"Seeing sentence boundaries: the production and perception of visual markers signalling boundaries in signed languages"

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Statement of originality

I, Jordan Fenlon, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Signed …………………………………

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Abstract

Current definitions of prosody present a problem for signed languages since they are based on languages that exist in the oral-aural modality. Despite this, researchers have illustrated that although signed languages are produced in a different modality, a prosodic system exists whereby a signed stream can be structured into prosodic constituents and are marked by systematic manual and non-manual phenomena (see Nespor & Sandler, 1999; Wilbur, 1999, 2000). However, there is little research examining prosody in British Sign Language (BSL).

This thesis represents the first serious attempt to address this gap in the literature by investigating the type and frequency of a number of visual markers at intonational phrase (IP) boundaries in BSL narratives. An analysis of 418 IP boundaries shows linguistic visual markers are not frequently observed. The most frequent marker observed were single head movements (46%) followed by holds (30%) and brow movement (22%) and head nods (21%). This finding suggests that none of the visual markers included in this study can be considered a consistent marker to IP boundaries in BSL narratives.

As well as examining the production of markers at IP boundaries, the perception of boundaries by different groups in a series of online segmentation experiments is investigated. Results from both experiments indicate that boundaries can be identified in a reliable way even when watching an unknown signed language. In addition, an analysis of responses suggests that participants identified a boundary corresponding to a discourse level (such as when a new theme is established). The results suggest that visual markers (to these boundaries at least) are informative in the absence of cues that can only be perceived by native users of a language (such as cues deriving from lexical and grammatical information). Following presentation of results, directions for future research in this area are suggested.

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Chapter 1: Introduction

1.1   Introduction

This thesis represents the first serious attempt to look at the production and perception of visual markers to boundaries in British Sign Language (henceforth BSL).[1] The field of sign language linguistics represents a growing area of interest amongst linguists since the 1960s and despite much advancement in what is known about signed languages today, some areas of sign language linguistics have not received a great deal of attention. One such area that is in need of investigation is the field of sign language prosody.

The field of prosody has been predominantly defined in the aural-oral modality. A number of studies have demonstrated that prosody plays an important role in communication (Cutler, Dahan, & van Donselaar, 1997; Frazier, Carlson, & Clifton Jr, 2006), and that speakers use prosody to structure what is being said and disambiguate between sentence meanings (Kim & Hyuck-Joon, 2004; Price, Ostendorf, Shattuck-Hufnagel, & Fong, 1990; Schafer, Speer, Warren, & White, 2000), to mark which item is in focus (Cruttenden, 1995; Ladd, 1996; Selkirk, 1995), and to convey attitudinal meanings (Cruttenden, 1995). It is well documented that listeners are sensitive to prosodic cues produced whilst speaking and that it can have a positive effect on performance and perception of speech (Epstein, 1961; Gussenhoven & Jacobs, 1998; Silverman, 1987; Speer, Crowder, & Thomas, 1993).

This thesis is primarily concerned with the production and perception of boundary markers. A number of markers (such as lengthening, pauses, anacrusis) are associated with boundaries in speech (Cruttenden, 1995; Ladd, 1996). Again, listeners are able to reliably interpret these markers, distinguishing between

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[1] BSL is a natural human language with its own grammar and lexicon (Sutton-Spence & Woll, 1999). It is distinct from other constructed signed systems such as cued speech, Paget-Gorman Sign System (PGSS) and Sign Supporting English (SSE). Although the origins of BSL are unclear, historical records of deaf people signing date back to the 16th century. The first records of widespread use of signing in Britain come from the late 18th century when Thomas Braidwood opened the first British school for deaf children in Edinburgh (Johnston & Schembri, 2007; Sutton-Spence & Woll, 1999). Today, BSL is the first and preferred language of the members of the British Deaf community.

boundaries that signal the end of a topic or the end of a speaking turn (Blaauw, 1994; Geluykens & Swerts, 1994). Interestingly, speakers are also able to identify boundaries in an unknown language suggesting that boundary markers are informative even when lexical and grammatical information is absent (Carlson, Hirschberg, & Swerts, 2005). However it has been demonstrated that more generally prosody only has a supporting role (to syntax) in language processing (Cutler et al., 1997).

Although sign languages are conveyed in the visual-gestural modality, it is becoming increasingly clear that there is a prosodic system that is similar to spoken languages in function but strikingly different in form (Nespor & Sandler, 1999; Sandler & Lillo-Martin, 2006; Wilbur, 1999, 2000). That is, sign language can be structured into prosodic constituents that are systematically marked by a number of manual and non-manual features. Despite relatively few studies, it is clear that signers can reliably identify prosodic boundaries in signing (Brentari, Gonzaléz, & Seidl, 2007; Nicodemus, 2009). However, a full understanding of sign language prosody has yet to be achieved since research is still in the early stages. Studies are primarily directed towards the identification of prosodic constituents in signing and understanding how these constituents are marked. It is not clear how certain markers compare with one another in terms of reliability or the extent to which they mark constituents. In addition, research on other aspects of prosody such as understanding the physical correlates of stress is still in the early stages (although see Wilbur, 1999). When attention is restricted to BSL, there is a large gap in the literature promoting a full understanding of how a prosodic system might work.

One area that provides a bridge between spoken and sign language prosody is the field of audio-visual prosody (as suggested in de Vos, van der Kooij, & Crasborn, 2009). Although this field is relatively small, it has been demonstrated that visual markers such as the head or the eyebrow are aligned with prosodic features in speech (such as pitch accents) and can be synchronised with prosodic boundaries (Flecha-Garcia, 2006; Graf, Cosatto, Strom, & Huang, 2002; Guaïtella, Santi, Lagrue, & Cavé, 2009; Yehia, Kuratate, & Vatikiotis-Bateson, 2002). In addition, listeners are

sensitive to these audio-visual markers and can use them to reliably indicate which item is in focus or to discriminate between a declarative and an interrogative statement (Bernstein, Eberhardt, & Demorest, 1998; Dohen, Loevenbruck, Cathiard, & Schwartz, 2004). There is evidence to suggest that a multi-modal approach to speech perception is beneficial since performance is improved greatly when speech is co-presented with corresponding visual stimuli (Bernstein et al., 1998) as has been demonstrated for boundary perception (Barkhuysen, Krahmer, & Swerts, 2008). The relationship between these markers and visual markers used in sign language has yet to be investigated in detail. Non-signers have shown themselves to be adept at responding to boundaries in ASL (Brentari et al., 2007) although they differ from signers in how they use markers to identify boundaries. These issues represent areas of interest for the thesis.

1.2   Principal aims and objectives

The thesis aims to answer two research questions that arise from a review of the relevant literature. These questions are concerned with the production and perception of visual markers to prosodic boundaries in narrative signing. The first asks: which markers are frequently observed at intonational phrase (henceforth IP) boundaries in BSL narratives and how do they compare with other markers of boundaries? In addition, some visual markers do not act as prosodic markers exclusively. In a signed narrative, the head and the torso can be used to mark role and the brows can be used to convey a character's attitude. Therefore, what effect (if any) does this overlap in function have on how often a visual marker occurs at boundaries in narratives? Secondly, can these markers be used independently of other cues to boundaries (such as those deriving from lexical and grammatical information)? That is, can these markers be seen by someone who does not know the language and used to segment a narrative in a reliable way? These are the main research questions with which the thesis is concerned although additional questions are addressed which are outlined in the relevant chapters.

This thesis addresses these questions by looking at the type and frequency of visual markers to boundaries in a set of BSL narratives. Firstly, IP boundaries are identified

in all narratives and a frequency analysis of visual markers to boundaries is conducted. This analysis also describes the function of markers occurring near boundaries, whether prosodic or performing a narrative function (such as marking role). The frequency of visual markers associated with IP boundaries in other signed languages is then discussed in relation to narratives.

In order to investigate whether signers and non-signers can identify boundaries in a reliable way, an online segmentation experiment is created which monitors the location of boundary decisions whilst watching a signed narrative. Responses by participants are then examined to see if they coincide with a set of predetermined boundaries. The conditions of this experiment are varied so that signers are not always watching a narrative signed in their native language. In these circumstances, signers will be unable to rely on cues to boundaries that come from knowing the language (such as those deriving from lexical and grammatical information) as are non-signers in each condition. This enables the thesis to determine the extent to which visual markers alone are effective when used to identify boundaries

1.3   Structure of the thesis

The structure of the thesis is as follows:

Chapter 1 introduces the reader to aims and objectives of the thesis and presents the general research questions that the thesis seeks to address.

Chapter 2 provides the reader with a review of the literature on the production of markers to prosodic boundaries. This review refers to both spoken and signed language literature but is primarily concerned with signed languages. To begin with, an introduction to prosodic structure (as outlined by Nespor & Vogel, 1986) and the type of markers associated with the IP in speech are explained. In the following sections, the case for a prosodic system in a visual-gestural language is put forward drawing on a number of studies ranging from a detailed linguistic analysis of signed languages to language acquisition and brain-imaging studies. The remainder of the chapter describes different types of non-manual and manual features that have been associated with boundaries (whether prosodic or syntactic). This description

provides the necessary justification for the inclusion of these features in the analysis reported in Chapter 3.

Chapter 3 reports an analysis of the type and frequency of visual markers present at 418 IP boundaries in 8 BSL narratives. Firstly, the research questions are introduced followed by the methodology which explains how boundaries were identified in the narratives and lists the non-manual and manual features that the chapter intends to examine. The results section is divided into two main parts: non-manual and manual features. In these sections, each feature is described in turn and their frequency at IP boundaries is given. In addition, the underlying function (whether linguistic or narrative) of each visual marker is explained and their respective frequency at boundaries is presented. This is followed by an overall picture of the most frequent marker at IP boundaries in the narrative data. The chapter ends with a discussion that takes into account the literature reviewed in Chapter 2 and highlights some considerations in determining a reliable marker in narratives based on frequency alone.

Chapter 4 marks a shift in focus from the production of visual markers to IP boundaries to the perception of boundaries in narrative signing. This shift begins with a review of the relevant literature on the perception of prosody in general. Firstly, studies that have focused on the perception of prosody in speech are discussed. These studies make clear that listeners are sensitive to speech prosody and that it can have an effect on performance when absent or incorrectly aligned with speech. In the next section, a review of the few studies looking at perception of sign language prosody is presented. These studies show that signers perceive prosody in a reliable way and strongly agree with one another in experimental tasks (i.e. being asked to detect a boundary or which sign is marked for stress). In studies on both spoken and signed languages, the review also highlights how people are able to perceive prosody in a language that they do not know in a reliable way. In addition, the review includes literature that examines the production and perception of audio-visual markers to prosody. The chapter ends with a discussion of the

relevant literature that highlights points of interest for the experiments reported in the following chapters.

Chapter 5 reports the results from an online segmentation experiment involving both native signers of BSL and non-signers. This experiment intends to address the extent to which boundaries can be reliably identified by signers and whether these boundaries can be identified in a similar way by a second group comprised of non-signers. The inclusion of a second group allows the thesis to determine whether visual markers to boundaries are effective when lexical and grammatical information is absent. To determine this further, a second narrative presented in an unrelated sign language (Swedish Sign Language (SSL)) is included. The chapter begins with an explanation of the research questions and possible outcomes followed by the methodology where the experiment and the analysis are explained in detail. The results section is divided into two parts: quantitative and qualitative. The quantitative section reports the number of responses by each group whilst watching a narrative in general and at boundaries. In order to determine whether groups are responding to boundaries at a level above chance, responses are compared to simulated data. In the qualitative section, an analysis of the type of markers present at boundaries that attracted a high number of responses by participants is compared to boundaries that attracted no responses at all. Each section ends with a discussion that summarises the findings and relates them to the research question and hypotheses set out at the beginning.

Chapter 6 reports a similar experiment to Chapter 5 but with several key changes in methodology. These changes include the addition of two signing groups (an SSL group and American Sign Language (ASL) group) and a third narrative presented in ASL is added to the experiment design. These changes aim to determine whether the findings made in Chapter 5 hold true for different groups of signers and for different languages (whether any differences can be observed between native and non-native users). Firstly, the aims and objectives of the chapter are presented followed by a discussion of methodological issues from Chapter 5. The research questions and hypotheses are then outlined. Key changes to the research design and analysis are

explained in the methodology. These include comparing the number of responses to a set of predetermined boundaries in order to see clearly any differences (if any) between groups. In other words, participants' responses are judged according to whether they occur at boundaries corresponding to the level of the phonological utterance (henceforth U) in general or to a discourse boundary at a higher level (one that represents an important point in a narrative when a new theme is introduced to the story or a previously mentioned referent is foregrounded). A similar quantitative analysis to the previous chapter is presented in the results section where responses at U boundaries are analysed and compared against simulated data. In addition to the preceding analysis, a report based on feedback given by participants in a questionnaire on how well they felt they had done at each task and how they determined the location of boundaries is given. This report provides an alternative perspective to other chapters in that it reveals the extent to which participants are aware of different markers to boundaries. The chapter ends with a discussion of the results and is compared to the results reported in Chapter 5.

Chapter 7 presents an overall discussion and summary of the findings reported in this thesis. This discussion is divided into two parts: the production of visual markers at boundaries and the perception of boundaries. In each section, the findings reported are discussed in context of relevant literature and the research questions set out in Chapter 1. This discussion is followed by a report of the strength and limitations of the thesis. The chapter ends with suggestions for future research.

In **Appendix 1**, a glossed transcript of the BSL and SSL narratives used in Chapter 5 is provided. These transcripts are segmented according to the location of boundaries that were identified prior to the testing. In each transcript, boundaries that attracted a high number of responses from participants in general are indicated with an asterisk. In **Appendix 2**, a glossed transcript of the BSL, SSL, and ASL narratives used in Chapter 6 is provided. These transcripts are segmented according to the location of IP and U boundaries that were identified using a linguistic analysis. The text is further divided into narrative units at the discourse level (which represent strong boundaries in Chapter 6). In **Appendix 3**, the post-experiment questionnaire used in

the experiment reported in Chapter 6 is provided. In **Appendix 4**, the glossing conventions for the thesis are provided.

