of *NINE* since it is the fifth digit away from the thumb.
[6] The thumb is also beyond the reach of *NINE* since it is the fifth digit away from the little finger.

Fig.4.4. NV1:

SIX *SEVEN* *EIGHT* *NINE*

Fig.4.5: NV1b

SIX *SEVEN* *EIGHT* *NINE*

Fig.4.6: NV2 & NV3

SIX *SEVEN* *EIGHT* *NINE*

Fig.4.7: NV4

SIX *SEVEN* *EIGHT* *NINE*

NV1 and NV1b both began a coherent progression of counting from the thumb but demonstrated some phonological differences. These differences are transitory and could be argued as still being part of the same category. *SIX* is almost identical for both NV1 and NV1b except for orientation of the palm. No current explanation can be given for this anomaly. Nowhere in the BSL number system does the palm orientate outwards for unit based numbers (*ONE – NINE*). Visibility of the handshape is equally transparent and does not improve with an outward palm orientation. Despite the difference in palm orientation the selection of fingers for numbers *SIX – NINE* correlate strongly between the two. The second difference between NV1 and NV1b is the number *NINE*. NV1 *NINE* is articulated using only four manual digits and abides to the expected progression of select fingers. NV1b appears to have over extended the expected number of manual digits. This over extension by default has converted a marked hand configuration (three fingers and one thumb) to an unmarked form (five extended digits).

Fig.4.8: Marked & Unmarked

Marked

Unmarked

It is possible that the unmarked NV1b version is a modified form of the NV1 marked handshape. Reasons for modifying this handshape is discussed further in Chapter 5.2. As this study repeatedly shows this marked handshape is substituted for alternative unmarked counterpart. The cause for this substitution is possibly due to a difficulty in producing the marked handshape configuration.

Another observation concerning the number expression *NINE* is NV2's similarity in handshape to *FOUR*. For now the two identical handshapes can be defined as a cardinal homonymy. Both handshapes recruit the same selected fingers, same palm orientation, same location and require no movement of any kind. This observation is repeatedly noted throughout this study and is suspected as being a general avoidance of an alternative marked handshape. One clear difference between the two number expressions is the orientation of the finger. *FOUR* is always expressed with a vertical up finger orientation while *NINE* has a horizontal out orientation. This same observation is discussed further in Chapter 5.4.

For some participants from NV1, NV1b, NV2, and NV3, the non-dominant hand was explicitly articulated in conjunction with the dominant hand see fig.4.9.

Fig.4.9: Non-Dominant hand

EIGHT

The majority of cases participants dropped the non-dominant hand from complete sight. Of the forty-four NV1, NV2 and NV3 participants (those who did not demonstrated a mixing of number variations) only four overtly articulated the non-dominant hand for numbers *SIX* - *NINE*. It appears to be easier to use one main articulator instead of raising and dropping the non-dominant hand throughout the counting sequence. It is worth noting the use of lip-pattern in conjunction with the established and distinctive handshapes for numbers *SIX – NINE* was enough for the sign to function alone. The main articulator can serve the intended purpose sufficiently while the second can be implicitly expressed out of sight.

The role of the non-dominant hand was pivotal for NV4 number expressions *SIX – NINE* (fig.4.7). It was the place of articulation and a symbolic representation of the base-5 concept. As the sign for *TEN* demonstrates each fist denotes the value of '+5', therefore, each extended finger expressed on the dominant hand is an 'addend' (a value that is added to the base-5 non-dominant hand). The dominant hand retains the same sequence of handshapes described in *ONE – FOUR* for *SIX – NINE*. The recruitment of the non-dominant hand differentiates the handshapes described for numbers *ONE - FIVE*.

To summaries, movement serves no specific phonological purpose as found with numbers *ONE – FIVE*. Location is articulated in again is established in neutral space except for NV4. The place of articulation for NV4 is on the non-dominant hand, which itself is positioned in neutral space.

4.4. Number 10:

The sign *TEN* has been isolated for descriptive purposes as there are several inconsistencies across many of the regions due to sub-regional and idiosyncratic variations. The pictures in the following sections provide a clear indication of the two handed number expressions. The following signs were found:

Fig.4.10:

2 x ‘5’ handshapes

Fig.4.11:

‘5 handshape’ + internal move (flick out or wiggle from the wrist)

Fig.4.12:

Closed handshape + move = full open spread

Fig.4.13:

‘T handshape’ + internal move (wiggle from the wrist)

Fig.4.14:

‘S handshape’ + internal move (wiggle from the wrist)

Fig.4.15:

‘5 handshape’ + internal move (wiggle from the wrist)

Fig.4.16:

‘2 x base-5’ or ‘5 + 5’

For obvious reasons fig.4.10 (2 x ‘5’ handshapes) retains the concept of a tally, each extended manual digit equates to the value of ten. As noted earlier the non-dominant hand has been known to drop for efficient ease in articulation. The same can be found for fig.4.11, the non-dominant hand has been made redundant possibly due to the internal move. So far movement has only been considered as transitional between signs. This is the first example of movement as part of the phonological parameter. A single ‘5’ handshape (all fingers and thumbs extended) clearly denotes the value of five while the added flick or wiggle from the wrist spatially implies, “*more than one*”, or “5 x 2”, or “5 and 5”. Fig.4.12 uses the same concept with an internal move. The sign begins as a closed ‘O’ handshape and finishes with the extension of all five manual digits.

Fig 4.13 & 4.14 at first appear to be very similar in handshape, ‘closed fist and twist at the wrist’. However, there is a subtle difference found in the articulation of the thumb. Fig 4.14 corresponds to the Irish Sign Language (ISL) *TEN*. The handshape represent the initial ‘T’ from the ISL manual alphabet. The closed fist handshape (‘S’ or ‘T’

handshape) resembles a metaphoric representation of ‘density’ or ‘maximum’, the additional move add to the essence of ‘*the limit*’ or ‘*complete*’.

Note that fig.4.15 is an unusual handshape and is classified as a marked form. This is the only example found from this study and is used in the BSL lexicon such as; *LIVE*, *LIFE*, *TOILET*, and *THEATRE*. No current explanation can be offered as to why this handshape is used to represent the value *TEN*. One possible argument is for the dominant handshape *TEN* to remain distinctive from the *FIVE* handshape.

Fig.4.16 belongs to NV4 and maintains the concept of a closed fist to represent base-5. Each closed fist assumes the value of five and provides a symmetrical iconic representation of “2 x 5” or “5 + 5.

4.5: Numbers 11 – 19

Handshape and palm orientation were the two main phonological parameters for defining the BSL cardinal numbers from *ONE* to *NINE*. As the counting approached ten the same handshapes to describe *ONE – NINE* reappear. Therefore, other phonological parameters such as movement become significant in establishing differences between lower and higher based numbers.

NV1 is now divided into the following three categories, NV1a, NV1b and NV1c. Differences with the number expressions *ELEVEN* and *TWELVE* was observed in addition to the *SIX* and *NINE* handshapes described in section 4.3.

NV1a, NV1b and NV1c *ELVELN* and *TWELVE* do not behave in the same way as other "*teen*" numbers. This pattern coheres to the English anomaly for the missing '*teen*' in '*Eleven*' and '*Twelve*'. This is an indicator of language transference – the roots of an English Indo-European number systems spreading to another language of different modality. This is not surprising as the British Deaf community are a minority with an English speaking majority. Their schooling and work life would involve using an English written number system. There is still an iconic connection in all examples, the number *ELEVEN* has one extended moving digit and *TWELVE* has two. These extended moving digits are the same selected fingers used for numbers *ONE* and *TWO*.