Chapter 2: Literature review on the production of prosodic markers in spoken and signed languages

2.1 Introduction

In this chapter, a literature review on prosody in spoken and signed languages will be provided. Specifically, the review will focus on how a signed or spoken stream can be divided into prosodic constituents and how these constituents are delimited by a range of markers. To date, the field of prosody has been predominantly defined within the aural-oral modality and has only recently been applied to signed languages. Therefore, the review begins with an introduction to prosodic structure and markers using relevant literature on speech prosody before moving onto a review of sign language prosody. In addition, this chapter will also argue the case for a prosodic system in signed languages using research from sign language studies in general.

2.2 Speech prosody

Prosody is the study of suprasegmental features in language. These features include pitch, loudness, length and tempo. Together these features combine to form a prosodic system that is complex and crucial to communication. For example, prosodic markers can be used to disambiguate between sentence meanings (Kim & Hyuck-Joon, 2004; Price et al., 1990; Schafer et al., 2000) and are employed by speakers to avoid any confusion in meaning when necessary, such as when both possible interpretations of an utterance are supported by context (Snedeker & Trueswell, 2003). Speakers can also use prosody to mark which item is in focus and to mark a declarative or interrogative statement (Cruttenden, 1995; Ladd, 1996) as well as using prosody to indicate when they have finished speaking (Geluykens & Swerts, 1994).

As well as investigating the suprasegmental properties of speech, research into spoken language prosody has shown how a speech stream can be divided into prosodic constituents which have a hierarchal ordering. This prosodic hierarchy, as outlined by Nespor and Vogel (1986), is set out as follows:

(2a)   phonological utterance > intonational phrase > phonological (or intermediate)

    phrase > clitic group > prosodic word > foot > syllable > mora

The largest prosodic constituent is the phonological utterance (henceforth U) and the smallest constituent is the mora. A prosodic constituent at one level can be divided into prosodic constituents at the next level below it. This means that a U consists of one or more IPs and that these phrases, in turn, consist of one or more phonological phrases. This hierarchy of prosodic constituents was developed after observing that morpho-syntactic constituents are insufficient when describing phonological rules. Nespor and Vogel (1986) demonstrate that each level of the prosodic hierarchy serves as the domain of application for specific phonological rules and phonetic processes. They demonstrate that these constituents also show non-isomorphism with the morpho-syntactic constituent providing further justification for the existence of a prosodic hierarchy. The domains that are of interest here are the IP and the U which are explained below.

Nespor and Vogel (1986) provide the following definition of an IP:

(2b)   IP Domain
    An IP domain may consist of:
    (i) all the phonological phrases (PP) in a string that is not structurally
    attached to the sentence tree at the level of s-structure,
    (ii) any remaining sequence of adjacent PPs in a root sentence.

The reasoning behind (i) above follows from the observation that some constructions, such as parentheticals (2c), non-restrictive relative clauses (2d), vocatives (2e), tag questions (2f), and topicalisations (2g), are 'outside of the sentence' they are associated with and obligatory form complete IPs of their own. As explained in (ii), the remaining sequence in each case also forms IPs.

(2c)   [Michael] [*as we all know*] [is always late]

(2d)   [My friend] [*who is an actor*] [just went for an audition]

(2e)   [*John*] [allow me to introduce Martha]

(2f)   [That's Jennifer] [*isn't it*]

(2g)   [*John*] [He was the one I bumped into yesterday]

Although syntax can clearly play a role in how an utterance is divided into prosodic constituents, an utterance can be restructured according to external factors. These include a speaker's style, their rate of speech and how often they tend to take a breath. Despite possible variation in the number of IPs in an utterance, Nespor and Vogel (1986) maintain that IP formation in languages is constrained by syntactic and semantic factors.

An IP has at least one pitch accent and is the domain of application for intonational contours and other segmental phonological rules (Cruttenden, 1995; Nespor & Vogel, 1986). The presence of a single pitch accent constitutes the minimum internal criterion by which an IP is defined (Cruttenden, 1995). Intonational contours are characterised by a sequence of high and low tones and these sequences combine to form intonational tunes which are associated with a wide range of meanings (Cruttenden, 1995; Fox, 2000; Ladd, 1996; Selkirk, 1995). For example, a rising tone towards the end of an utterance is typically associated with interrogatives and a falling tone may be associated with declaratives. Other functions linked to the intonational contour include indicating which item is in focus or conveying the attitude of the speaker (e.g. adopting a condescending tone) or as a discourse tool to invite someone to participate in a conversation.

At the next level of the prosodic hierarchy is the phonological utterance. The definition of the U is as follows.

(2h)   Phonological Utterance Formation
        PU domain:
        The domain of U consists of all the IPs corresponding to X^n in the syntactic tree.
        PU construction:
        Join into an n-ary branching U all IPs included in a string delimited by the definition
        of the domain of PU

This definition explains that the following example must be divided as in (2i) and not in (2j).

(2i)   [[Mark is tall]IP]U [[Henry] IP [on the other hand] IP [is short] IP] U

(2j)   *[[Mark is tall] IP [Henry] IP] U [[on the other hand] IP [is short] IP] U

Nespor and Vogel show that phonological rules, such as the linking-r in British English, apply to this domain. In this rule, morphemes that end in non-high vowels are followed by [r] if the next morpheme begins with an onsetless syllable (Gussenhoven & Jacobs, 1998). This rule is observed to apply between words and across words but not between words that belong to a separate U as in the example below.

(2k)   […sti[r]ing…] U
(2l)   [A fai[r]idea] U
(2m)   [Hi Shelia! [r] Everything all alright] U
(2n)   [Hi Peter] U *[r] [Open the window, Shelia]U

(Gussenhoven & Jacobs, 1998)

In the examples above, (2m) represents a single U but is at odds with the definition provided in (2h). This illustrates that a string of Us can be restructured under some conditions (e.g. if a sentence is short or if there is no intervening pause between the sentences). Thus, (2m) shows that the linking-r can apply within syntactic sentences but not in (2n) where the two sentences are contained in different Us. Therefore, the domain of application for this rule is the U and, as seen in (2m), the U is not necessarily iso-morphic with the syntactic sentence.

What is of particular interest here is how the boundaries of these phrases are delimited and whether any variability in cue-usage exists in spoken languages. The literature indicates that IP boundaries can be marked in several ways: pauses, anacrusis, final syllable lengthening and a change in pitch on unaccented syllables (Cruttenden, 1995). Pauses fall into two categories: unfilled and filled pauses. Although it is accepted that speakers do pause to take a breath, it has been demonstrated that this explanation cannot account for all the pauses that are produced whilst speaking. Instead, it is argued that pauses are linguistically motivated in that they are systematically observed at specific points in an utterance and that the length of a pause can be correlated with the strength of a boundary (Cruttenden, 1995; Grosjean & Lane, 1981). In addition, pauses can be subject to

external factors such as being filled (as opposed to unfilled) at major constituent boundaries to avoid relinquishing a turn (Clark & Fox Tree, 2002).

Anacrusis refers to the tendency to produce syllables in phrase-initial position at a faster speed (or reducing the number of syllables) than following unstressed syllables, and this tendency may aid in the detection of an IP boundary (Cruttenden, 1995).[2] This is particularly noticeable when considering that the final syllable in an IP can be lengthened (Cruttenden, 1995; Cutler et al., 1997; Wightman, Shattuck-Hufnagel, Ostendorf, & Price, 1992). Final syllable lengthening is observed to mark an IP boundary on its own or in combination with a following pause. It has often been explained as indicative that the speaker is naturally relaxing towards the end of an utterance before a pause, providing an opportunity to review what has been said and to plan ahead (Cruttenden, 1995). It has also been noted that many languages, on a cross-linguistic scale exhibit phrase-final lengthening and it is therefore considered to be a feature independent of any specific language (Vaissiere, 1983). Finally, a change in pitch level and pitch direction on unaccented syllables can also indicate boundaries to the listener. Although the pitch at the start of a phrase generally begins at a low level, it is at a higher level than the low unaccented syllables towards the end of the preceding phrase (Cruttenden, 1995; Ladd, 1996). This difference in pitch level, as well as anacrusis, final syllable lengthening and pauses, are external criteria which delimit the IP in speech.

However, it should be noted that the presence of these features does not always mark an IP boundary. That is, the occurrence of pauses, anacrusis and lengthening may also be linked to periods of hesitation and planning. It is suggested that such occurrences should be considered in combination with the internal criterion for an IP: that it has at least one pitch accent (Cruttenden, 1995). However, although such markers are well established, not all boundaries will be marked by these external criteria and some pitch sequences (such as the falling and rising tone that characterise sentence final adverbials) where these markers are absent present

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[2] Cruttenden does not use the term 'intonation phrase' but 'intonation group' when referring to boundary markers.

problems when deciding whether a given utterance is to be analysed as one or two IPs (Cruttenden, 1995). In addition, prosodic features can exhibit variability in usage and are influenced by a number of factors such as idiosyncratic variation and pragmatic intent and setting (Cruttenden, 1995; Geluykens & Swerts, 1994; Schafer et al., 2000; Shriberg, Stolcke, Hakkani-Tür, & Tür, 2000).

As we begin to look at sign language, several questions are raised. What might a prosodic system look like in a language which does not exist within the oral-aural modality? Do we observe similarities or differences between spoken and signed languages where prosody is concerned? The next section marks a move away from speech prosody and towards a discussion on prosody in signed languages.

2.3 Sign language prosody

The field of sign language prosody is relatively new. As a consequence, there are significant gaps in the literature such that a full understanding of sign language prosody is not yet possible. Furthermore, when the search for studies on prosody is limited to BSL, there is almost nothing available to the researcher. Fortunately, what little literature there is (on signed languages in general) goes a long way in establishing the case for a prosodic system in signed languages. These studies are reported below.

Wilbur (1999) states that the adaptation by ASL to the production and perception requirements of the visual-gestural modality has resulted in a prosodic system that is similar in function to spoken languages but different in form. There is strong evidence from a wide range of sign language studies to suggest that this is the case.

As in spoken languages, a signed stream can be divided into constituents that are organised according to the prosodic hierarchy (as outlined above) and are marked systematically by manual and non-manual features. This has been demonstrated in Israeli Sign Language (ISL) at the level of the prosodic word, phonological phrase, and IP to a great extent (Nespor & Sandler, 1999; Sandler, 1999a, 2005, 2006; Sandler & Lillo-Martin, 2006). For example, Sandler (1999a) outlines two phonological processes whereby a pronoun can attach to a lexical host to form a

prosodic word. These post-lexical processes (termed assimilation and coalescence) are non-structure preserving (orientation does not assimilate with handshape in assimilation as expected and the symmetry condition is violated in coalescence), have been compared to similar process in spoken languages where function words cliticise to a host to form the constituent prosodic word. At the next level in the prosodic hierarchy, and using the algorithm outlined in Nespor and Vogel (1986), Nespor and Sandler (1999) show that an ISL corpus can be structured into phonological phrases. Furthermore, a signed utterance can be segmented into IPs and, as in spoken languages, parentheticals (2o), non-restrictive relative clauses (2p), right-dislocated elements (2q), and topicalised elements (2r) obligatorily form IPs in ISL as seen below (examples taken from Sandler & Lillo-Martin, 2006).

(2o)   [DOGS THOSE] [(YOU) KNOW] [LIKE EAT COOKIES]
         'Dogs, as you know, like cookies.'
(2p)   [BOOKS HE WRITE PAST] [I LIKE] [DEPLETE]
         'The books he wrote, which I like, are sold out.'
(2q)   [THEY TIRED] [PLAYERS SOCCER]
         'They're tired, the soccer players.'
(2r)   [CAKE] [I EAT COMPLETELY]
         'The cake, I ate up completely.'

As well as demonstrating that a signed utterance can be structured into prosodic constituents, these studies have shown that prosodic constituents are typically marked by non-manual and manual features. For example, in prosodic words, the mouthing which is co-articulated with the host manual sign has been shown to spread onto the neighbouring pronoun providing further evidence that the two can be delimited as a single unit. At the next level in the prosodic hierarchy, systematic manual behaviour which has the phonological phrase as its domain of application is observed (see Section 2.5.2 below). Furthermore, in their ISL data, an overall change in facial expression, as well as a change in head and body position, consistently coincide with IP boundaries (Nespor & Sandler, 1999).[3]

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[3] Findings from the ISL studies are based on individual elicited sentences, and not narratives as discussed in later chapters.

The observation that a change in facial expression aligns with IP boundaries supports the suggestion that facial expression represents an intonational system within a visual-gestural language. Like spoken language intonation, the meaning associated with a particular facial configuration is 'broad and gains specific interpretation through its interaction with the text with which it is associated' (Sandler & Lillo-Martin, 2006:258). This interpretation is at odds with previously held views of components of facial expression (such as the brows) being intrinsically associated with specific syntactic constructions (Liddell, 1980; MacLaughlin, 1997; Niedle, Kegl, MacLaughlin, Bahan, & Lee, 2000). However, the claim that these markers are grammatically significant is not disputed by the studies from ISL. Rather, the authors propose that whilst these markers significantly correspond to grammatical units, they are better explained as a system akin to spoken language intonation.

The syntactic analysis of non-manual markers claimed that the onset and offset of these markers strictly coincide with the beginning and end of the syntactic constituent they are articulated with and that these markers are obligatory. Two arguments put forth to support the prosodic argument contradict this: non-isomorphism with the syntactic constituent and the context in which an utterance is signed. In the example below, a case of non-isomorphism between the non-manual marker and the syntactic constituent is presented.

(2s)   _____y/n
           Ix2 LIKE ICE CREAM VANILLA OR CHOCOLATE?
           Do you like vanilla ice cream or chocolate ice cream?

                                        (from Sandler & Lillo-Martin, 2006:463)

In order to support the translation given above (as opposed to a choice between vanilla ice cream *or* some chocolate), the non-manual marking associated with yes/no questions in ISL does not span the entire question but is completed after the articulation of VANILLA. This example demonstrates that non-manual features (functioning as intonation) exhibit non-isomorphism with the syntactic constituent. Secondly, the meaning associated with a specific facial expression is dissociable

from the syntactic structure and is, in part, influenced by the pragmatic context in which an utterance is signed. Facial expressions that are strongly associated with WH-constructions in signing (furrowed brow, forward head tilt) may be overridden when the underlying intent of the utterance is not interrogative (even when a WH-element is present) (Sandler & Lillo-Martin, 2006).