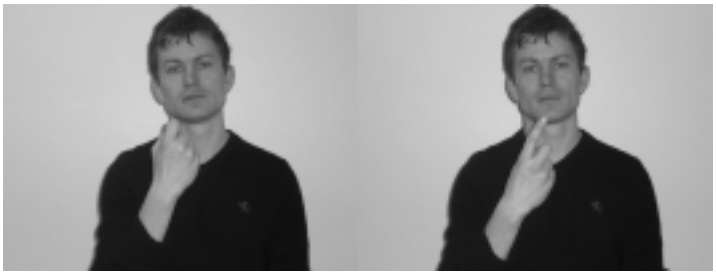
Fig.4.20: NV1a & NV1b *ELEVEN*

Internal move (index finger tapping thumb)

Fig.4.21: NV1a & NV1b *TWELVE*

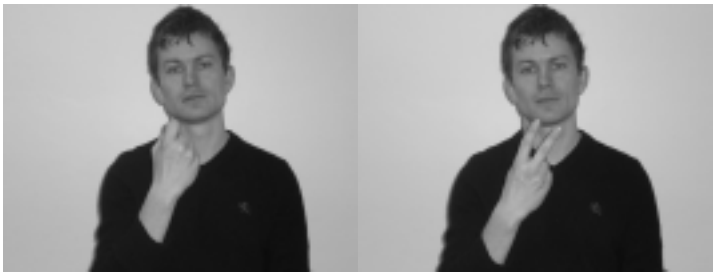
Internal move (index & middle finger tapping thumb)

Fig.4.22: NV1c *ELEVEN*



Closed fist + internal move (index finger flick open)

Fig.4.23: NV1c *TWELVE*



Closed fist + internal move (index & middle finger flick open)

The place of articulation for NV1a and NV1b *ELEVEN* and *TWELVE* is a localised tapping on the thumb. NV1c instead uses localised flick extension on the selected fingers. The remaining numbers *THIRTEEN – NINETEEN* for NV1a, NV1b & NV1c followed a simple formula of Handshape + path movement:

Fig.4.25: NV1 *SEVENTEEN*

Handshape + Side to side move

The side to side movement incorporates the same handshapes defined in section 4.2. There does not seem to be a strict limit on the repetition of the side to side movement since participants varied between two - four moves. Once again the non-dominant hand is used inconsistently for *SIXTEEN* to *NINETEEN* and appears to be articulated on individual preference. There were only ten recorded instances of non-dominant hand usage from forty-four NV1, NV2 and NV3 participants singing numbers *SIXTEEN - NINETEEN*. This result shows that the non-dominant hand was overwhelmingly dropped by NV1a, NV1b, NV1c, NV2 and NV3 participants.

The NV4 region provides a straightforward concept of counting and uses a consistent and clear formula. The sign *TEN* is always pronounced explicitly, the joining of two closed fists, followed by a flick movement where the second cardinal figure is articulated (as found in *ONE – NINE*). For the number '*ELEVEN*', one would sign '*TEN* – flick – *ONE*'; or if one was to sign '*SEVENTEEN*', one would sign '*TEN* – flick – *SEVEN*'. Numbers *ELEVEN* to *NINETEEN* recursively build on an agreed method of counting established from *ONE* to *TEN*.

Fig.4.26: NV4 *TWELVE*

TEN + *TWO*

Fig.4.27: NV4 *SEVENTEEN*

TEN + *SEVEN*

NV2 and NV3 *ELEVEN – NINETEEN* were highly complex to define for several reasons. Firstly, there is a change in the handshape sequence for numbers denoting *ONE – FOUR*. The counting process for *ELEVEN* is realigned and begins from the thumb instead of the index finger. The linear counting then builds round to the little finger for *FIFTEEN*. The handshape itself merely denotes the cardinal addend '***ONE*** + *TEN*', '***THREE*** + *TEN*', '***NINE*** + *TEN*' etc. It is the movement which denotes the second set of higher based numbers.

Fig4.28: NV2 & NV3 *ONE - FOUR*

ONE *TWO* *THREE* *FOUR*

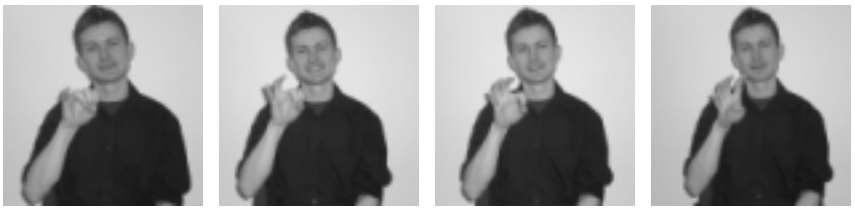
Many of the handshapes were marked and required an additional complex internal move. The marked nature of a sign plus internal move generated some idiosyncratic variations within both categories. The internal move for numbers *ELEVEN – FIFTEEN* was a curling, bending or flickering of the selected fingers. Some participants used a combination of these internal moves. This mixing of local movements may be a consequence of the marked nature of the move, which itself changes in markedness based

on the select finger/s recruited. For example the thumb physically cannot curl back in the same way the index finger can.

Fig.4.29: NV2 & NV3 *ELEVEN – FIFTEEN*:

ELEVEN *TWELVE* *THIRTEEN* *FOURTEEN* *FIFTEEN*

Fig.4.30. NV2 & NV3 *SIXTEEN – NINETEEN*:



SIXTEEN *SEVENTEEN* *EIGHTEEN* *NINETEEN*

As Fig.29 demonstrates there is a difference with the selection fingers between *ONE* and *ELEVEN*, *TWO* and *TWELVE* (see section 4.2). However, numbers *THIRTEEN* to *NINETEEN* maintained the same sequence of progression as numbers *THREE – NINE* (as described in section 4.2 and 4.3). One possible explanation for this discrepancy is another example of the English "*eleven*" and "*twelve*" missing "*-teen*". However, unlike

the other number variations in this study the changes are rooted in the selection of fingers and not the movement parameter. This change in finger selection is permanent adaptation for all higher numbers. These changes observed results in a more coherent mode of progression beginning from the thumb as opposed to the linear progression described in section 4.2. The change in sequence from the thumb is discussed further in Chapter 5 as being a hybrid of two counting systems.

The key difference between NV2 and NV3 participants is the number *FOUR* in *FOURTEEN*. Participants from NV3 used a marked handshape and maintained an expected linear mode of progression commencing from the thumb. Eleven out of the thirteen participants for NV2 violated this expected mode of progression and possibly substituted the marked handshape for an unmarked counterpart. This same handshape was discussed in section 4.3 for NV1b *NINE*. NV1b participants appeared to have substituted the same marked handshape *NINE* by over extending all manual digits and removing any gaps between the fingers. NV2 instead recruit an identical handshape configuration for *FOUR* and *NINE*, *FOURTEEN* and *NINETEEN* to overcome this difficulty in articulation. This inevitably results in a cardinal homonym for numbers denoting the value of *FOUR* and *NINE*. The nature of this marked handshape has frequently disrupted an expected flow progressing along neighbouring fingers and continues to do so throughout the remained of this study.

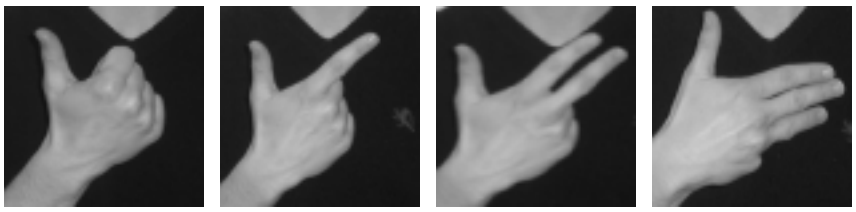
4.6. Numbers 20 – 99:

The counting process described for *TWENTY – TWENTY-NINE* develops in a similar recursive pattern for numbers up to *NINETY-NINE*. NV3 and NV4 show minor modifications to the phonological elements upon reaching *SIXTY*; such as a change in movement, orientation and/or location. These changes arise for articulation purposes to accommodate complex handshapes and internal moves.

The labels previously used for NV1 sub-categories (NV1a, NV1b, NV1c) will only be used to distinguish instances of sub-variations. For simplicity with the current discussion the generic label NV1 will be used henceforth to encapsulate all three sub-categories. All handshapes sub-variations still exist as described over the preceding sections (*SIX* and *NINE*).

The same NV1 and NV4 handshapes *ONE – NINE* described in sections 4.2 and 4.3 are reused throughout the entire counting process. There are phonological discrepancies and changes which occur with the established handshapes for participants from NV3 and NV2. For the following discussion NV2 has now been divided in to two sub-categories (NV2a and NV2b). NV3 and NV2a maintain the realignment described in the previous section *ELEVEN* to *FOURTEEN*, see fig.4.31.

Fig4.31: NV2a & NV3 *ONE* - *FOUR*:



ONE *TWO* *THREE* *FOUR*

The thumb replaces the position of the index finger and becomes the starting point for the linear mode of progression. NV2b participants however revert back to the linear progression from the index finger as described in section 4.2, see fig.4.32.

Fig.4.32: NV2b *ONE* - *FOUR*

ONE *TWO* *THREE* *FOUR* *FIVE*

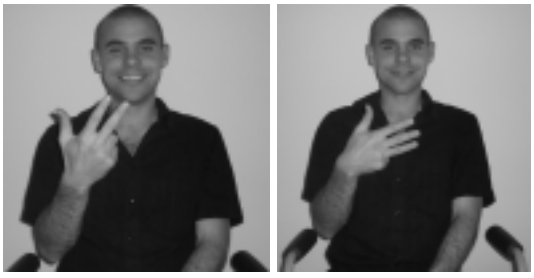
This double shift in alignment for NV2b participants is another piece of evidence which support the claim of a hybrid number system. It is important to note that for three of the NV2b participants this shift back to the previous established handshapes is delayed and does not occur until reaching *THIRYTY*.

The spatial and sequential movement found for all number variations could be best described as an equivalent to the English morpheme "*-ty*". For example, the sign *TWO* denotes the value 2, the arched move right represents the base-10 "*-ty*", and the second handshape *FOUR* denotes the second (lower) placement value.

Fig.4.33: NV1 *FOURTY-SIX*

FOUR + outward sweep ('*-ty*') + *SIX*

Fig.4.34: NV1 *EIGHTY-NINE*

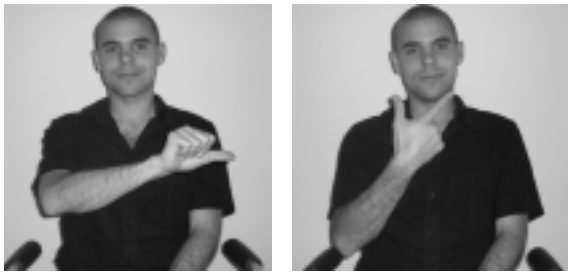


EIGHT + tilt at wrist + *ONE*

Fig.4.35: NV1 *TWENTY-ONE*

TWO + *m*ove right + *ONE*

Fig.4.36: NV1b *SIXTY-SEVEN*



SIX + orientation change + *SEVEN*

Fig.4.37: NV2 *SEVENTY-FOUR*

SEVEN + wrist move + *FOUR*

Fig.4.38: NV2a & NV3 *TWENTY-THREE*

TWO + orientation change + *THREE*

Fig.4.39: NV2b *THIRTY-TWO*

THREE + orientation change + *TWO*

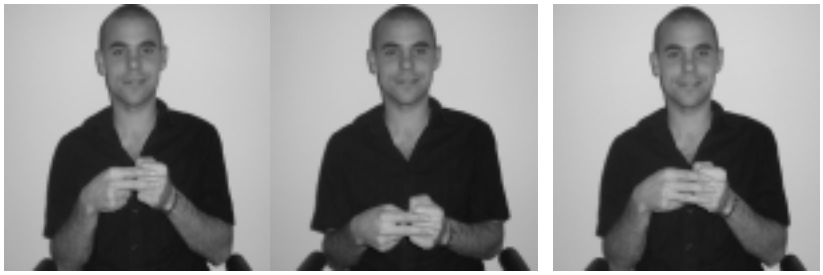
Fig.4.40: NV3 *SEVENTY-THREE*

SEVEN + orientation change + *THREE*

Fig.4.42: NV4 *SIXTY-FIVE*

(*SIX* + circling move) + *FIVE*

Fig.4.43: NV4 *SEVENTY-EIGHT*



(*SEVEN* + Circling move) + *EIGHT*

Fig.4.44: NV4 *TWENTY-NINE*

TWO + *NINE*

All regions maintain the English written Arabic order of *tens* + *units*; therefore, the first number shown is always of the higher value and the second being the lower value.

The orientation of the palm for the lower unit based numbers always finished facing **in** towards the signer (except for the NV1b *SIX*). However, the orientation of the palm for the higher based numbers was inconsistent. In addition, the types of movement between "*Tens* – **move** – *Units*" were also highly inconsistent. These two phonological inconsistencies were possibly a methodological fault. Participants were asked to count up a stream of numbers (1 – 100) thus building a momentum which skewed the natural movement rhythm and palm orientation.

There were several types of movement found to exist between the two number expressions. Thirty-seven of the participants mainly demonstrated a simple move to the right[7], thus leading to a change in location. This move to the right was often reduced to a simple tilt from the wrist. Few elder participants from the NV1 category would use an outward sweep to the right. NV3 and NV2a participants generally used a palm orientation change (out to in). This same palm orientation change was infrequently used by other categories intermittently. The mixing between the types of moves such as a tilt at the wrist or palm orientation rotation could be defined as a movement reduction. One can easily manoeuvre a tilt at the wrist or orientation change in sync with a handshape change. This reduced synchronised movement would speed up the counting process.

[7] Right handed signers demonstrated a move to the right while the opposite direction was observed for left handed signers. This applies to all types of movement described in this study; left handed signers will perform the opposite movement direction to right handed signers.

For participants from NV1, NV2b and NV4 the outward orientation could possibly be a left over affect from signing *ZERO* for numbers divisible by ten (2<u>0</u>, 3<u>0</u>, 4<u>0</u>, 5<u>0</u>, etc). Numbers ending with a *ZERO* (20, 30, 40, 50) tended to finish with a palm out or a palm profile orientation. If the palm for *ZERO* was to face inwards the receiver's vision would be obscured by the back of the hand. For visibility purposes *ZERO* is articulated either with a palm out or profile perspective, see fig.4.45.

Fig.4.45: *ZERO*

ZERO (Palm in) ZERO (Palm out) ZERO (Palm profile)

As a consequence the momentum built from signing "*THREE* – *<u>ZERO</u>*" or "*SEVEN* – "*<u>ZERO</u>*", where the number ended with a palm 'out' or 'profile', may have trigged a 'palm out – palm in' rotation sequence to follow. If so, this theory implies there is an assimilation of palm orientation or movement. A follow up investigation is required to ascertain if this assumption is true.

The articulation of expressing ten-based numbers for NV3 and NV2b (20, 30, 40, 50) incorporated a select finger tapping of the thumb, see fig.4.46. This internal move (tapping of the thumb) only applies for numbers up to *FIFTY*.

Fig.4.46: *TWENTY - FIFTY*

TWENTY *THIRTY* *FORTY* *FIFTY*

Due to visibility constraints, as described with *ZERO*, these numbers require a palm out orientation. Hence the orientation rotation between ten based numbers and unit based numbers for NV3. Facing any other direction would shroud the visibility of the select finger making contact with the thumb. The select finger performing the tapping is related to the allocated ranking of the select finger. *TWENTY* would be expressed using the second finger in the sequence, *THIRTY* is articulated by the third finger, *FOURTY* the fourth and so on. The select finger replaces the original role of the index finger for *ZERO*, see fig.4.45. This assimilation of handshapes has reduced the length of signs from two moves to one move. Instead of signing "*TWO + ZERO*" the sign *TWO, THREE*, *FOUR* and *FIVE* have been recruited into the sign *ZERO*. Upon reaching *SIXTY* the

tapping of the thumb no longer works since it would replicate numbers *TWENTY* to *FIFTY* backwards. Instead the establish handshapes for *SIX – NINE* (little finger round to index finger, see section 4.3) assume an internal move, a curling back of fingers.