As well as being influenced by pragmatic context, prosodic phrasing of an utterance can also be determined by signing rate. In other words, and like spoken languages, a given utterance can have several different prosodic readings depending on the speed at which it is signed. Wilbur (1999; 2009) reports that, when asked to vary signing rate, ASL signers demonstrate prosodic reorganization at phrase level and consequently in placement and production of non-manual features (such as blinks and brow movement) and duration and number of pauses. This variability in intonational phrasing reinforces the viewpoint that sign language prosodic structure exhibits non-isomorphism with syntactic structure. In addition, it can be expected that the prosodic phrasing of an utterance and the production of features may vary between signers depending on their style (idiolectal variation), as has been reported between sign language interpreters in the production of boundary markers (Nicodemus, 2009) and between Swiss German Sign Language (DSGS) signers (Boyes-Braem, 1999), Variability in intonational phrasing depending on style and rate of speech is a characteristic that has also been observed for intonation in spoken languages (Cruttenden, 1995; Nespor & Vogel, 1986).

Other evidence of the linguistic status of non-manual features is provided by brain imaging studies and studies looking at atypical signers. Brain imaging studies have indicated that grammatical and affective facial expressions are lateralised differently in the brain (Corina, Bellugi, & Reilly, 1999; McCullough, Emmorey, & Sereno, 2005). Studies that focus on atypical signers provide further evidence that non-manual features in signing may have a prosodic (as opposed to syntactic) function. In a study which included BSL signers with right hemisphere lesions, the perception of manual and non-manual features of negation was tested (Atkinson, Campbell, Marshall, Thacker, & Woll, 2004). Using a picture selection task, these signers were

asked to match the correct picture to a signed statement. Each statement varied according to whether they featured a lexical and non-manual marker of negation, or a non-manual marker alone. Results showed that the right-lesioned signers were unable to fully understand negative statements when negative information was only available through non-manual features (lexical information was absent). Results suggest that non-manual features of negation are processed in the right hemisphere, unlike syntactic elements of sign language, and therefore may be, in part, prosodic.

It has also been suggested that mastery of prosodic elements in signing is supported by earlier exposure to sign language. Studies looking at deaf babies learning ASL as a first language have demonstrated that correct grammatical use of the brow in WH-questions is acquired in a gradual analytic manner (Lillo-Martin, 2000) and in contrast to affective facial expressions (Reilly & Anderson, 2002). In a different study which compared sign language data produced by early and late learners of DSGS, it was found that the two groups differed in their use of a side-to-side movement of the torso marking discourse units (Boyes-Braem, 1999). This use of the torso was observed more frequently in the early learners compared to the late learners, who preferred to use prosodic markers from their first language (German) instead. In a BSL study comparing the use of the head by Deaf[4] and hearing translators/interpreters (T/Is), Stone (2009) demonstrates that head movements produced by the two groups serve to mark lexical, phrasal and discourse units. However, the hearing T/Is are unable to nest smaller head movements within other head movements linking together discourse units, which the Deaf T/Is were able to do. The findings from these studies suggest that the alignment and mastery of non-manual features is learned at an early age and that there may be a critical period for the acquisition of sign language prosody.

These studies contribute to growing evidence for the existence of a prosodic system in signed languages, one that is different in form but similar in function to prosody in spoken languages. In the following sections, an overview of visual features that

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[4] The use of the upper case in 'Deaf' denotes someone who uses sign language and considers themselves to be a part of the British Deaf community.

align with prosodic constituents is provided. The aim is to provide the necessary background for a further investigation in the occurrence of these markers in BSL narratives. This is divided into two sections: non-manual and manual features. Once again, this review will draw from general sign language literature and will not be restricted to studies on BSL.

2.4   Non-manual features

This section, titled non-manual features, includes: the head, the face and the torso. The section, 'the face', is further divided into the following sub-sections: brows and blinks.

2.4.1 Head

In BSL, it has been reported that head movements and nods can perform several grammatical functions. For example, a head dip can be used to indicate first person or a rapid sequence of head nods can be used for emphasis in some contexts (e.g. when insisting the truth) and a single head nod articulated at the end of an utterance may also indicate when a phrase is complete (Sutton-Spence & Woll, 1999). In addition, head-shakes (non-manual markers to negation) can also span the scope of the constituent they modify (such as a topic, a rhetorical question or a whole clause) (Sutton-Spence & Woll, 1999). Similar claims have been made for head nods and head shakes in ASL (Liddell, 1980; Wilbur, 2000, 2009). In this sense, head movements can be perceived as either boundary or domain markers and are closely associated with specific grammatical constructions. It has been suggested that a change in head position corresponds to an IP boundary in ISL and may function as a rhythmic cue to boundaries (Nespor & Sandler, 1999; Sandler, 2005; Sandler & Lillo-Martin, 2006). This is supported by Sze (2004) who suggests that head position may be a more reliable marker of IP boundaries than blinking for Hong Kong Sign Language (HKSL) (see 2.4.2.2 below). In a study referred to earlier, it was shown that head positions which correspond to phrasal and discourse units can be nested within other head positions or movements to form larger units and that deaf BSL signers were more proficient at this when compared to sign language interpreters (Stone, 2009). Although these studies show a strong tendency for head

movements to align with constituents, they are not restricted to occurring in this way. For example, head nods can co-occur with a lexical sign (Liddell, 1980; Wilbur, 2009); head thrusts which occur with the last sign in the clause perform a semantic function and are distinguished from other head movements which are boundary or domain marking (Wilbur, 2000).

2.4.2 Face
This section moves onto a review of non-manual features expressed on the face. This is divided into two sections: brows and blinks.

2.4.2.1 Brows
The use of the brows during signing has been well documented. In BSL, several functions are associated with the brows. These include lexical distinctions (with a specific position of the brow obligatory for some signs), marking of certain grammatical constructions (e.g. yes/no questions, WH questions, topics, conditionals) and conveying the affective state of the signer (Sutton-Spence & Woll, 1999). These findings have been reported for other signed languages as well (e.g. NGT in Coerts, 1992; Auslan in Johnston & Schembri, 2007; ASL in Liddell, 1980; and in Sandler & Lillo-Martin, 2006, who also report on ISL). The grammatical status of the brows has been distinguished from affective use in several ways. For example, in ASL, the onset and offset of brow movement closely correspond with the syntactic constituent they modify and are obligatory when the corresponding manual element is absent (Liddell, 1980; MacLaughlin, 1997; Neidle, Kegl, MacLaughlin, Bahan, & Lee, 2000).[5] In contrast, affective use of the brows has been claimed to be gradable, to exhibit a degree of variability, and to not be aligned with specific syntactic constituents (Liddell, 1980). Wilbur (2000) distinguishes between three different positions of the brows which are 'linguistically significant'. These are: raised brow, furrowed brow and neutral brow. This positions have been further associated with specific syntactic constructions. A neutral brow position marks assertion and furrowed brows are strongly associated with WH-questions (Wilbur,

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[5] The scope of eyebrow movement (as well as other non-manual markers such as eye-gaze and head tilts) has been used to provide evidence for underlying sentence structure (MacLaughlin, 1997; Neidle et al., 2000).

2000). It is observed that raised brows are more difficult to characterise in that they occur on a number of unrelated syntactic constructions such as relative clauses, conditionals, topics, left dislocations, yes/no questions and WH-clauses of WH-cleft constructions (Wilbur, 2000).

As outlined earlier, it has been proposed that facial expressions correspond to a system of intonation which in turn has the IP as its domain of application. In this approach, the use of the brow is said to combine with other facial actions to form arrays (independent of the sentence they are co-articulated with). For example, in ISL, raised brows 'signal continuation and forward directionality' indicating that the phrase it spans is linked to following the following phrase. Additionally, lower-lid squint is said to designate shared information between the speaker and the addressee. Together, they combine to characterise counter-factual conditionals as below:

(2t) _____ Brow Raise + Squint
      IF GOALKEEPER HE CATCH-BALL, WIN GAME WIN
      If the goalkeeper had caught the ball, they would have won the game

(from Dachovsky & Sandler, 2009)

Here, the brow raise and the lower-lid squint make a contribution to the overall meaning of the sentence. The lower-lid squint acknowledges that the signer is aware that the event did not happen and the brow raise predicts the information in the following clause (what would have happened if the first clause was true) (Dachovsky, 2007; Dachovsky & Sandler, 2009; Sandler & Lillo-Martin, 2006). These arrays are likened to intonational tunes where the meaning associated with each marker is broad and gains specificity in combination with other features and with the sentences they are co-articulated with (Dachovsky & Sandler, 2009; Sandler & Lillo-Martin, 2006). In an analysis preceding Sandler & Lillo-Martin, Wilbur (2009) argues against a purely pragmatic analysis of brow movements; such an approach cannot account for all instances of brow raises in ASL and cannot explain why brow raises are not observed on constructions where they would be expected.

It has also been demonstrated that there is an interaction between grammatical and affective use of the brows and that they cannot always be separated into two clear units. In the following study, the position of the brow was analysed in a set of questions signed in Sign Language of the Netherlands (NGT) and articulated in neutral and various affective states (de Vos et al., 2009). Using the Facial Action Coding System (FACS) to distinguish between brow movements, results indicated that when the target linguistic and affective positions of the brow were similar, phonetic enhancement of the brows was observed (surprised yes/no questions or angry content questions). When linguistic and affective positions of the brows were in conflict, they were either blended or occurred simultaneously. This study shows that the position of the brow can be influenced by external factors such as the speaker's emotional state.

2.4.2.2 Blinks

It has been suggested that blinking during signing is linguistically constrained (Baker & Padden, 1978) and aligned with boundaries in ASL (Wilbur, 1994, 2000) and in ISL (Nespor & Sandler, 1999). In ASL, Wilbur (1994) identifies two categories of blinks: inhibited periodic blinks and voluntary blinks. Inhibited periodic blinks occur at IP boundaries (at the right-edge of an ungoverned maximal projection) whilst voluntary blinks occur simultaneously with a lexical sign and are said to perform a semantic/prosodic function marking emphasis, assertion or stress. Evidence for the two categories in ASL is provided by Wilbur's observation that voluntary blinks that occur in phrase-final position are followed by periodic blinks marking an IP boundary. In addition, voluntary blinks are slower and longer than periodic blinks. When considering the placement of periodic blinks, Wilbur states that although it cannot be predicted that a signer will blink, when blinks do occur, it can be predicted with 90% accuracy that they will be aligned with an IP boundary.

The fact that blinks systematically occur at IP boundaries has led researchers to liken blinking to the act of breathing in spoken languages. Where speakers tend to take a breath at IP boundaries, signers blink. Nespor and Sandler (1999:165) state that the act of blinking and breathing are both 'a function of the physical system independent

of the language, but during linguistic production, both are restricted to occurring only at IP boundaries. In this way, the physiological system is recruited to augment the phonological organisation of utterances into constituents.'

However, Sze (2004) considers that whilst markers for IP boundaries in spoken languages (such as a change in pitch, phrase-final lengthening, and pauses) are directly related to the articulation of speech, blinks produced during signing are not directly related to the articulation of signs and can be influence by non-linguistic factors. Based on her observations of blinking in HKSL, Sze (2004) proposes an alternative classification system for blinks which considers other non-linguistic factors. Her classification of blinks is outlined below.

(2u)   Type I: Physiologically induced blinks
        Type II: Boundary sensitive blinks
        Type III: Blinks linked to head movement and gaze change
        Type IV: Voluntary/lexically related blinks
        Type V: Hesitation

Additional factors that account for blink production in Sze's classification system are represented in Type I, III, and V blinks. Type I blinks are produced either as a response to the hands moving close to the face during the production of a sign or in response to sudden head movements brought about by forceful hand/arm movements. Although Type I blinks do overlap with lexical signs, it is generally agreed that these blinks do not serve a linguistic function. In addition, Type III blinks are also linked to the physiological need to blink during a change in head position or gaze direction in order to minimise blurred vision. Type V blinks are hesitation blinks and are linked to false starts and moments where a signer hesitates. As with Type I blinks, it is suggested that Type III and V blinks are not linguistically motivated.

In Sze's HKSL data, Type II blinks represent the largest proportion of blinks (68% of blinks recorded are classed as Type II). However, of all the boundary blinks, only 55% occurred at IP boundaries. Boundary blinks were also observed at other grammatical boundaries (such as between a subject and predicate or a verb and

object) not linked to the intonational phrasing of an utterance. In addition, she observed that not all IP boundaries are marked with a blink. These observations led to her conclusion that blinks may not be a reliable indicator of IP boundaries in HKSL.

Although Type III blinks account for 6% of Sze's data, it is noted that this figure may be higher. Of her monologue data, 63% of blinks are linked to head movement and 55% linked to gaze change. In the conversational data, 49% are linked to head movement and 43% linked to gaze change. Although the production of blinks has been closely linked to head movement (Stern et al. in Sze 2004, Wilbur, 2000) and eye movement (Fogarty & Stern, 1989) in general, not all changes in head position and eye gaze produce a blink. These tokens were placed in other categories because they fulfilled other criteria (i.e. were temporally located at a boundary). Together with the observation that other types of boundaries feature a blink, Sze suggests that a change in head position and other non-manual features may be a more reliable indicator of IP boundaries.

When compared to Wilbur's data, the difference in blink placement in these studies may be down to methodological differences (as noted by Sze). Wilbur's data involves ASL signers signing well rehearsed stories whilst Sze's findings are based on monologue and spontaneous conversational data from two native signers of HKSL. If blinks have a similar function to pauses in spoken languages this could account for the high occurrence of blinks at IP boundaries in Wilbur's data since rehearsal would have an effect on pause and thus on blink placement.

Blinking rate was affected by context within the HKSL data. For example, in her conversational data, Sze observes a reduction in the overall number of blinks which she attributes to the need to maintain eye-contact with a conversational partner. Interestingly, she notes a significant drop in the number of blinks at non-intonational boundaries. In contrast, the proportion of boundary blinks at IP boundaries increases. She reasons that higher demands on visual attention cause a reduction in blinks at smaller boundaries with retention of blinks at major boundaries. In addition, while

one of her two participants exhibited a higher blink rate overall, this was associated with an increase in the number of blinks at grammatical boundaries other than IP boundaries, suggesting that an increase in blink rate results in an increase in blinks at lower-level boundaries.

As well as examining head movements, Stone (2009) shows a difference in blink production between Deaf and hearing T/Is which is attributed to the level of preparedness. In this study, blinks produced by Deaf and hearing T/Is whilst presenting headline news on television were examined using Sze's (2004) classification system. Although there was a similar distribution of blink type between the two groups, a higher blink rate was reported for the hearing T/Is. That is, boundary blinks accounted for the majority of blinks (Deaf T/Is: 89%, hearing T/Is: 68%) followed by voluntary (Deaf T/Is: 8%, hearing T/Is: 20%) and finally physiological blinks (Deaf T/Is: 12%, hearing T/Is: 3%).[6] Similar observations in the distribution of blink types were found for blinks produced in similar contexts: translating/interpreting a weekly news review which was for television and in a (relaxed) experimental setting. Stone (2009) concludes that although blink distribution is similar, the hearing T/Is use 'greater emphasis via voluntary blinks and less segmentation of the boundaries' suggesting a higher level of preparedness by the Deaf T/Is. Alternatively, the difference in blink rate can be attributed to differences in the translation process. The Deaf T/Is read the news off an autocue whilst the hearing participants had a soundtrack available to them. This study demonstrates that the production of blinks at boundaries is evident in BSL (the vast majority of blinks in Stone's data are classed as boundary blinks) and that there may be a difference in blink production between Deaf and hearing sign language users in the context reported here which can be attributed either to the process by which a translation occurs or (as argued above for head movements in the same study) linked to fluency in the signed language.

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[6] No blinks linked to head and gaze change or hesitation was observed in either group.

2.4.3 Torso

In BSL, 'body shifts' function to identify the character within a discourse and a change in position corresponds to a change in role (Earis, 2008; Sutton-Spence & Woll, 1999). Body shifts during narratives have been placed on a continuum with the degree of movement whilst shifting ranging from the very subtle (slight forward and backward movement) to larger side-to-side movements (Sutton-Spence & Woll, 1999). Two studies which have focused on body leans in ASL (Wilbur & Patschke, 1998) and NGT (van der Kooij, Crasborn, & Emmerik, 2006) have highlighted several functions associated with this non-manual marker. In both, it is demonstrated that forward and backwards leans convey contrast at different levels in the grammar. For example, in Wilbur and Patschke (1998), leans are shown to prosodically mark stress on a focused lexical item. At the lexical level, they reinforce the meaning of specific lexical items (e.g. verbs) and the direction of the lean conveys the idea of involvement and non-involvement. At the semantic level, forward and backwards leans are contrasted in that they mark two broad categories termed inclusion and exclusion respectively.

The extent to which torso movements correspond to prosodic boundaries is not well documented. However, Boyes-Braem (1999) reports a rhythmic side-to-side movement of the torso which she identifies as phonetically marking large discourse units in DSGS. These movements were observed to be matched in duration and amplitude across units, suggesting that signers use the torso to rhythmically balance segments during signing. It is also reported that the point at which the body changes direction coincides with the edge of a prosodic unit. In addition, Boyes-Braem (ibid.) suggests that observers can use torso movements to anticipate whether someone has finished signing. For example, when the torso moves to one side, it can be expected that a matching balancing movement to the opposite side will occur. This expectation might lead the observer to conclude that the signer has not finished signing. In addition, the torso moving towards or remaining in the neutral upright position indicates to the observer that the signer has completed signing and may mark a larger discourse unit. Boyes-Braem (ibid.) also notes that this movement is not observed in specific types of discourse such as pantomimic-like passages, the

beginning of a narrative where elements (e.g. themes, characters) are introduced, short or interpolated explanations, or short emotional reactions.

2.5   Manual Features

In this section, manual features that have been associated with sign language prosody are discussed. These include prominence, pauses, PALM-UP signs and spreading.

2.5.1 Prominence

Signs in phrase-final position are prominent in ISL (Nespor & Sandler, 1999). Manual features that correspond to prominence include reduplication and holds. It has been claimed that repetition, holds and pauses marks the edges of phonological phrases in ISL and that they are in complementary distribution (Nespor & Sandler, 1999). This is supported by the observation that signs which are lexically specified for repetition are neutralised when they are not in phrase-final position (Nespor & Sandler, 1999). In ASL, Brentari and Crossley (2002) also observe repetition at phonological phrase boundaries but state that these boundaries also coincide with IP boundaries. They conclude that lengthening is a more reliable cue to phonological phrase boundaries. Phrase-final lengthening has been demonstrated in ASL, accounted for by phonological rule of mora-insertion where lengthening is applied not to the syllable nucleus (movement) but on the final segment (location) in some signs (Perlmutter, 1992).

It has also been shown that stressed signs (or signs in focus) are strongly preferred in phrase-final position in ASL (Wilbur, 1997, 1999; Wilbur & Zelaznik, 1997) and ISL (Nespor and Sandler 1999). In Wilbur's study, signs analysed as stressed are produced higher in the signing space, display increased muscle tension and sharp transition boundaries from unstressed signs. Wilbur (1997) also shows that ASL's preference for prominence in phrase-final position can explain variability in word order since prominence is required in phrase-final position (in contrast to spoken English where stress can be shifted to the lexical item in focus) and therefore sign order has to change in order to achieve this. Similar conclusions have been made for ISL (Nespor & Sandler 1999). Again, these findings provide strong evidence of an

underlying prosodic system, one that interfaces with the grammar at the level of syntax in similar way to spoken languages.

2.5.2 Spreading

As sign language production frequently involves the use of multiple articulators, these articulators do not always adhere to boundaries at different levels of the language but exhibit a tendency to spread onto neighbouring signs. One such example can be seen with non-manual features such as mouthings which are reported to spread beyond their lexically specified sign (Boyes Braem, 2001; Crasborn, van der Kooij, Waters, Woll, & Mesch, 2008; Sandler, 1999a). Here we are particularly interested in manual spreading behaviour. Although it is noted that the production of signs involves two hands, there is strong consensus that one hand is dominant in signing. However, this does not imply that the non-dominant hand is a redundant articulator. At the lexical level, the non-dominant hand can mirror signs produced on the dominant hand and function as a place of articulation in some signs (Battinson, 1978; Johnston & Schembri, 2007; Sandler & Lillo-Martin, 2006; Sutton-Spence & Woll, 1999). At the prosodic and discourse level, this articulator functions to mark prosodic constituents and act as a point of reference in signing (Liddell, 2003; Nespor & Sandler, 1999; Sandler, 2006; Sandler & Lillo-Martin, 2006).

Nespor and Sandler (1999) structure their ISL corpus into phonological phrases and observe systematic spreading behaviour on the non-dominant hand which has the phonological phrase as its domain of application. They describe this behaviour as an optional rule of external sandhi observing that the non-dominant hand can spread either leftwards, rightwards, or in both directions beyond its lexically specified sign and always within a phonological phrase. In some cases the non-dominant hand does not always spread up to a phonological phrase boundary because it is interrupted by the articulation of a two-handed sign. They also observed that the end of a handshape spread coincided with both a phonological and intonational phrase boundary. In such cases, it could be argued that non-dominant hand spread may have the IP as its domain of application. However, as phonological phrases are nested

inside intonational phrases, Nespor and Sandler (1999) conclude that it is the phonological phrase that dictates the extent to which the non-dominant hand can spread. In contrast, the non-dominant hand is reported to be an unreliable cue to prosodic constituency in ASL (Brentari & Crossley, 2002). In this study, it is reported that the non-dominant hand can spread beyond a phonological phrase boundary and fail to spread to a phonological phrase boundary when expected. They propose instead that features on the lower face are more reliable markers to phonological phrases.

The non-dominant hand can also be reanalysed as a classifier acting topographically rather than as an empty phonological unit spreading beyond its lexically specified sign. In such an analysis, the non-dominant hand makes a specific contribution to the meaning of the utterance and maps signs in relation to each other within the signing space (Brentari & Goldsmith, 1993). Such cases have been reported in ISL above (Nespor & Sandler, 1999).[7] Although different to classifiers, list buoys are another such example of this. As buoys, the non-dominant hand is held in a stationary position for a long or short period of time whilst the dominant hands continues to sign (Liddell, 2003). In these cases, the non-dominant hand can be said to function as an important reference point and to mark larger discourse units.

2.5.3 Pauses
Pauses in signed languages are not random but organised in a systematic way and can reliably indicate sentence boundaries. Grosjean and Lane (1977) analysed pauses produced by five native signers of ASL reciting a narrative. Following the recording, the occurrence and duration of all pauses were assessed. The results indicated a relationship between pause length and the strength of a syntactic constituent. For example, the mean pause duration was highest between sentences (229ms). At lower-level boundaries, the mean pause duration was shorter: between conjoined sentences, 134ms; between NP and VP, 106 ms; within NP, 6ms; and within VP, 11ms. When directly compared to spoken languages, pause duration at

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[7] Classifiers on the dominant hand are reported to be independent of prosodic structure and can 'continue without rearticulation over a number of prosodic boundaries (Aronoff, Meir, Padden, & Sandler, 2003)

syntactic boundaries in sign languages is shorter overall (for spoken languages: > 445ms between sentences; 245 to 445ms between conjoined sentences and between NP and VP; less than < 245ms corresponds to breaks within constituents). However, the pattern remains the same for both language types, the higher the syntactic break, the longer the pause.

The definition of pauses in the study reported above is extended to include holds which are described as a type of filled pause occurring at the end of a segment, topic or important idea (Winston & Monikowski, 2003, reported in Nicodemus, 2009). Pauses in signing may also be characterised by dropping the hands to the lap or by clasping the hands together (Brentari et al., 2007; Nicodemus, 2009). In a study examining the frequency of markers present at boundaries perceived by ASL signers, hand clasps were found to be the most frequent marker present at these boundaries (Nicodemus, 2009). This study focused on boundary markers produced by interpreters and therefore it is a possibility that this finding may be unique to interpreters.

2.6   Discussion

Studies of sign language prosody in general and those that focus on non-manual and manual features have combined to produce a strong argument that these features are not meaningless units co-articulated with manual signs but have an important function to play at different levels of the language. Although this review has focused on each feature in turn, it should be remembered that these features do not occur independently but combine with one another sequentially and simultaneously (termed 'prosodic layering') (Wilbur, 2000). This is evident in many of the studies which mention other features that are co-articulated with the feature under examination. For example, in their NGT study on body leans, van der Kooij et al. (2006) note although the movements of the head correspond with leans, both articulators can move independently. That is, they move in different directions and convey different meanings related to the syntactic and pragmatic context within which they are articulated. A similar observation is made for BSL by Stone (2009) where smaller head movements are nested within head tilts to link discourse units. In

a study of markers present at boundaries perceived by ASL signers, Nicodemus' (2009) analysis frequently observes clusters of 6 and 7 markers layered at boundaries within a two second interval. An analysis of how theses features are layered with respect to the most frequent marker (hand clasps) show nearly one-third of markers were produced sequentially. She shows that multiple markers to boundaries are timed to occur within a small time frame in respect to one another.

These studies highlight a complex system of prosodic marking for sign languages where multiple articulators combine with one another either across large discourse units or within a short space of time at boundaries. However, although this system is very different to spoken language prosody, several similarities are observed. For example, specific constructions are noted to form IPs in signed languages (such as topics, parentheticals, conditionals) as in spoken languages and are delimited by changes in facial expression which have been likened to intonational tunes (Nespor & Sandler, 1999). In addition, prosodic phrasing and marking have been shown to exhibit a high level of variability which is determined in part by signing rate (Wilbur, 2009) and idiosyncratic style (Nicodemus, 2009).

However, just as the literature clearly shows a prosodic system at work within signed languages, several questions remain unanswered. For example, it is not clear which markers reliably indicate IP boundaries. Although markers of these boundaries have been clearly established, it is not clear if they are consistently present. In other words, although the brow is strongly associated with IPs, it is not expected the brow will mark every IP boundary. However, when they do occur with specific constructions such as topics or WH-questions, their domain will be the IP. Therefore, how frequently can we expect to see each marker at boundaries? In addition, the status of any particular marker is not clear. As in Sze (2004), it was suggested that the claim that blinks are a reliable marker of boundaries is dubious and that a change in head position may be a more reliable indicator of IP boundaries. In other words, we need to ask how several markers compare with one another in terms of reliability and consistency. We also do not know whether these markers can be used to delimit prosodic constituents in BSL.

Another question comes to the fore here: how might these features interact with the task of telling a story? The distribution of features might be affected by certain tasks, as seen in the rate of blinking in conversational discourse when compared to monologue and in the effect a formal setting can have on sign register (Zimmer, 1989). In addition, certain articulators can have multiple functions which may overlap during signing, such as combining affect and grammar in the eyebrows. When one considers what the task of telling a story in sign language involves, conveying a character's attitude, frequent role shifts, the use of classifiers to convey spatial information, and signs involving constructed action, then one begins to ask what effect this has on visual markers of boundaries. Will there be specific types of visual markers used to indicate boundaries in signed narratives? Is there an overlap in function for the articulators involved in narrative signing? Do signers make use of a different set of visual markers when indicating boundaries in narrative signing than in other signing contexts? These questions are addressed in the next chapter.

2.7   Summary

Signed languages use a number of manual and non-manual features to mark prosodic boundaries which share similar characteristics with speech prosody. Although there have been great advances, little is known about how BSL marks IP boundaries and how visual markers interact with narrative devices when telling a story.

Chapter 3: The production of visual markers at IP boundaries

3.1   Introduction

The current chapter will present an analysis of non-manual and manual features that coincide with IP boundaries in BSL narratives. In the previous chapter, it was established that a number of features occur at IP boundaries in other signed languages; however, a description of which features are frequently present at IP boundaries in BSL has not been made. Therefore, this chapter aims to clarify which features typically characterise boundary marking in BSL narratives. Throughout the chapter, the term 'visual markers' will be used to refer to the non-manual and manual features investigated here and the term 'boundaries' will be used to refer to IP boundaries only. The discussion of which visual markers are frequently found to coincide with boundaries is limited to those presented in the methodology (see Section 3.4.5 for an outline of features included in analysis).