The NV4 counting sequence from *TWENTY – FIFTY-NINE* was not too dissimilar to the pattern described for NV1 – NV3. The same handshapes for *ONE – NINE* were reused and placed in sequential order of "*Tens + Units*". Movement appeared to be for transitional purposes and numbers were built in sequential ordering. For unit based numbers ending *ONE –FIVE* there was a path movement left[8], while unit based numbers ending *SIX – NINE* the movement needed to be directed toward the non-dominant hand. Upon reaching *SIXTY* a natural change in movement arose due to articulatory constraints. NV4 numbers *SIX – NINE* could not be articulated with a rightward sweep, tilt or change in palm orientation since the location was fixed on the non-dominant hand. Once the two hands are in contact this immediately reduces the scope for movement. The move instead is a forward circling motion; which is easy to articulate when there is contact between the dominant and non-dominant hand, see fig.4.42 & fig.4.43.

Overall, the key features which distinguish higher based numbers from the lower unit based numbers is; 1) the sequencing of handshape changes; 2) the spatial location between *TENS* (to the left) followed by the *UNIT* (to the right); and 3) the movement in between the two handshape changes. The location and movement parameter are additional phonological characteristics that develop simple handshape configurations into complex lexical items.

[8] Or right for left handed signers.

Finally, the non-dominant hand was only consistently used by NV4 participants since it form the place of articulation for the number expression. All other participants predominantly operated with the single dominant hand.

5.0 Discussion

The following chapter will provide several generalisations that encapsulate the nature of the BSL cardinal number system. The purpose of these generalisations is to provide an explanation of the cardinal numbers expressions and interpretations behind the concept of the iconic signs. Many of Greenberg's original generalisations based on world spoken languages equally apply to the BSL number system. The BSL number system mirrors the English number system in many ways. Therefore, several of the generalisations that describe the English cardinal number system transfer directly to BSL. These generalisations are not conclusive and need to be tested against other sign languages as well as other undocumented BSL regional variations.

5.1. Numbers 1 – 9

The previous chapter described the counting process as a tally format; each additional manual digit represents one additional cardinal figure. Each digit has been allocated a specific cardinal ranking from *ONE* to *NINE* (see table 5.1). Despite having up to ten manual digits at one's disposal not all are used to provide a direct quantifiable representation. *SIX* was not always expressed as six selected fingers and *SEVEN* did not always bear seven selected fingers (and so on). The non-dominant hand was predominantly dropped by most of the participants (with exception to NV4).

The number variations arose from where cardinal numbers were ranked along the sequence of extendable digits. One region may choose to allocate the 6th select finger to begin from the little finger while another assign this same role to the thumb and another to the index finger.

Table 5.1:

Ranking	**NV1**	**NV2, NV3**	**NV4**
1st Digit	Index Finger	Index Finger	Index Finger
2nd Digit	Middle Finger	Middle Finger	Middle Finger
3rd Digit	Ring Finger	Thumb	Ring Finger
4th Digit	Little Finger	Ring Finger*	Little Finger
5th Digit	Thumb	Little Finger	Thumb
6th Digit	Thumb	Little Finger	Index Finger
7th Digit	Index Finger	Ring Finger	Middle Finger
8th Digit	Middle Finger	Middle Finger	Ring Finger
9th Digit	Ring Finger	Index Finger	Little Finger

These hand configurations are established early on and reused throughout the entire counting sequence. NV2a and NV3 realign the ranking of fingers upon reaching *ELEVEN* and begin a counting sequence from the thumb. This realignment is a

* There were two alternative handshapes assigned to the 4th position. This discrepancy is discussed further within section 5.1.

permanent change for all higher numbers. Based on table.5.1 the following generalisations can be made for numbers *ONE – NINE*:

Generalisation 1: The BSL cardinal number system uses a base-5 system.

Generalisation 2: Each selected finger is allocated a specific ranking.

Generalisation 3: Each selected finger represents an additional higher cardinal ranking (NV1b *NINE* violates this rule with an over extension of digits).

Generalisation 4: The counting process runs along neighbouring fingers. (NV2 *FOUR* is a violation as it deselected the thumb before being reselected for *FIVE*).

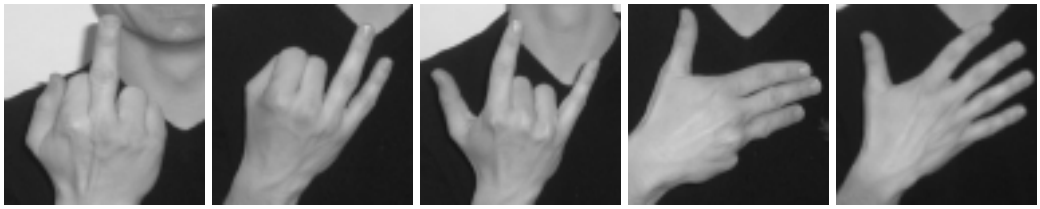
Generalisation 5: It is not possible to have an unselected finger in-between two selected fingers.

Generalisation 6: Each handshape is a simple lexical item.

Generalisations 1 - 6 suggest there is a systematic counting process where there is a defined mode of progression. This observation is corollary to using five extendable digits on the hand to perform the counting process. Like many other base-5 or base-10 counting system its roots can be traced back to using fingers as a method for counting (Greenberg 1978). The sequence of counting is constrained and runs along neighbouring

digits where each added finger (or thumb) denotes one added value. If these generalisations were deemed false then one could produce a sequence of number that does not transcend from previous selected fingers, for example:

Fig.5.1: Violation of Generalisation 1, 2, 3, 4, & 5.



ONE *TWO* *THREE* *FOUR* *FIVE*

To begin counting from the middle two fingers would bring a number of complexities. Firstly, it is a marked handshape and difficult to articulate. Secondly, which neighbouring finger should follow, to the left or the right? To begin counting from the outer most digit (thumb, index finger or little finger) gives rise to a coherent and open sequence of progression along a row of manual digits. All variations opt for different starting points, the thumb, index finger, or little finger, and this leads to further number variations.

Each handshape has been defined as a simple lexical item, each selected finger represents an additional cardinal value. Greenberg (1978) defines these simple lexical expressions as ‘atoms’. Each select finger equates to one additional atom and form the number bases

(base-5 and base-10). It is these atoms which experience additional modifications as part of the counting process. Once these handshapes become inflected they become internally complex and are deduced using an arithmetic formula.

Both NV1b *NINE* and NV2 *FOUR* have violated one rule each. These transgressions are best described as a fault belonging to the marked handshape, see fig.5.2 and fig.5.4. The marked form has been replaced with an unmarked counterpart:

Fig.5.2: Marked

FOUR/NINE

Fig.5.3: Unmarked

NV1 *FOUR*

NV2, NV3 *FOUR & NINE*

Fig.5.4: Unmarked

NV1b *NINE*

Anderson, L ([1979] cited in Wilbur, 1983: 161), who conducted an international survey of sign language number systems, notes the unmarked handshape was the only easily made number handshape. The marked counterpart was found to be less favoured in several of the sign language number systems. A similar issue was noted in the McKee & McKee (2006) study on New Zealand Sign Language number variation (NZSL). The

marked form for *NINE* was least favoured compared to the iconic *NINE* handshape with younger deaf signers, see fig.5.4.

Fig.5.5: NZSL *NINE*

NINE *NINE*

Using an articulator that has only five extendable digits and a base-5 system there are only two possible options available where four of them can be extended (with no unselected finger in-between). The selection of fingers is further constrained by the ordering built from the preceding selected fingers *ONE – THREE* and *SIX – EIGHT* (generalisation 2 & 4). Therefore, to avoid confusion between the two numbers a single handshape must be selected to represent one of the cardinal figures. Few participants were able to comfortably produce the marked handshape and as a consequence most regions used the same selected fingers to represent *FOUR* and *NINE*. The difference with the participants in Anderson's study was the use of the non-dominant hand. Anderson notes that if a number system was to use the same handshapes established from *ONE – FOUR* for *SIX - NINE* the non-dominant hand is needed to separate between the

two sets (cited in Wilbur 1983: 161). However, NV1b and NV2 participants did not use the non-dominant hand reliably to create this distinction. The NV1b unmarked *NINE* handshape avoided any sense of a homonymy between *FOUR* and *NINE* by over extending the number of manual digits (Fig.5.4). In addition, all sense of space between the fingers have been removed, otherwise the five extended digits would replicate the sign *FIVE*. Furthermore, this over extended handshape is a valid alternative since it successfully maintains its own unique identity and partially adheres to the expected mode of progression. NV2 participants do not conform to the expected mode of progression and instead opted for a cardinal homonymy between *FOUR* and *NINE*. Although the two numbers at first glance appear to be a cardinal homonymy there is in fact a difference in finger orientation, this phonological difference is discussed further in section 5.4.

> Generalisation 7: Due to manual digit constraints on the articulator (the hand) *FIVE* will always be presented with four extended fingers and one extended thumb.

The constraint of only having five digits on one hand inevitably means that number *FIVE* will have general agreement, 'the extension of four fingers and one thumb'. This constraint ultimately leads the sign language number system adopting a base-5 and base-10 counting system. Although this level of description of a tally system may seem obvious to many it is not the only possible counting system used in Sign Languages. There are alternative approaches such as an iconic representation of the written Arabic numeral, see fig.5.6.

Fig.5.6: Brazilian Sign Language (Libras) &

Portuguese Sign Language & Ugandan Sign Language.

SEVEN *EIGHT* *NINE*

These items would pose a challenge to pronounce for many BSL users as these hand arrangements are not part of the BSL lexicon. Each number expression is visual representation of the written Arabic number form. These sign language numbers systems demonstrate a base-5 system simply because they are borrowing an established spoken language cardinal number system.

> Generalisation 8: BSL numbers *ONE – NINE* have a palm **in** orientation, towards the signer. *ZERO* and NV1b *SIX* are the only examples which violates this rule with a palm **out** orientation.

The orientation of the palm is one overriding difference between the gestural systems and sign languages. Fischer's (1996) analysis of American gestures, American Sign Language (ASL) and Langue de Signes Française (LSF) number system made the same observation. Unlike gestures, where the palm could face in or more commonly outwards,

BSL, like many other sign languages, use a conventionalised palm in orientation for numbers 1-9. As explained in Chapter 4.6, *ZERO* needs to be articulated with a palm out, or palm profile, for it to be visible to the receiver. No explanation or reasons can be given for the RV1b *SIX* palm out orientation. There is no added clarity to either palm orientation. It is the only example found for all unit based BSL numbers where the palm faces outwards.

> Generalisation 9: The dominant hand is the main articulator. For numbers above five the dominant hand denotes the quantity of digits to be added to the non-dominant hand.

> Generalisation 10: The non-dominant hand, whether explicitly or implicitly expressed, functions as the base-5; thus automatically increasing the number of digits found on the dominant hand by + 5.

For numbers *ONE – FIVE* the dominant hand is capable of performing the counting task alone. All five manual digits fit perfectly onto one hand and the non-dominant hand serves no added or required purpose. Unlike counting gestures described in Greenberg (1978) and Menninger (1969), the sequence did not spread to the second hand. This is possibly a consequence of diachronic change from gestures to language and of the dominance condition described in Battision (1978).

> **The Dominance condition:** states that (a) if the hands of a two-handed sign do not share the same specification for handshape (i.e., they are different), then (b)

> one hand must be passive while the active hand articulates the movement and (c) the specification of the passive handshape is restricted to be one of a small set: A, S, B, G, C, O, 5. (Battision 1978: 34)

The dominant hand will always be the main and active articulator, whilst the non-dominant hand will assume an unmarked and supportive role. For some participants the non-dominant hand was explicitly articulated in conjunction with the dominant hand (see fig.5.10) using the unmarked '5' handshape. The same was noted for many other countries in the Anderson study (1979. [cited in Wilbur 1983]). The majority of participants within in this study it was dropped from complete sight and instead implicitly expressed.

Fig.5.7: Non-Dominant hand

EIGHT

This optional use of two hands is another example of a base-5 system being used in the BSL cardinal number system and is in agreement with Generalisation 1. The freedom to

use one or two hands is because the handshapes described for *ONE –NINE* were all distinctive (with minor exception to NV2 *FOUR* and *NINE*). Therefore, for effective and economic ease in articulation one main articulator can serve the intended purpose sufficiently, while the second can be implicitly expressed out of sight.

The NV4 use of two hands was unlike all other variations described and again conforms to Battison's (1978) dominance condition. The main and active articulator functioned as the addend while the non-dominant hand assumes a passive role with an unmarked 'S' handshape (symbolising a base-5 concept). The closed fist is instantly recognised as denoting the value '5' and functions as an augends to the dominant hand. The NV4 style of counting is highly unique as the place of articulation is on the non-dominant. It is rare to find contact being made between the two articulators for number expressions. Only two other example of contact being made between the two hands could be found. The first was in the Irish Sign Language (ISL) number system and the second was from an old Glaswegian BSL number system. The place of articulation for the ISL number expressions was in the palm of the non-dominant hand. Contact was made with by a single selected finger on the dominant hand, the thumb represented *SIX* and progressed round to the ring finger for *NINE*. Contact between the two hands occurred at the same point as NV4 for numbers symbolising *SIX – NINE*. The rational is possibly to due to having only one active articulator (with five extendable digits) and the need to distinguish between *ONE – FIVE* from *SIX – NINE*. The Glaswegian number system used the sign 'O' from the BSL two handed finger-spelling alphabet to symbolise *ZERO*. Therefore, numbers like ten and three hundred would be signed as '*ONE* -O', '*THREE – O –O*'.

The data in Chapter 4 demonstrated that the location for counting was predominantly based within the signing space in front of the body. However, the counting is not solely constraint to this area as the example below demonstrates. For spatial & pragmatic purposes one can move the numbers freely around the signing space. Fig.5.8 has the number *TWO* on the right and *ONE* on the left.

Fig.5.8.

" 1-2"

In a football match the left hand denotes the score *ONE* (the home side) while the right hand indicates the score *TWO* (the away side). For this reason the parameter of location needs to be treated with some flexibility as it can be adapted or inflected for productive, spatial and pragmatic meaning. The place of articulation for NV4 was located on the non-dominant hand; however, the non-dominant hand itself was positioned in neutral signing space. Further research is required to assess the degree of freedom to move number *SIX – NINE* around the signing space. Since the two hands come in to contact

the ability to move spatially is heavily constrained as opposed to the single dominant hand.

5.2. Numbers 10 - 19

Handshape and palm orientation were the two main phonological parameters for defining the BSL cardinal numbers from *ONE* to *NINE*. As the analysis approaches ten and above the same handshapes described in *ONE – NINE* begin to reappear. Therefore, other phonological parameters such as movement, location and palm orientation, become significant in establishing differences between lower and higher number sets. A similar comparison can be found with many other spoken language number systems where established forms are reused, see table 5.2. Reusing established forms is what gives the number system its recursive strength and enables it's users to build higher and higher onto the next set of numbers (Greenberg 1978). Modifications are needed to distinguish one set from another. In English there is the use of morphemes '*-teen*' and '*-ty'*.

Table.5.2.

English		**French**	
Four	*Fourteen*	*Quatre*	*Quatorze*
Six	*Sixteen*	*Six*	*Seize*
Seven	*Seventeen*	*Sept*	*Dix-sept*

The same principle can be found for BSL numbers; each handshapes is a symbolic representation of the written Arabic number system while the movement is the modifier.

> Generalisation 11: Movement is used to modify the value of the cardinal number sign. It can denote the following assumptions '*more than one'*, 'x 2', 'X + Y', '*-teen*' or '*-ty*'.

> Generalisation 12: Each handshape is a symbolic representation of an Arabic number.

> Generalisation 13: A set group of symbolic handshapes are reused as part of a recursive counting mechanism (NV2 and NV3 establish a new set of handshapes for numbers *ONE – FOUR* upon reaching *ELEVEN* and become the established norm throughout the remainder of the counting sequence).

These generalisations expand on the foundations already laid in the previous section (5.1.) and accommodate the additional phonological movement incorporated in the sign. Overall, the generalisations 1 – 13 can be summarised as:

Fig.5.9: NV1, NV2, NV3 one handed number signs.

X + 10 = Y

H1 + move = Y

Fig.5.10: NV1, NV2, NV3 two handed number signs.