The chapter will be structured as followed. In 3.2, the aims and objectives of the chapter will be outlined followed by the research questions in 3.3. In 3.4, the methodology of the current chapter is explained; which includes a description of visual markers (categories of non-manual and manual features) that will form the focus of the chapter as well as a description of how IP boundaries were identified in the video data. The results are presented in 3.5 and are divided into non-manual and manual features accordingly. This is followed by a discussion and summary in 3.6 and 3.7 respectively.

3.2   Aims and objectives

This chapter aims to provide a thorough description of the production of visual markers at IP boundaries in BSL narratives. At present, there is little in the literature which describes the type and occurrence of visual markers at prosodic boundaries in BSL specifically. Therefore it is the intention of this chapter to address this gap in the literature and to suggest avenues for future research. In addition, the second part of this thesis is directed towards examining the perception of these same boundaries by native signers and non-signers. It is necessary to make sure the frequency and

underlying nature of visual markers coinciding with IP boundaries in BSL is clearly understood in order to address the possible role they may play in the perception of boundaries by different subjects. To achieve these aims, an analysis of visual markers present at IP boundaries in eight BSL narratives will be carried out. This analysis will also investigate the frequency with which each individual marker is observed at boundaries. Decisions concerning which visual markers the investigation will focus on will be based on the existing sign language literature on visual prosody and through this a secondary aim will be achieved: that of comparing the relationship of visual markers to prosodic boundaries in BSL to other signed languages.

3.3 Research Questions

Through an examination of visual markers produced at IP boundaries in BSL narratives, this chapter intends to answer several research questions which are discussed below. As mentioned previously, the term 'visual marker' is limited to the set of manual and non-manual features listed in the methodology (see Section 3.4.5).

Firstly, can the criteria used to identify IP boundaries in other signed languages be applied successfully to different types of signed discourse (e.g. narrative signing in BSL)? In the previous chapter, several visual markers including blinks, pauses and head nods were shown to align with IP boundaries in other signed languages and their occurrence was taken as evidence of an IP boundary in some studies. Can these markers also be used with BSL narratives to identify prosodic boundaries? Consequently, are there any problems or issues that arise from using these markers to define boundaries in a BSL narrative? It is known that signers can vary in their style depending on their surroundings (e.g. a formal setting might see an increase in amount of fingerspelling) (Quinto-Pozos, Mehter, & Reynolds, 2006; Zimmer, 1989) and therefore it is a possibility that a difference can be seen in the type and occurrence of visual markers at IP boundaries in narratives. Therefore, which visual marker(s) signalling boundaries are characteristic of signed narratives? In what ways are these markers used in narratives similar to, or different from the same markers signalling boundaries in other signing contexts? For example, are similar markers

observed frequently at boundary points in signed narratives as are seen for other types of signed discourse and in other signed languages in general?

Secondly, how frequently are these markers observed at IP boundaries in narratives? Following segmentation, is it possible to observe one visual marker as being a consistent marker of boundary position above other markers? Which visual marker is observed the least at boundaries in BSL narratives? By exploring the occurrence of a set of visual markers, it is hoped that the reliability of a particular marker for indicating boundaries can be assessed. This in turn raises several issues: namely, how can the reliability of a given marker be determined? Can this be determined based on how frequently a marker occurs at IP boundaries alone or must other factors be considered?

Thirdly, how do these markers combine with the task of telling a story? That is, signers frequently use the head, face, and the body in order to convey elements of the story. What consequence does an overlap in function have for markers which serve as a narrative element in storytelling as well as delimiting a signed stream into prosodic constituents? Do these narrative elements (e.g. the use of the torso to signal role) frequently align with IP boundaries?

Finally, does the use of visual markers at IP boundaries vary across signers? In other words, is the selection of visual markers for boundaries idiosyncratic in BSL narratives? How might these visual markers be expected to vary? For example, one possibility is that a signer may employ a particular marker to a greater extent compared to other signers to indicate boundaries in signing.

Using narrative data from BSL, the research presented in this chapter hopes to shed light on these issues. In the following section, the methodology is explained.

3.4   Methodology

To study how visual markers pattern at boundaries in BSL narratives, eight narratives were taken from an online corpus and were coded for a set of manual and non-manual features associated with boundary marking in other signed languages

(see Chapter 2) Following coding, IP boundaries present in all eight narratives were identified and a frequency count of visual markers occurring at these IP boundaries was conducted. In this section, a description of these visual markers which were coded is provided as well as a timing principle for associating visual markers with a particular IP boundary. In addition, a description of the online corpus and the annotation program used in this chapter is included.

3.4.1   ECHO corpus data

Data for the current chapter was taken from the European Cultural Heritage Online (ECHO) Sign Language Corpus. The ECHO corpus contains annotated data from three sign languages: BSL, NGT and SSL. The sign language data consists of five of Aesop's Fables signed by two narrators in each language, as well as a small lexicon and an interview with the narrators. For this study, the BSL narratives (fables) will be used to analyse visual markers that occur at IP boundaries. The method of data collection used by the ECHO project is provided in the following section.

3.4.2   ECHO data collection

In preparation for filming, two participants were given a summary of a selection of Aesop's Fables a week in advance and were asked not to translate the fables verbatim but to re-tell the fables in their own way. The two participants, one male (PS) and one female (CN), were chosen because they were native signers of BSL who used BSL as their main language everyday and because they were experienced story-tellers.[8] On the day of filming, both signers were asked to individually retell all five fables whilst facing a camera. PS was seated for all narratives and CN chose to stand.

Eight narratives were used for analysis in the current chapter. These narratives were: 'The Hare and the Tortoise' (referred to from here on as Narrative A), 'The Boy

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[8] The use of the ECHO data for the analysis conducted here was chosen principally because they involved native signers. It is common practice in sign language research to look at native signers and their signing as a starting point. This is because the majority of sign language users learn to sign at a later age (e.g. at school with other deaf children) and native signers (e.g. signers who are born to at least one signing parent and therefore acquired sign language as their first language) represent a small minority of the deaf community. Research into the production of markers by early and late learners of sign language has shown a difference between the two groups (Boyes-Braem, 1999).

Who Cried Wolf' (referred to as Narrative B), 'The Dog and the Bone' (referred to as Narrative C), and 'Two Friends and the Bear' (referred to as Narrative D). The recordings are available online (at http://www.let.kun.nl/sign-lang/echo/index.html) through the ECHO website.

Table 3.1 below provides an overview of narrative length for each fable.

	Narrative length (in minutes)	
	CN	PS
Narrative A	2:22	1:26
Narrative B	2:18	1:05
Narrative C	1:57	0:50
Narrative D	2:11	1:35

Table 3.1: Length of each signed narrative by signer

When the length of all the narratives are added together, the total running time for PS is 4 minutes 55 seconds and the total running time for CN is 8 minutes 48 seconds. For PS, the longest narrative was timed at 1 minute 35 seconds and the shortest at 50 seconds with an average length of 1 minute and 4 seconds overall. For CN, the longest narrative was timed at 2 minutes 22 seconds and the shortest at 1 minute 57 seconds with an average length of 2 minutes 12 seconds overall.

3.4.3 Annotations

All eight BSL narratives were coded for ten manual and non-manual features. These categories are outlined in the following section. The entire narrative was annotated for these markers irrespective of their position within the text (i.e. whether they appeared at a supposed boundary point or not). The annotating of these narratives was carried out using ELAN (Eudico Linguistic Annotator). ELAN is a computer program that allows users to time-align textual annotations to a specific point in a video file. Following coding, the video file can be played simultaneously with the completed annotations as seen below.
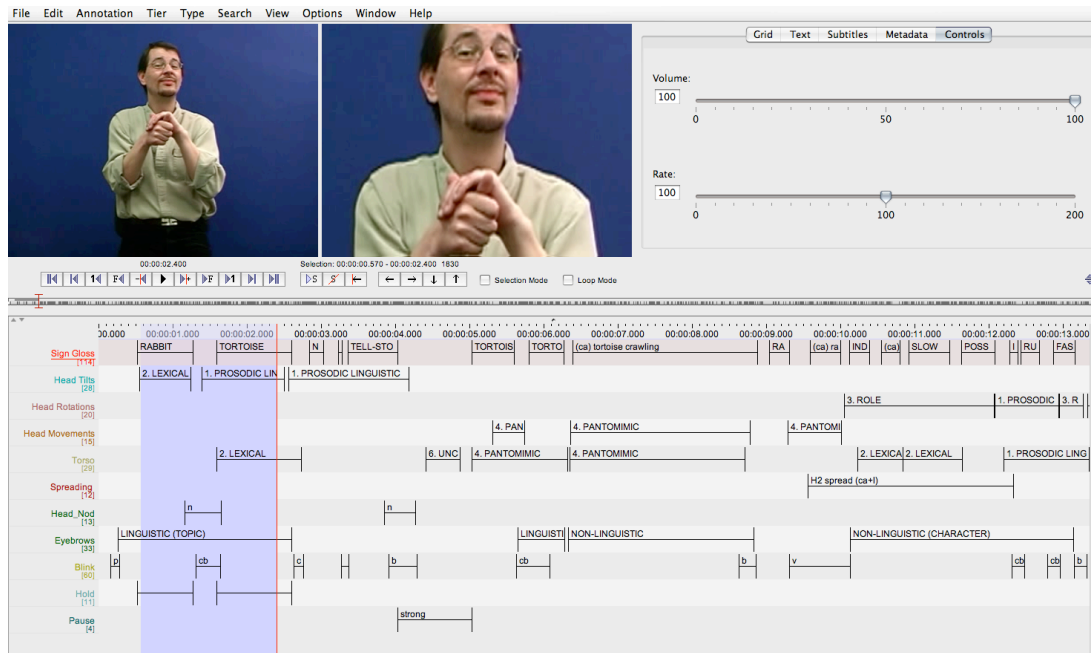
Figure 3.1: Screen grab of ELAN

In the figure above, the annotation viewer occupies the bottom half of the screen. The annotation viewer is divided into rows known as 'tiers'. Each tier is assigned to a specific visual marker (e.g. head nods, blinks, pauses) and all occurrences of that specific marker are annotated on that tier. Since the annotation viewer reflects the real time actions of the signer, markers that are produced simultaneously or co-occur in part with other markers can be seen to 'overlap' with each other from their respective tiers. In the figure above, the annotation viewer is associated with two video files displayed in the top left corner. The two video files present two different views of the signer: a full body capture and a close up of the head. This allowed for much more accurate coding of non-manual features displayed on the face (e.g. blinks and the brows). One of the advantages of using ELAN to annotate manual and non-manual features is that because annotations are time-aligned to real data, the data can easily be checked and verified by further annotators (see Section 3.4.6 for information on how reliability for the coded data was assessed).

3.4.4 Timing principle for markers at IP boundaries

It was necessary to introduce a timing principle in which all markers counted can be said to co-occur at a specific boundary. This principle was used to further justify the

grouping together of markers co-occurring at boundaries and to provide a consistent view of markers at boundaries across narratives. The reference point for this time window was from the final frame in which the final sign in an IP was visible (i.e. the frame before the hand was relaxed). This reference point was treated as a mid point in the time window. So the time window began 0.25 second before this mid point and ended 0.25 second after this mid point. This is displayed in the Figure below where the one second window is highlighted in blue.
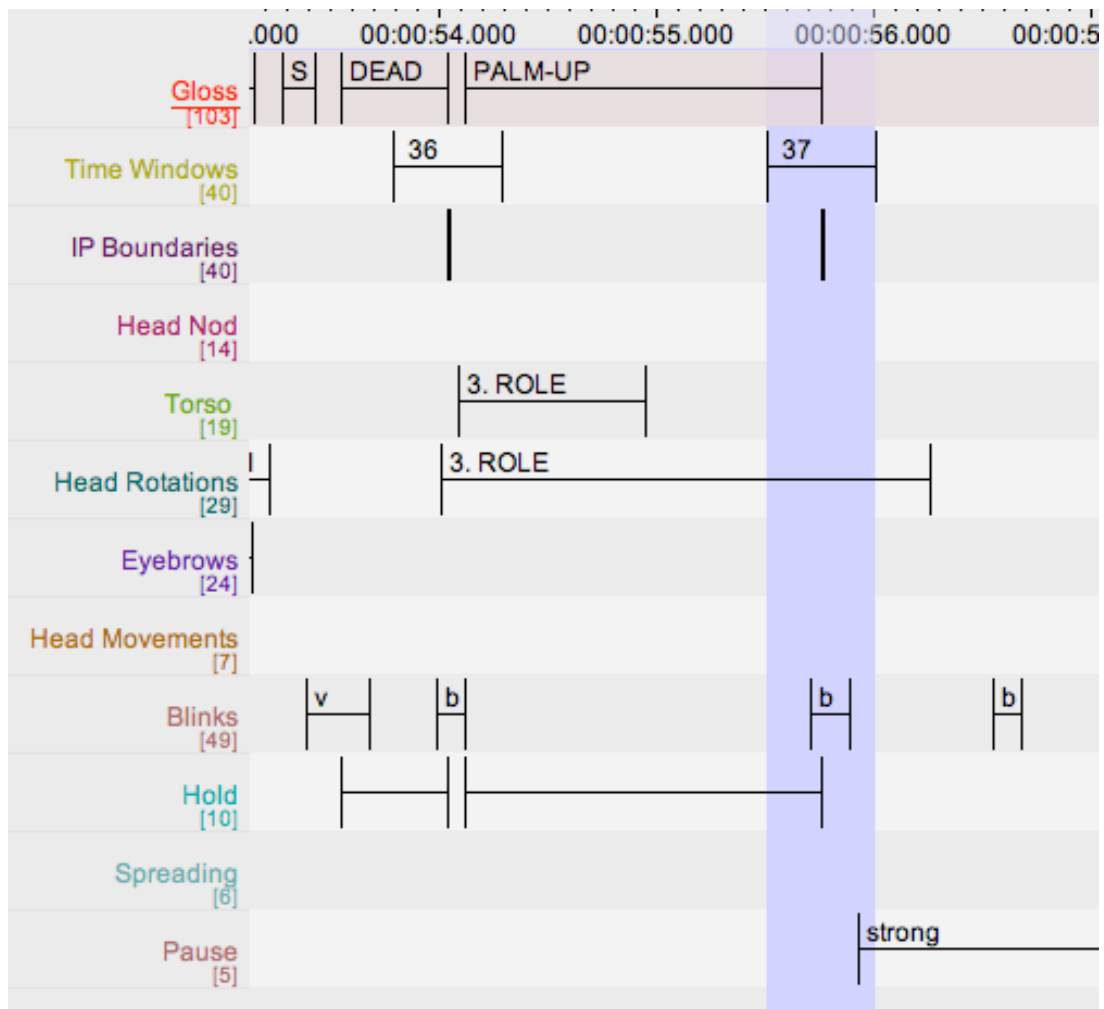
Figure 3.2: Boundary association using the ELAN annotation viewer

As shown in Figure 3.2 above, the 0.5 second time window is highlighted in blue and clearly shows the annotations made on tiers co-occurring with this window. These annotations include a boundary blink, pauses and a hold on the final sign

(PALM-UP). Only a change in position was counted. Therefore, if a particular marker was held in position over a time window, then the marker was not counted as co-occurring with other markers. In some cases, the beginning of a lengthened sign overlapped with the end point of a time window (i.e. the first sign in the following phrase was lengthened). A decision was made to exclude these occurrences from analysis as they would not be visible markers of a boundary because they had not been completed (this was extended to include spreading). Therefore, only lengthened signs in phrase final position are counted. The length of the time windows assigned to boundaries was motivated by the decision that some markers are precisely aligned with specific constructions (Boyes-Braem, 1999; Liddell, 1980; MacLaughlin, 1997; Neidle et al., 2000). Therefore, it is expected that linguistic markers will be completed at the boundary and inside the time window assigned and in contrast, to other uses of the same markers (pantomimic gestures for instance) which may persevere beyond the time window. In the table below, the proportion of each narrative that is covered by the time windows is shown.