(X + Y)	+	10	= Y
(H1 + H2)	+	move	= Y

Fig.5.11 : NV4 *ELEVEN – FIFTEEN*.

TEN	+	X	= Y
(H1 + H2)	move	H1	= Y

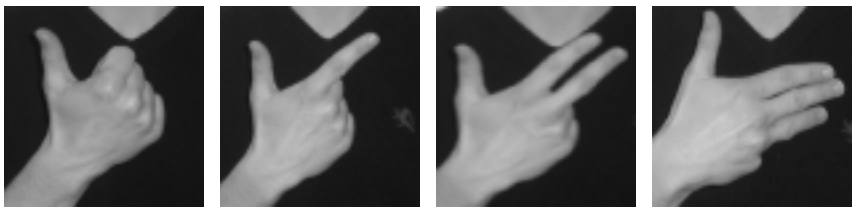
Fig.5.12: NV4 *SIXTEEN – NINETEEN*.

TEN	+	(X + 5)	= Y
(H1 + H2)	move	(H1 + H2)	= Y

(Note: H1 = Dominant hand / H2 = non-dominant hand)

NV2 and NV3 both realigned the selection of fingers for numbers *ONE – FOUR* (as explained in Chapter 4). These modified handshape strongly resembles the LSF number system described in Anderson (1979 [cited in Wilbur 1985]) and Fischer (1996):

Fig.5.13: LSF, NV2 & NV3 *ONE* - *FOUR*



ONE *TWO* *THREE* *FOUR*

The counting process begins at the thumb for and builds across to the little finger. Numbers *SIXTEEN* to *NINETEEN* maintains the same sequence described before for *SIX* - *NINE*. The digression described here correlates to Fischer's (1996) evidence of creolization within ASL and Anderson's observation of handshape changes upon reaching twenty (1979 [cited in Wilbur 1985]). Fischer, S. (1996) carried out research on ASL and found that the number system had diachronically changed into a hybrid number system of LSF (it's ancestral language roots) and the indigenous American gesture system. The use of the thumb originally found in LSF for *ONE* was replaced in favour of the index finger, which was more commonly found with American gestures. The second was the LSF number *THREE* was preserved since the gestural *THREE* equivalent conflicted with the established alphabetical sign 'W'.

Fig.5.14:

THREE *W* (ASL)

THREE (American gesture)

The same argument could be extended to NV2 and NV3. There appears to be some form of hybrid within the counting system since it partially behaves in a similar pattern to LSF for numbers *ONE – FIVE* and departs for *SIX –NINE*. A historical analysis and broader data collection is needed to assess whether such a phenomena existed.

The important difference between NV2 and NV3 is the number *FOUR* in *FOURTEEN* and *NINE* in *NINETEEN*. Participants from NV3 adheres to Generalisations 1 – 5 and maintain the expected marked handshape (three fingers and one thumb) for *FOUR-TEEN* but NV2 participants substitute (or assimilated) this configuration for an unmarked handshape (four extended fingers). NV2 has violated the Generalisation 1 - 4 for the second time and used the same handshape configuration for *FOURTEEN* as *NINETEEN* as well as *FOUR* and *NINE*. The marked handshapes combined with the internal moves are not easy to articulate simultaneously and may be the cause of the constant violations and discrepancies. NV2 participants demonstrate a preference to selecting the unmarked handshape to overcome this articulator constraint. These inconsistencies pose typological

issues when trying to describe a particular phonological pattern. This discrepancy is resolved in the following section 5.3.

5.3. Numbers 20 – 99

Key to understanding the recursive manner in the BSL number system are; 1) what are the symbolic handshapes for denoting the Arabic numbers; 2) the spatial sequencing of numbers follows the written Arabic format; 3) Movements function as either linking or morphological devices. It is obvious that the BSL number system described here correspond to the English decimal (base-10) number system. This is possibly a consequence of either borrowing from the English or written Arabic number system and/or having ten extendable manual digits.

Fig.5.15: NV1 *FOURTY-SIX*

FOUR + outward sweep (‘*-ty*’) + *SIX*

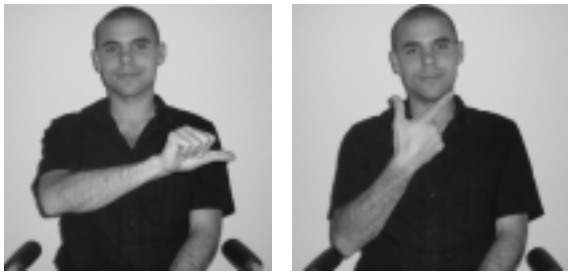
Fig.5.16: NV1 *EIGHTY-NINE*

EIGHT + tilt at wrist + *ONE*

Fig.5.17: NV1 *TWENTY-ONE*

TWO + *m*ove right + *ONE*

Fig.5.18: NV1b *SIXTY-SEVEN*



SIX + orientation change + *SEVEN*

Fig.5.19: NV2 *SEVENTY-FOUR*

SEVEN + wrist move + *FOUR*

Fig.5.20: NV2a & NV3 *TWENTY-THREE*

TWO + orientation change + *THREE*

Fig.5.21: NV2b *THIRTY-TWO*

THREE + orientation change + *TWO*

Fig.5.22: NV3 *SEVENTY-THREE*

SEVEN + orientation change + *THREE*

Fig.5.23: NV4 *SIXTY-FIVE*

(*SIX* + circling move) + *FIVE*

Fig.5.24: NV4 *SEVENTY-EIGHT*

(*SEVEN* + Circling move) + *EIGHT*

Fig.5.25: NV4 *TWENTY-NINE*

TWO + *NINE*

Generalisation 14: BSL cardinal number system uses both a multiplication and addition formula.

Generalisation 15: The BSL number system is a Base-10 system.

Generalisation 16: The sequence of numbers is expressed as highest first followed by the lowest cardinal unit: *TENS* + *UNIT.*

Generalisation 17: Like English the serialized augends is always larger than its addend.

These generalisations conform to many of Greenberg's observation. Firstly, BSL uses a multiplication and addition formula as found with English. The BSL number system is structured in a serialized hierarchical sequence where the first number refers to the base and the second is the atom:

Fig.5.26: "*Twenty-four*"

$$\frac{[(2 \times 10) + 4]}{[(\text{base}) + \text{atom}]}$$

Not all spoken or sign languages operate in this hierarchical formula. German Sign Language (DGS) functions in the reverse order replicating the spoken German number system:

Fig.5.27:

$$\frac{[4 + (2 \times 10)]}{[\text{atom} + \text{base}]}$$

The reason for raising this observation is that like any other number systems a single formula is used and maintained throughout (Greenberg 1978: 273). The preferred order in the instance of BSL mirrors the English and written Arabic form, larger number expressions precede the smaller number expression. This hierarchical formula also happens to be the preferred method for most number systems which use addition as a linking device (Greenberg, 1978: 252). Using an agreed hierarchical sequence is a

necessary mechanism for any number system. It is this agreed formula and understanding which allows the users of the language to progresses onto higher numbers and/or refer to any part of it.

For all regions the orientation of the palm for the unit based numbers (atoms) predominantly finished facing **in** towards the signer as stated in Generalisation 9 (except for the NV1b *SIX*). However, the orientation of the palm for the higher base numbers was often inconsistent. The same observation was made in the Anderson survey of world sign language number systems (1979 [cited in Wilbur 1985: 163]). In addition, the types of movement within number expressions were highly inconsistent. These two phonological inconsistencies were possibly a methodological fault. Participants were asked to count up a stream of numbers (1 – 100) thus building a momentum which skewed the natural rhythm and orientation. It was not always clear with all signers if the movement parameter functioned as a morphological inflection or a linking device between two spatial locations.

In the case of NV4 the circling movement clearly represented a morphological inflection. This interpretation can be confidently made as the location for *SIXTY-SEVEN* was expressed in the same position. The dominant hand's place of articulation was on the non-dominant hand, where both were located directly in front of the signer's body. The only difference between the two number expression *SIX* and *SEVEN* was the circling move on *SIX* followed by a null move for *SEVEN* (no movement).