	Combined length of time windows (%)	
	CN	PS
Narrative A	40.5 (29%)	25 (29%)
Narrative B	41.5 (20%)	19 (29%)
Narrative C	40 (34%)	12.5 (25%)
Narrative D	33.5 (26%)	28.5 (30%)

Table 3.2: Proportion of each narrative covered by time windows

Table 3.2 shows that sum of the time windows account for 29% of the total narratives. That is, nearly a third of the narrative data represent boundary points which are analysed here. Some issues arise from the use of time windows to justify which markers co-occur; this is discussed further in Section 7.3.

3.4.5 Description of tiers

Each narrative was annotated for thirteen manual and non-manual features. All instances were annotated (whether they occurred at a boundary or not) and each category was assigned its own tier in ELAN. The following section will also detail how the start and end point of each marker was determined. As a timing principle

(described above) is assigned to boundaries, it is necessary to be clear on this so that a consistent view is applied across the data.

3.4.5.1 Coding of non-manual features

An overview of non-manual features annotated for in all BSL narratives is provided in the diagram below. Following this, each feature is described in turn.
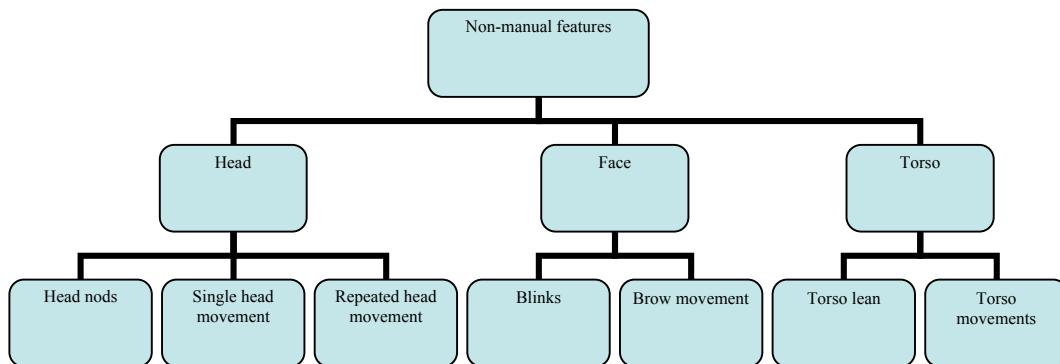
Figure 3.3: Tree diagram of non-manual features

3.4.5.1.1   Head

Within this category, actions of the head are defined as the following: head nods, single head movements, and repeated head movements. It is reported in the sign language literature that a change in head position marks the end of an IP (e.g. Nespor & Sandler, 1999; Sandler & Lillo-Martin, 2006; Wilbur, 2000, 2009). Each sub-category is outlined below.

3.4.5.1.1.1   Head nods

Head nods have been identified in the literature as a possible rhythmic cue for IP boundaries (Wilbur, 2009). Therefore, it has been assigned its own category here (separate from head movements). All occurrences were coded whether it was a single head nod or a combination of head nods. The start point for a head nod was the first frame in which the head began to move downwards. The end point for a

head nod was the first frame where the head appeared to complete the nod (or a sequence of nods).

Figure 3.4: Head nod

3.4.5.1.1.2 Single head movement

Single head movements represents periods where the head rotates or tilts in any given direction and is held in position over a sign sequence. They are categorised further as a linguistic or narrative element. An example of a single head movement which is classed as linguistic is a backward head tilt that marks a topic as pictured in Figure 3.5. Single head movement that are characterised as narrative elements include those that mark role as well as those enacting an action of a character in the story (e.g. looking into a puddle or looking back down a road). Linguistic head movements are further categorised according to whether they are articulated on a single sign (lexical head movement) or over a sequence of signs (domain-marking head movement). The start point of a single head movement was taken to be the first frame where the head began to rotate/tilt in one direction. The end point of a single head movement was taken to be the first frame where the head began to rotate/tilt back to its initial position (or began to rotate/tilt towards a new position).

Figure 3.5: Single head movement as a linguistic element (marking a topic)

Figure 3.6: Single head movement as a narrative element (marking role)

3.4.5.1.1.3   Repeated head movement

This category is distinct from the previous two categories in that it represents repeated or continuous head movement such as a continuous side-to-side movement (without pausing) as seen below. The start a repeated head movement was taken to be the first frame where the head began to move. The end point of the head movement was the first frame in which the head completed its sequence of movements. If there was a rest between movements then a new sequence of head movement was coded. As in the previous section, continuous head movements were further categorised into two groups: linguistic and narrative elements. Linguistic elements include negative headshakes and instances where the head appeared to imitate the movement of the hands adding meaning and emphasis (as pictured in Figure 3.7 where the head imitates the circular movement of the hand in FAR to mean 'very far away'). Narrative elements refer to head movements which enact a character's action as pictured in Figure 3.8 where the head mimics the action of a bear approaching aggressively.

Figure 3.7: Head movement (linguistic element)

Figure 3.8: Head movement (narrative element)

3.4.5.1.2   Face

Visual markers on the face are divided into two categories: brow movement and blinks. These markers and their sub-categories are outlined below.

3.4.5.1.2.1   Brow movement

Two categories were used to code brow movements: linguistic or as a narrative element. Linguistic use of the brow includes brow movements that characterise questions, topics and relative clauses as well as brow movement on a single lexical item. Brow movement characterised as a narrative element refers to affective uses such as depicting a character's emotional state (such as anger or surprise). The start of a brow movement was taken to be the first frame where the brows began to move from their initial position. The end point of a brow movement was taken to be the first frame where the brow returned to its initial position. If the brow moved to a different position (e.g. raised to furrowed), then the end point of a brow movement was taken to be the first frame in which the brow moved towards its subsequent position. Often, for both categories, it was difficult to determine the offset of brow movement. Signers would often gradually relax the brow over an utterance. By contrast, the onset of brow movement was more marked and easier to code. In addition, it was difficult to determine brow movement when movement of the head coincided with a change in brow position. To avoid over estimating brow movement, care was taken to code only visible changes in position.[9]

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[9] CN's brows were only partly visible at times because of the signer's fringe as seen in Figure 3.9.

Figure 3.9: Brow movement (linguistic)

Figure 3.10: Brow movement (narrative element)

3.4.5.1.2.2   Blinks

The start of a blink was identified as the frame before the eyelid appeared to begin a closing phase. The end of a blink was identified as the final frame in which the eyelid appeared to complete its opening phase. In order to distinguish between linguistic blinks and blinks linked to the physiological need to blink or the movement of the head, Sze's (2004) five-way classification of blinks is adopted here. Thus, all blinks were coded according to categories set out in 2(e).

3.4.5.1.3   Torso

Two categories here define torso activity: torso leans and torso movement. This is displayed in Figure 3.11 and 3.12 below respectively.
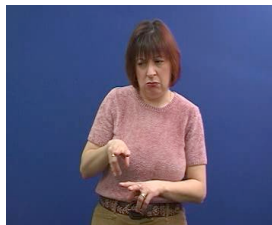
Figure 3.11: Torso lean

Figure 3.12: Torso movement

All leans, in any direction, were all grouped together in one category: torso leans. The start of a torso lean was taken to be the first frame where the torso began to lean away from its initial position. The end point of a torso lean was taken to be the first frame where the torso returned to its initial position (thus completing the lean). If the torso moved to a different position (e.g. right to left), then the end point of the lean was taken to be the first frame where the torso began to move towards its subsequent position. The second category, torso movements, represents all repeated movement of the torso (such as a side to side movement as in Figure 3.12 above). The start of a period of torso movements was taken to be the first frame where the torso began to move. The end point of the torso movement was the first frame in which the head completed its sequence of movements. If there was a rest between movements (i.e. the torso paused between movements), then a new sequence of torso movements was coded. All torso activity was further categorised according to whether it was a linguistic or narrative element.

3.4.5.2 Coding of manual features

Manual features are divided into the following three categories: spreading, holds, and pauses. These features are represented in the tree diagram shown in Figure 3.13 below.
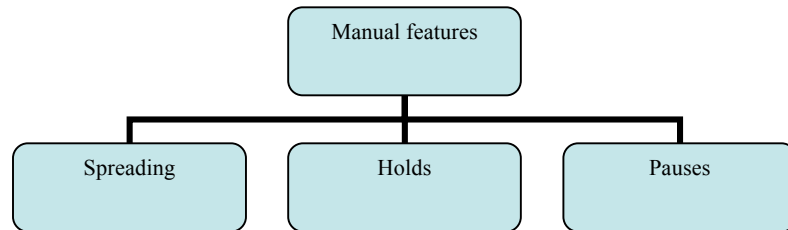
Figure 3.13: Tree diagram of manual features

Each category shown in the figure above is described in turn below. As well as coding for manual boundary markers, a full glossing of the signed narrative was carried out. In each case, the start and end point of a sign was defined as follows: the first frame in which the target handshape of a sign was fully formed and the last frame in which the target handshape was held (the frame before it began to move away and towards the target handshape of the following sign).

3.4.5.2.1   Manual spreading

In some narratives, the handshape of an initial sign spreads over neighbouring signs. As well as being marked in ELAN, each spreading activity was coded according to whether it was either phonological/prosodic (non-dominant hand spread), or if it was performing a discourse function (e.g. a list buoy or an index directed at a point in space), or if it was performing a narrative function (such as spreading originating from a classifier or a constructed action sequence).

Figure 3.14: Manual spreading (phonological/prosodic)

Figure 3.15: Manual spreading (narrative function)

3.4.5.2.2 Holds

In some signs, the final handshape was held in final position for a longer duration. Where this occurred, the full sign was glossed as a hold as seen below.

Figure 3.16: Hold

Once signs were identified as featuring a hold, the duration of the sign was then compared to that of phrase-internal signs. In order to do this, an average length of phrase-internal lexical signs (therefore classifier predicates, functional indexes, fingerspelled signs and signs in phrase-final position were excluded) was calculated. Signs were then analysed with the average length of a phrase-internal sign as a reference point. This procedure was repeated for each narrator so that idiosyncrasies in sign length and speed were accounted for.

3.4.5.2.3   Pauses

Pauses are defined as periods of no signing at all and are therefore distinct from holds. They include cases where the hands are held in the signing space but the configuration is meaningless as opposed to cases where the hands are returned to the signer's lap. Thus pauses were further divided into two categories: weak and strong. They were analysed as 'weak' if the hands were still raised (but relaxed) in signing and as 'strong' if the hands were dropped to the signer's lap.

Figure 3.17: Weak pause
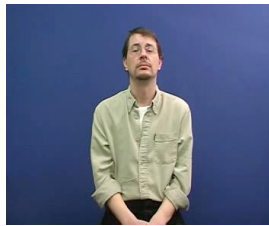
Figure 3.18: Strong pause

The start and end point of a pause was taken to be the first frame where the hands had stopped moving and the resultant handshape (if any) was making no contribution to meaning. The end point of a pause was taken to be the first frame when the hands began to move towards the handshape of the next sign.

3.4.6   Reliability assessment

In order to strengthen the analysis outlined here, a proportion of the data was tested for reliability. Coded data taken from the ECHO corpus (the source of the narratives) were compared to a subset of the codings created in this study.[10] This comparative

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[10] It was decided that all the narratives would be recoded for the current study, rather than use the annotated data available from ECHO, in order to ensure that all the start and end points of the features (as set out in Section 3.4.5) were applied in each instance.

analysis was conducted for the following features: blinks, head nods and brow movement. Four narratives in total (two from each signer) were selected for analysis.[11] The results for each narrative are displayed in the table below.

	Head Nods	Blinks	Brow movement
Narrative C (PS)	80%	90%	83%
Narrative D (PS)	72%	93%	84%
Narrative C (CN)	80%	86%	76%
Narrative D (CN)	81%	95%	71%

Table 3.3: Percentage of agreement between coded data in this chapter to the ECHO corpus

In Table 3.3 above, the figures given in percentages indicate the level of agreement between the data coded here and the coded data taken from the ECHO corpus. Agreement was defined as any instance where activity coded for a specific marker in this study was found to overlap with the ECHO coding. In each case, the level of agreement is high, at over 80% except for three cases.