Three of the NV1 participants demonstrated a consistent outward sweep between the base and atom. This outward sweep was suspected as being a morphological inflection

equivalent to the English "*-ty*". This outward sweep would end with a palm orientation change from in to out. The entire move was clearly pronounced and highly deliberate. The controlled presence of this sign is what creates the impression of it being a morphological addition. Since only three produced this move it is hard to defend this line of reasoning. Therefore, one would prefer to acknowledge this difference and leave this interpretation open for future verification.

The spatial shift to the right and reduced movements (tilt at the wrist and palm rotation) observed with the remaining NV1, NV2 and NV3 participants appear to function as underlying linking device. The first location denotes the base number (*TENS*) and the second location represents the atom number expression (*UNIT*). This type of counting resembles the spoken Mandarin method where the word ordering denotes the implicit formula; 32 is expressed as "3, 10, 2", while 23 is constructed in the following way "2, 10, 3" (Greenberg, 1978: 264). In the case of BSL the handshapes undoubtedly represent overt expressions for *TWO* – THREE. The location change or internal move between the two number expressions implicitly functions as the place '*TENS* and *UNITS*'.

The non-dominant hand was near non-existent for NV1, NV2 and NV3 participants. This was because there is more effort incurred when using the non-dominant hand above twenty. Participants would be required to keep raising and dropping the '5' handshape. This is another possible fault in the methodology as participants were expected to count through high and low numbers. Therefore, the lack of presence is defined as optional.

One final observation is the use of the sign *ZERO* for all numbers divisible by ten (20, 30, 40, and 50). Unlike any other spoken language BSL overtly expresses the position of zero. Greenberg makes the following generalisations for all spoken number systems:

> Zero is never expressed as part of the numeral system (Greenberg, 1978: 255).

This is a unique difference as a result of the iconic nature of the BSL number system and its visual representation of the written Arabic form. The iconic nature of the language generates so expressive differences to an abstract language.

5.4. Cardinal Homonymy

Several participants continually violated Generalisation 2 & 4 by using the same handshapes for *FOUR* and *NINE*.

> Generalisation 2: Each selected finger is allocated a specific ranking.

> Generalisation 4: '…the counting process runs along neighbouring fingers.

If the counting sequence was to respect the generalisations laid out in this chapter the following handshapes in Table.5.3 should be used to represent *FOUR* and *NINE*:

Table.5.3

Markdness	Handshape	Number expression	Variation group
Marked		FOUR	NV2 & NV 3
		NINE	NV1
Unmarked		FOUR	NV1
		NINE	NV2 & NV3

Few participants maintained the defined and expected mode of progression established in generalisations 1-5. Nine NV1, ten NV2, and two NV3 participants would substitute or opt for the unmarked handshape over the marked counterpart. As a consequence the number the BSL *FOUR* and *NINE* are identical to each and present a cardinal homonymy in BSL. This high proportion of similarity in handshape and orientation could be a fault in the methodology. During the counting process it is potentially easier and less demanding to revert to an unmarked form, which also allows one to maintain their rhythm. However, the same issue was noted in Anderson (1979 [cited in Wilbur 1985: 161]) and McKee & McKee (2006). According to Wilbur, Anderson notes that the unmarked handshape is the only easily made handshape with four fingers (1985: 161). If

one looks closely at the finger direction between *FOUR* and *NINE* one can see that *FOUR* is consistently pointing up whereas *NINE* point towards the left[10].

Fig.5.28: Minimal pair by finger orientation

FOUR

NINE

This distinction was found to be true for all instances of when this unmarked handshape was in use. The diagonal dividing line across the image marks where the finger orientation changes. There is an implicit 45^0 dividing line of separation. The finger orientation leaning towards the vertical axis is *FOUR* and the finger orientation towards the horizontal axis is *NINE*. The use of finger orientation can also explain the differences between NV2 *FOUR*/*NINE*, *FOUTTEEN/NINETEEN*. *FORTY/NINETY*. Unlike the general established lexicon finger orientation is not considered a primary parameter. However, for numbers it clearly provides a minimal pair and is a key phonological distinction. Lip-pattern is a second optional feature that can add clarity to the sign. The similarity between *FOUR* and *NINE* is comparable to the phonological closeness between "*fifteen*" and "*fifty*". Participants when signing *FORTY-NINE* or *NINETY-FOUR* would

[10] Or right if one is left handed.

demonstrate a clear change in finger orientation. This defining characteristic resolves all concerns relating to a cardinal homonymy and confirms that they are two distinct number expressions.

6.0 Conclusion

6.1. Future study:

There are several aspects of the BSL cardinal number system still to be discussed and analysed. The main potential areas for future study are; 1) counting above one hundred; 2) lip-patterns with number signs; and 3) assimilation of number expressions.

This study collected data of deaf people counting up to ninety-nine and a set of numbers within the hundreds, thousands and millions as well. Unfortunately, this data set could not be discussed within the scope of this thesis. The additional data collected as part of this study did however reveal several variations for the lexical signs denoting 'hundred', 'thousand' and 'million'.

Lip-pattern was a dominant feature recruited by many of the participants. The data collected in this study did raise several questions relating to the use of lip-pattern such as, is it compulsory? Do lip-patterns follow the English pronunciation? Has the English lip-pattern been modified (reduced or extended) to fit the length of the sign?

Finally one interesting and noticeable feature was the assimilation of handshapes, movement and palm orientation. There were several instances where two signs were compounded into one sign, such as: *TWENTY-ONE*, *TWENTY-TWO, TWENTY-SIX, THIRTY-THREE, SIXTY-SIX, EIGHTY-EIGHT etc.,* and numbers ending with a *ZERO*. The compounding of number expressions resembled the nativisation process of finger-spelled signs described by Battison (1978) and Brentari & Padden (2001). There are many instances of these borrowed signs within the BSL lexicon which have experienced modification to bear native sign like qualities.

6.2. Summary

The data in Chapter 4 provided clear evidence of number variation in BSL. The variations were all phonological in nature. The first type of phonological variation arose with handshape configuration (NV1, NV2 & NV3), followed by orientation of the palm (NV1b), place of articulation (NV4), and then finally movement (NV1c). Each phonological parameter had a role to play in the recursive mechanism of the counting systems. The handshapes were symbolic representations of cardinal numbers while the introduction of movement and spatial location modified the value of the sign to a higher base level.

The laws that systemised these phonological parameters were then encapsulated in Chapter 5. The validity of these generalisations presented in Chapter 5 needs to be tested against other number systems. As shown in this thesis not all sign language number systems employ the same concept in counting. Several of Greenberg's original generalisations based on world spoken languages equally apply to the BSL number system. These transferable rules could be related to the gestural origins for number expressions and/or the closeness in structure to the English and written Arabic system. Although the origins may have been gestural the current system is not. The BSL cardinal number system has been conventionalised in a particular way that would not be understandable to those who do not share the same language, and possibly to those who do not share the same variation. This is not surprising as different concepts of counting also exist globally within spoken language number systems and finger counting systems.

There were methodological issues arising from the constraints of this study should be borne in mind. The task of counting to a hundred possibly skewed the natural movement patterns and encouraged a higher rate of phonological assimilation. It was not always clear if the data presented evidence of idiosyncratic articulation styles, evidence of mixing between regions, evidence of a further sub-category or instances of skewed articulation (or combination of the mentioned). One alternative approach to over come these flaws would be to use a smaller set of number stimuli and present them in random order; and/or to film the same deaf people constructing sentences which involve number expressions. This would certainly remove the momentum generated when counting to one hundred.

To conclude, it was the intention of the author to create a document that described and explained the different types of number variations in BSL. Within the time constraints the study has successfully recorded four types of variations plus several other sub-type variations. It is hoped that this thesis can be used as a form of reference which describes and explains a set of BSL cardinal number variations.

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DVD:

Using Numbers in British Sign Language: Interactive CD-Rom. Produced by the Centre for Learning Technologies and the Deaf Studies Team at the University of Central Lancashire.

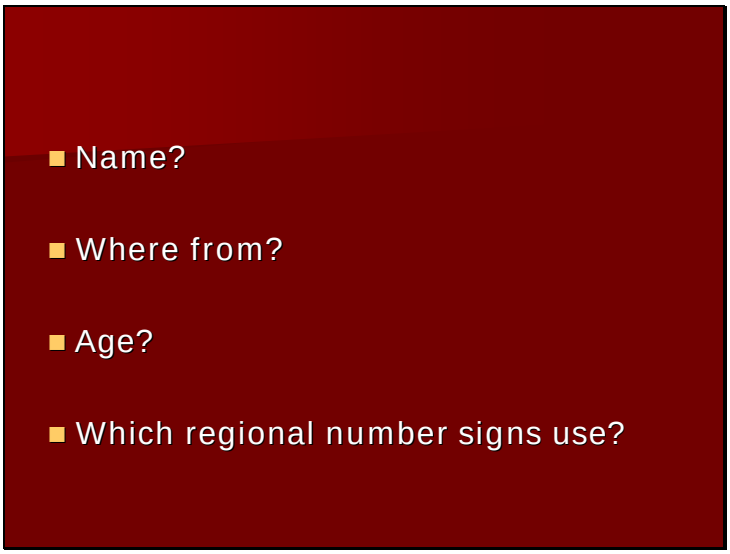
Web-domains:

Number systems of the World: www.sf.airnet.ne.jp/~ts/language/number.html

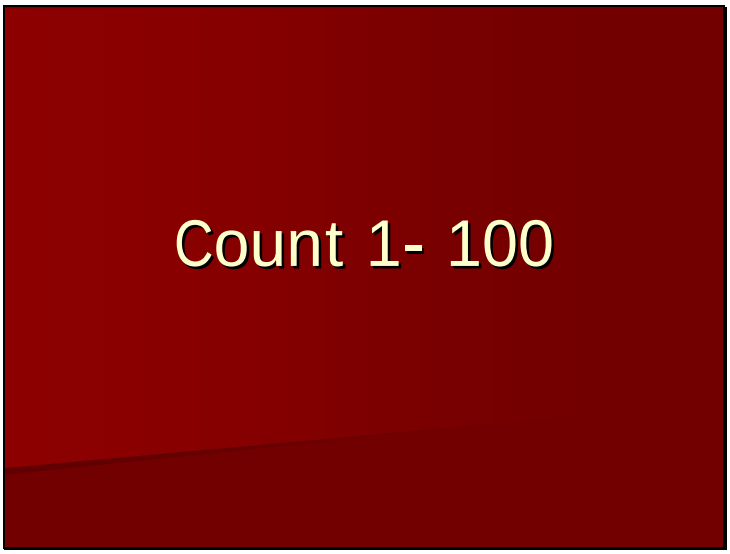
APPENDIX

Appendix 1. Power-point stimuli

Slide 1

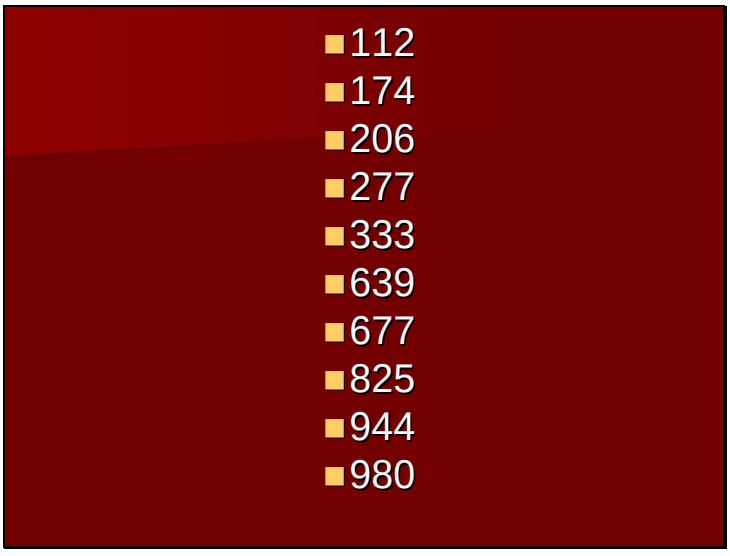


Slide 2



Slide 3

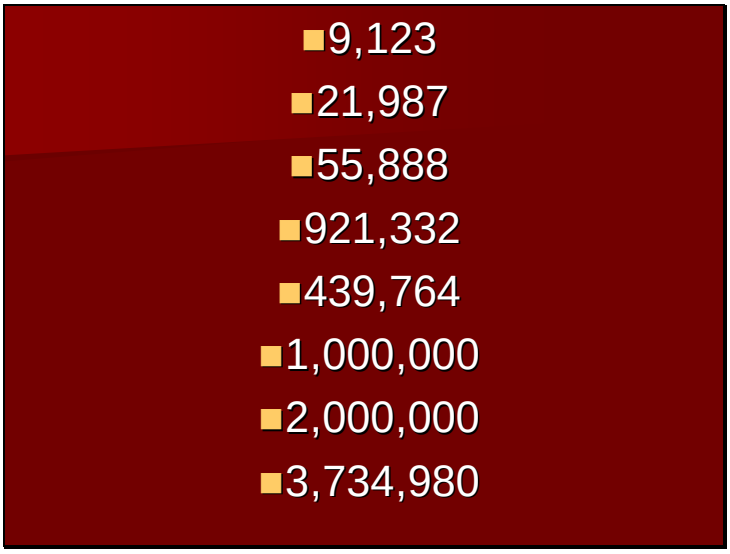
Slide 4



Slide 5

Slide 6

Slide 7



Slide 8

Appendix 2. Number Variation categories.

Number Variation		Regions
NV1	NV1a	Derby, Eastbourne, Edinburgh, Exeter, Glasgow, Haywards Heath, London, Oxford, Portsmouth, Southampton.
	NV1b	Aberdeen, Wolverhampton.
	NV1c	Liverpool.
NV2	NV2a	Birmingham, Bristol.
	NV2b	Glasgow, Northern Ireland, Hertfordshire, Oxford, Solihull, Swindon, Wolverhampton.
NV3		Newcastle, Leeds, Bristol.
NV4		Manchester.

Appendix 3. Participant consent form:

VIDEO & PARTICIPANT CONSENT FORM
Confidential

Study name: British Sign Language Number research
This study is part of a MA dissertation in Applied Linguistics at Birkbeck University. The aim of this research is to collect and analyse different British Sign Language (BSL) number variations that are currently in use within the British Deaf Community. You will be asked to demonstrate your knowledge of your own (and other) regional BSL number variation.

Your participation in this study is greatly appreciated and consent is required before any analysis can be conducted. If you mark "NO" between 1 – 3 your contribution will be erased and cannot be used within this research.

Do you give permission for this use?

1. Analysis of your responses for this research project	YES	NO
2. Do you agree with the publication of the results of this study in an appropriate outlet/s?	YES	NO
3. Do you agree to take part in this study?	YES	NO

Your responses will be video-recorded in the course of this study. We will label all data with identifying numbers rather than your name or any other information associated with your identity. However, because face information is important in BSL, it is not possible to fully conceal your identity. Therefore we will seek your specific consent for the different possible uses of still images or video clips from which you might be recognised. We will only use your still or video images in those circumstances for which you have explicitly given consent.

Please mark "YES" between 4 – 9 if you give permission for us to use images or brief clips from your video data for a particular purpose, "NO" if you do not give permission. All of the following uses are strictly **optional** and will **not** affect your participation in this study. Please feel free to respond "NO" for any reason. You do not need to provide any explanation to the experimenter.

Do you give permission for this use?

4. Presentations at academic research conferences		YES	NO
5. Academic publications reporting the results of these studies, including journal articles, book chapters, technical reports, reports to funding bodies		YES	NO
6. Educational uses in classroom settings to demonstrate the research methods and/or outcomes		YES	NO
7. Academic Web pages describing the research methods and/or outcomes		YES	NO
8. Media reports of the research:	a. Print	YES	NO
	b. Television	YES	NO
	c. Internet	YES	NO
9. Community relations: presentations of the research to groups/organisations within the Deaf community		YES	NO

Please note any additional concerns or restrictions on the reverse of this sheet.

Thank you kindly for your support and time.

Signed: …… Date: ……

Name (please print) ……..