Further reliability testing was applied to the blink data. In Section 3.4.5.1.2.2, a five-way classification system for blinks (based on Sze, 2004) was adopted for the current study. In order to assess whether the division of blinks into these five types can be considered reliable, blinks from four narratives were also classified by a second coder. The two sets of coded data were then compared to find the level of agreement. The results are displayed in the table below.

	Level of agreement (blinks)
Narrative A (PS)	82%
Narrative C (PS)	83%
Narrative A (CN)	85%
Narrative C (CN)	81%

Table 3.4: Level of agreement between two independent coders in assigning blink type

The figures, shown in percentages above, indicate the level of agreement when data from two independent coders are compared with each other. For all four narratives, the level of agreement was above 80%.

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[11] These narratives were Narrative C and D for both signers.

3.4.7 Identification of IP boundaries

Following coding of all non-manual and manual features in all eight narratives, the next step was to determine the location of IP boundaries. IP boundaries in the BSL narratives were identified by using manual rhythm and syntactic structure as a reference to determine which signs could be joined together to form an IP. Since it is argued that prosodic structure is projected from syntactic structure (see Nespor & Vogel, 1986) it is expected that IPs will (roughly) correspond to clauses within the narratives. As a starting point, attention was paid to the articulation of the hands. Specifically, signs were examined for holds, repetitions, and whether the size of the sign in phrase-final position was larger than in non-final positions. In addition to this, signs were also grouped together according to semantic roles to determine which signs were likely to 'go together'. For example, a verb can join with adjacent nouns that are related semantically to it (as in 'Billy kicked the football', where 'Billy' is the agent of the verb 'kicked' and 'football' is the patient). As prosodic structure is also dependent on factors linked to production and individual style, using this combined approach (referring to the signer's rhythm as well as meaning) to indicate boundaries is highly satisfactory.

Following identification of IP boundaries in the narrative data, reliability was assessed through the use of a second coder. The second coder, an experienced linguist, was provided with a definition of IP boundaries in signed languages in general and was given a video copy of all eight narratives as well as a fully glossed transcript and was asked to indicate on the transcript where they felt an IP boundary occurred. This was then compared to the boundaries originally identified as set out above. That is, did the second coder agree with the boundaries identified in all eight narratives? The level of agreement between coders for each narrative is displayed in Table 3.5 below.

	Level of agreement (actual figures & %)
Narrative A (PS)	40/50 (80%)
Narrative B (PS)	33/40 (83%)
Narrative C (PS)	26/27 (96%)
Narrative D (PS)	50/59 (85%)
Narrative A (CN)	65/81 (80%)
Narrative B (CN)	76/84 (90%)
Narrative C (CN)	72/80 (90%)
Narrative D (CN)	50/67 (75%)

Table 3.5: Level of agreement between two independent coders on placement of IP boundaries

In the table above, the number of boundaries the second coder marked (i.e. agreed that there was a boundary present at that point in the narrative) is given out of the total number of boundaries identified by the first coder. For all narratives except one, an agreement level of at least 80% is recorded.

Once all the IP boundaries had been identified and verified, a frequency analysis of markers present at boundaries was conducted. The results from this analysis are presented in the results section below. Since the level of agreement is high, all 481 boundaries identified are included here. As well as a frequency analysis, attention was paid to how some markers combine with the task of signing a narrative.

Throughout this chapter, attention will be restricted to the occurrences of these markers only at the boundaries identified using this criteria. In other words, the investigation does not assume that all the boundaries present in the narrative have been included here. Therefore, the chapter does not intend to examine whether a particular visual marker is exclusive to IP boundaries. This is to leave open the possibility of other IP boundaries in the video data and to avoid overestimating the effectiveness of a given marker at boundaries (e.g. a marker may occur at other points in the narrative yet to be identified as a boundary).

3.5   Results

The results section will be organised as follows: firstly, an overview of IP boundaries identified in all eight BSL narratives will be provided. This will be followed by an analysis of all visual markers and the extent to which they occur at IP

boundaries. This section will be divided further into non-manual and manual features and will focus on each feature in turn. In addition, the presentation of the data will include a breakdown of the results by narrators to highlight any idiosyncrasies in use of visual markers at boundaries. This will be followed by an overview of visual markers and prosodic layering at IP boundaries in general.

3.5.1 Overview of the number of IP boundaries

Analysis of the eight BSL narratives revealed a total of 481 IP boundaries. The following table provides a breakdown of this total by signer and narrative.

	Narrative A	Narrative B	Narrative C	Narrative D	Total
PS	50	38	25	57	170
CN	81	83	80	67	311

Table 3.6: Overview of IP boundaries by signer in each narrative

Overall, Table 3.6 shows 141 fewer IP boundaries for PS than for CN. It is worth remembering that in Section 3.4.2, it was mentioned that PS's narratives are all shorter than CN's (averaging a minute shorter in length). A frequency analysis of visual markers is presented in the following section.

3.5.2 Non-manual features

In this section, non-manual features occurring at IP boundaries will be analysed. This category comprises: head nods, single head movements, repeated head movements, brow movement, blinks, and torso activity. Each feature will be analysed separately. An overview of non-manual features (together with manual features) is provided in 3.5.4.

3.5.2.1 Head

3.5.2.1.1   Head nods

The number of IP boundaries that was counted as having a head nod or a sequence of nods was 102. A breakdown of results by narrator is presented in Table 3.7 below.

	Head nod	Repeated nods	Total
PS	27 (16%)	6 (4%)	33 (19%)
CN	57 (18%)	12 (4%)	69 (22%)
Total	84 (17%)	18 (4%)	102 (21%)

Table 3.7: Number of IP boundaries with head nods

The figures above represent the number of boundaries at which a head nod or repeated nods were observed. The frequency analysis reveals that a fifth of the data featured a head nod at an IP boundary. That is, out of 481 IP boundaries analysed, 102 boundaries (21%) co-occurred with a head nod or a sequence of nods. Head nods were more frequent at IP boundaries than repeated head nods. A similar proportion (around 20%) of IP boundaries is marked with a head nod by the two signers (PS: 19%, CN: 22%).

In the narrative data, head nods can follow an adverbial (3a), conditional clause (3b), and a major IP boundary (3c) as shown below.[12]

                    hn
(3a)   [WINTER DARK IX] IP [BOY READY GROUP] IP
        In the winter when it got dark, the boy got ready to gather (the sheep.)

                    hn
(3b)   [ANYTHING HAVE] IP [SHOULD SATISFIED HAPPY] IP
        If you already have this, you should be happy with just that.

                    hn
(3c)   [RELIEVED TWO-OF-US HUG] IP
        Relieved, the two of us hugged.

The timing of the head nods with the sign can vary. In (3a) and (3c), the head nod is on the last sign in the IP (IX and HUG). In (3b), the head nod is articulated at the start of the following phrase and co-occurs with the beginning of the sign SHOULD. In each case, head nods are analysed as performing a delimitative function, marking the end of a phrase. Further examples regarding head nods at IP boundaries are presented in the following section on single head movements.

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[12] All examples will be presented in parentheses dividing a signed stream into IPs. The start and end point of an IP reflect the location of boundaries found using the criteria outlined in this chapter. The focus of the chapter will be on visual markers co-occurring with these boundaries only.

3.5.2.1.2   Single head movements

In this section, the results for single head movements are presented. Table 3.8 below provides an overview of the number of IP boundaries where a single head movement was recorded.

	Single head movement
PS	133 (78%)
CN	239 (77%)
Total	372 (77%)

Table 3.8: Number of IP boundaries with single head movements

Table 3.8 shows that a change in head position was observed at 77% of the IP boundaries analysed. Actual figures show that there is more frequent use of single head movements by CN. However, when individual tallies are compared, the proportion of boundaries featuring a single head movement is nearly identical (PS: 78%, CN: 77%).

Single head movement occurring at IP boundaries in BSL narratives perform a number of functions (as has been reported for BSL (Sutton-Spence & Woll, 1999) and other signed languages (Sandler & Lillo-Martin, 2006)). The head can be tilted backwards and held in position to mark a topic, a question, or the beginning of a phrase as in Figure 3.19.

MORAL
                                                            ht
[IX MORAL IX TRUE SHOW WHAT] IP
The moral of the story tells you that…

Figure 3.19: Head tilt (backwards) marking the beginning of a phrase

They can be held in position to mark a character's voice or change position to mark a shift in character as in Figure 3.20.

LET SEE   WHAT   WHICH

                ht   ht   ht

[LETS-SEE BET] IP [IX WHAT] IP [TWO-OF-US WHY-NOT WHICH FIRST] IP
"Why don't we have a bet?" (said the tortoise). "What?" (replied the hare).
"Why don't we see who is first out of the two of us?" (the tortoise answered).

Figure 3.20: Change in head position at an IP boundary represents a change in role

As well as being held in position over more than one sign, they can also occur on a single lexical item in phrase final position as in Figure 3.21.

PALM-UP

         ht

…TAKE-EASY] IP [ACHIEVE PALM-UP] IP
If you take it easy, you can succeed.

Figure 3.21: Change in head position on a single lexical item

Table 3.9 provides an overview of single head movements at IP boundaries according to its underlying function. The figures reported do not reflect the number of IP boundaries but the actual number of single head movements since two periods of head movements can occur at a single boundary (i.e. the offset of a head movement is followed by the onset of a head movement in the following phrase). A single head movement analysed as linguistic is further divided according to whether it spans a domain (D) or a single lexical item (L).

	Linguistic (D)	Linguistic (L)	Narrative element	Total
PS	33 (22%)	33 (22%)	82 (56%)	148 (100%)
CN	108 (38%)	67 (24%)	110 (39%)	285 (100%)
Total	141 (33%)	100 (23%)	192 (44%)	433 (100%)

Table 3.9: Types of single head movements at IP boundaries

The most frequent type of single head movement observed at IP boundaries are those with a narrative function (such as marking role or enacting an action of a character). The proportion of single head movements that are linguistic and domain marking is 33% followed by those that span a single lexical item (23%). When the two linguistic categories are combined, they account for 56% of single head movements observed at IP boundaries. Therefore, although the number of IP boundaries where a single head movement is observed is high, nearly half of single head movements occurring at IP boundaries are analysed as a narrative element. When individual results are compared, a high number of linguistic head movements are observed with CN than PS although the percentage shows them to be more similar (PS: 22%, CN: 38%). Furthermore, a higher proportion of single head movements as a narrative element is observed with PS (56%) than for CN (39%).

Not all boundaries featured a change in head position. At some IP boundaries, the position of the head was held over a boundary. In the following table, the number of IP boundaries where this spreading was observed is provided. This is further divided according to its underlying function (whether it is linguistic or a narrative element).

	Linguistic	Narrative element	Total
PS	0 (0%)	28 (100%)	28 (100%)
CN	2 (7%)	26 (93%)	28 (100%)
Total	2 (4%)	54 (96%)	56 (100%)

Table 3.10: Number of IP boundaries where the position of the head was held over a boundary

Table 3.10 shows that head position was held over a small proportion of boundaries (12% of total boundary data). However, when the function of the head in these incidents is examined, nearly all could be analysed as a narrative element (96%). At

only two boundaries, a single head movement was analysed as linguistic. An example is provided in (3d) below.

(3d)
_____ (hn)_____ht
[WOLF IX] IP [IX TELL] IP
There was a wolf. I'll tell you the story.

The head is tilted backwards over both phrases marking the overall topic and intent of the signer and links the two phrases together. However, the IP boundary is still signalled using a head nod which does not change the overall position of the head. Further examples of spreading are provided in (3e) and (3f) below.

(3e)
_____ (hn) _____hr
[IX SAY HANG-ON WELL] IP [WANT TWO-OF-US SEE BET] IP
'Hang on! I could do this' (said the tortoise). 'Would you like the two of us to bet on it?'

(3f)
_____(hb)_____(hb)
[TORTOISE HANG-ON] IP [IX CAN] IP [BUT TAKE-IT-EASY IX] IP
_____hr
[TWO-OF-US RACE TWO-OF-US OKAY] IP
'Hang on, I can go fast but I'm taking it easy' (said the tortoise), 'why don't the two of us settle this with a race?'

In (3e) and (3f), the overall position of the head is analysed as a narrative element. The direction the head is facing and the position it is held in represents the character that is speaking which, in both cases, is the tortoise in the story 'The Tortoise and the Hare'. This head position is held over an IP boundary and whilst in this position, the IP boundary is signalled by a head nod in (3e) or a slight backwards movement of the head in (3f). These examples show that the head does not always return to a neutral position at the end of an IP but can indicate a boundary using the head in other ways.

In an examination of head position and IP boundaries it has been shown that whilst a change in head position corresponds to nearly four-fifths of the IP boundaries analysed, nearly half of these single head movements can be analysed as a narrative element (such as marking role or enacting an action in the story). Therefore, it is not always functioning as a linguistic marker to boundaries. In addition, head position

can also be held over an IP boundary. This spreading behaviour is linked to function. Only head movements analysed as a narrative element spread beyond an IP boundary. This section has demonstrated that the position and movement of the head can be very complex in storytelling, performing more than one function at a time (as explained in (3e) and (3f) where the overall position of the head marks role and a slight movement (of the head) at a specific point marks a boundary). In addition, it was observed that signers showed no differences in the proportion of boundaries at which a change in head position was recorded.

3.5.2.1.3 Repeated head movement

Repeated head movements are distinct from single head movements since they contain more than a single movement. Table 3.11 presents the total number of IP boundaries where the completion (or beginning) of a head movement was observed for each signer.

	Repeated head movements
PS	42 (25%)
CN	78 (25%)
Total	120 (25%)

Table 3.11: Number of IP boundaries with completed head movements

The number of boundaries where head movements are completed or begins at boundaries is twice as much for CN when compared to PS. However, when percentages are calculated, head movements are observed at 25% of boundaries produced by PS and at 25% of boundaries produced by CN. Therefore, an identical proportion of IP boundaries are represented by repeated head movements.

Head movements in narratives have several functions. In (3g) below, the head movement (a headshake) is a linguistic negative marker co-occurring on the final sign in the phrase (also a negative manual marker). In (3h), the head movement enacts the movement of a character in the story. That is, the swaying head movement mimics the action of the boy walking casually. Other functions include imitating the movement of the hands. For example, in (3i), the side-to-side movement of the head mirrors the side-to-side movement of the hands tracing the sign LINE-THE-PATH.

These examples also show that the span of a head movement can vary. That is, a head movement can be produced over one or more lexical items as seen in (3g) – (3i) below.

                                __hm

(3g)   [SPECIAL IMPORTANT NEG] IP [BUT PALM-UP] IP [IX KNOW] IP
        It was nothing important. But I know something now.

                                                                hm

(3h)   [BOY BORED WALK-ALONG-HOLDING-STICK] IP
        Holding his stick, the boy walked along feeling bored.

                                    hm

(3i)   [C.O.R.N] IP [LINE-THE-PATH] IP
        Corn lined the path.

When head movements are further categorised according to its function, the majority of head movements can be analysed as a narrative element. This is illustrated in Table 3.12 below.

	Linguistic	Narrative element	Total
PS	11 (26%)	31 (74%)	42 (100%)
CN	33 (39%)	52 (61%)	85 (100%)
Total	44 (35%)	83 (65%)	127 (100%)

Table 3.12: Type of head movements at IP boundaries

The table above shows that 65% of head movements occurring at boundaries can be analysed as having a narrative function. When individual results are examined, the majority of repeated head movements by each signer is analysed as a narrative element. In the third column, the overall total exceeds the number of IP boundaries at which head movements were observed. This is because at many boundaries, a cessation of head movement was followed by the onset of another head movement as shown in (3j).

                                    hm   hm

(3j)   [TORTOISE CRAWL-SLOW] IP [HARE RUN-FAST] IP
        The tortoise crawled slowly. The hare ran really fast.

In (3j), the two head movements represent how two different characters move. A slow side-to-side movement depicting the tortoise spans the first phrase and is

contrasted with a fast movement of the hare spanning the second phrase. The change in movement occurs at the IP boundary and signifies a change in role. In the following example, in contrast to (3j), a case of two similar head movements belonging to separate phrases is presented.

<div style="text-align:center">
      <u>   </u>hm   <u>   </u>hm
</div>

(3k)   [LAND EXCITING LOOK-AROUND] IP [TWO-FRIENDS-WALKING] IP
       The view excited them as they looked around. The two friends walked along.

In both parts above the movement is side-to-side. In the first IP, the side-to-side movement traces the direction of the sign in LOOK-AROUND and represents the character 'looking around'. In the second IP, the side-to-side movement again performs the actions of the characters in the story, this time the action of walking casually. The movements in both cases are highly similar but have been categorised as two separate markers because of a slight backwards movement of the head between the two movements.[13] An IP boundary was judged to be present because of an overall change in facial expression. At some boundaries, head movements were found to persist beyond a boundary. The number of boundaries where this was observed is provided in the table below and organised according to the head movement's underlying function.

	Linguistic	Narrative element	Total
PS	0 (0%)	1 (100%)	1 (100%)
CN	0 (0%)	5 (100%)	5 (100%)
Total	0 (0%)	6 (100%)	6 (100%)

<div style="text-align:center">

Table 3.13: Number of IP boundaries where head movement persisted over a boundary
</div>

The number of cases where head movements persists beyond a boundary is small (1% of all the IP boundaries analysed). In each case, the head movement has a narrative function. These instances do not necessarily persist onto an adjacent phrase. Rather, they are not precisely aligned with a specific boundary point and are completed outside the time windows assigned to boundaries. In contrast, linguistic

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[13] Additionally, the handshape used in the final sign and initial sign of the following phrase are identical although they differ in orientation (and movement slightly).

head movements do not persist beyond (or, are aligned precisely with) an IP boundary in the narratives analysed here.

3.5.2.2 Face

3.5.2.2.1   Brows

An overview of the frequency of brow movement at IP boundaries is provided in Table 3.14 below. In this table, the number of IP boundaries where a change in brow position occurs for each signer is reported.

	Brow movement
PS	96 (56%)
CN	107 (34%)
Total	203 (42%)

Table 3.14: Number of IP boundaries with a change in brow position

Of the 481 IP boundaries analysed, brow movement was found to coincide with 203 IP boundaries (42%). When individual responses are compared, PS has 96 boundaries (56%) with an overall change in brow position whilst CN has 107 boundaries (34%). Although both signers show a similar number of IP boundaries featuring a change in brow position, the proportion of boundaries between signers show them to be different. Therefore, a difference between individual signers in the use of visual markers is exposed.

The data show that brow movement coinciding with IP boundaries in BSL narratives can function as a linguistic marker for topics (3l), conditional clauses (3m), and for questioning (3n).[14] In the following examples, the onset and offset of the brow movement correspond with the location of the boundaries identified in the analysis. That is, they are held in position over more than one lexical item and return to a netural or new position at the next IP boundary.

---

[14] It has been noted in ISL that topics, conditionals and relative clauses obligatory form IPs as seen in spoken languages (Nespor & Sandler 1999).

```
                _____r
(3l)    [BOY IX] IP [LIVE VILLAGE IX] IP
        The boy who lived in a village…
```

```
                _____r
(3m)    [I.F. BEAR] IP [BEST LIE-DOWN] IP [TRICK WHAT DEAD] IP
        If you see a bear, better to lie down and play dead.
```

```
                _____r
(3n)    [TWO-OF-US RACE TWO-OF-US ALRIGHT] IP
        Why don't the two of us have a race?
```

As well as functioning as a linguistic marker, the brow can be used to convey a character's emotional state.

```
                _____f
(3o)    [BEAR BEAR-APPROACHES-GROWLING]
        The bear approached aggressively.
```

```
                _____r
(3p)    [PANIC TRUE WOLF WOLF WOLF]
        'It's true!' (the boy cried) 'there's a wolf over there'.
```

In (3o), a furrowed brow portrays the bear's aggression and in (3p) a raised brow conveys the fear felt by the boy as his flock of sheep are attacked. When the frequency of brow movement is analysed according to type, it can be seen that a similar proportion of brow movements can be analysed as either linguistic or as a narrative element. This is displayed in Table 3.15 below.

	Linguistic	Narrative element	Unclear	Total
PS	39 (36%)	61 (57%)	7 (7%)	107 (100%)
CN	67 (58%)	41 (36%)	7 (6%)	115 (100%)
Total	106 (48%)	102 (46%)	14 (6%)	222 (100%)

Table 3.15: Type and frequency of brow movement at IP boundaries

At some IP boundaries, an offset of one position was followed by the onset of another in the next IP (raised brow to furrowed brow). This is why the sum of brow type exceeds the number of boundaries where brow movement was observed. Table 3.15 show that 48% of brow movements occurring at IP boundaries are analysed as linguistic (e.g. marking a topic or a question) and 46% are analysed as a narrative element (e.g. conveying a character's emotional state). Therefore, as with single

head movements, not all brow movements observed at IP boundaries are linguistic. When individual tallies are compared, the results are mixed. The majority of brow movements by PS can be analysed as a narrative element (57%). In contrast, the majority of brow movements by CN can be classed as linguistic (58%). Therefore, a further difference between signers in the use of the brow at boundary points is observed. In some cases (6%), the nature of the brow movement is unclear as explained in Figure 3.22 below.

STARED-BACK   BONE

_____f _____r
[STARED-BACK-AT-THE-WATER] IP [BONE-FALL] IP
The dog stared back at his reflection. The bone fell out of his mouth.
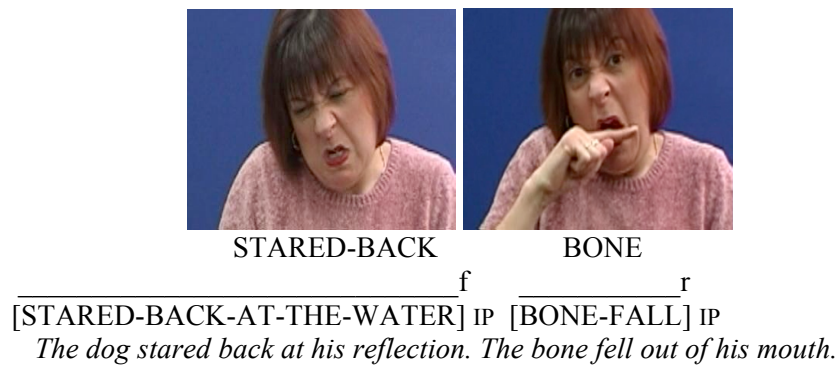
Figure 3.22: Overlap in brow function

In Figure 3.22, the brow is furrowed over the first IP but rises over the second IP (BONE FALL). The use of the furrowed brow in the first is analysed as an affective marker signalling the mood of the dog in the story (staring aggressively). In the following IP, the raised brow marks a new phrase although the signer appears to hold the affective marker from the preceding phrase (a furrowed brow noticeable from the wrinkles between the brows). This raised brow (along with a change in gaze direction) is analysed as a linguistic marker. This overlap in brow use is expected in narrative signing when the brow is used as an affective marker to portray attitudes and feelings of the characters in the story.

At some IP boundaries, the position of the brow is held over a boundary. In the table below, a breakdown of these incidents for each signer and according to the function of the brow (whether it is linguistic or a narrative element) is provided. The figures represent the number of boundaries where brow movement was held.

	Linguistic	Narrative element	Unclear	Total
PS	6 (14%)	34 (77%)	4 (9%)	44 (100%)
CN	7 (15%)	33 (70%)	7 (15%)	47 (100%)
Total	13 (14%)	67 (74%)	11 (12%)	91 (100%)

Table 3.16: Number of IP boundaries where brow position was held over a boundary

The number of IP boundaries where spreading activity was recorded was 91 (19% of the total boundary data). When individual results are compared, the distribution of type is very similar. That is, both signers show that at least 70% of brow movements that spread beyond an IP boundary can be analysed as a narrative element. Examples of brow spreading (as a narrative element) are provided in (3q) – (3s) below.

                                       r

(3q)   [DOG'S-REFLECTION IX] IP [BONE GONE] IP
The dog looked at his reflection. The bone was gone!

                                       f

(3r)   [LOOK-AT-EACH-OTHER] IP [DOG LOOK LOOK] IP
They looked at each other. The dogs looked at each other.

                                              r

(3s)   [SHOCK SAW BEAR COME PANIC] IP [ONE PANIC TRUE SCARED] IP
He began to panic when he saw the bear. As he was alone, he was really scared.

In the three examples above, the position of the brows was analysed as being constant throughout, although they spanned more than one IP. In the first two examples, an IP boundary was judged to be present because of a hold on the IX in (3q) and on LOOK-AT-EACH-OTHER in (3r). In the final example (3s), an IP boundary was judged to be present because of a change in head position. In all cases, the use of the brow is affective and depicts the character's emotion. In (3q), the raised brow signals the shock and amazement of losing the bone, and a look of terror at the presence of a bear in (3s). In (3r), the furrowed brow creates a look of aggression that imitates the attitude of the dog. The affective use of the brow is held over an IP boundary that is signalled using other visual markers.

In the examples below, the position of the brow is held across an IP boundary and could not be analysed as an affective marker.

                                                                      r

(3t)   [IX MORAL IX TRUE SHOW WHAT] IP [ANYTHING HAVE] IP
            The moral of the story goes to show that anything you have…

                                r

(3u)   [RABBIT] IP [TORTOISE] IP [NEVER-MIND IX TELL-STORY] IP
            The rabbit and the tortoise. Don't worry, I'll tell you the story.

In (3t) and (3u) above, the position of the brow (raised) is held across two IPs. In each case, it is possible that the brow has failed to return to neutral position and has merged with the raised brow position in the following IP (cf. Wilbur 2000) particularly if the signer is signing quickly. For example, in (3t), the raised brow in the first IP marks an interrogative statement and a conditional clause in the second. In the second example (3u), the raised brow over two IP phrases ([RABBIT] & [TORTOISE]) marks two separate topics. A raised brow has been associated with these phrase types in the literature (Coerts, 1992; Johnston & Schembri, 2007; Liddell, 1980; Sandler & Lillo-Martin, 2006; Sutton-Spence & Woll, 1999; Wilbur, 2000). In these examples, including (3q) - (3s), where affective uses of the brow persists over an IP boundary, what is important is that there are cases where the brow does not return to a neutral position. This presents problems for using the brow to identify IP boundaries and raises issues as to whether it can be classed as a consistent marker. However, these examples account for a fifth of the boundaries analysed here (19%) in comparison to the 46% where an overall change in brow position is observed. Furthermore, brow movement coinciding with IP boundary points are not always linguistic and the results reported here must be considered with this in mind. Finally, the extent to which brow movements coincide with IP boundaries is subject to idiosyncratic variation (PS: 56%, CN: 34%). These issues are returned to in the Section 3.6.

3.5.2.2.2   Blinks
In the table below, the number of IP boundaries that featured a blink is provided.

	Blinks
PS	103 (61%)
CN	165 (53%)
Total	268 (56%)

Table 3.17: Number of IP boundaries with a blink

Table 3.17 shows that the majority of the boundary data (56%) feature a blink. When individual results are compared, the majority of boundaries by both signers feature a blink. However, some issues need to be addressed before determining whether blinks are a reliable indicator of IP boundaries. These issues are discussed below.

Analysis of the boundary data as a whole revealed a total of 297 blinks. An overview of these blinks occurring at IP boundaries by type (using the classification set out by Sze, 2004) is provided in Table 3.18 below.

Type	PS	CN	Total
Type I: Physiological blinks	4 (3%)	2 (1%)	6 (2%)
Type II: Boundary blinks	69 (60%)	118 (65%)	187 (63%)
Type III: Head/gaze change	5 (4%)	21 (12%)	26 (9%)
Type IV: Voluntary blinks	37 (32%)	41 (23%)	78 (26%)
Type V: Hesitation/false starts	0 (0%)	0 (0%)	0 (0%)
Total	115 (100%)	182 (100%)	297 (100%)

Table 3.18: Overview of blink type at boundaries

According to the table above, the most frequent blink type at IP boundaries in BSL narratives is Type II (63% of total blinks at IP boundaries). The next frequent type of blinks seen at boundaries is Type IV, which accounts for 26% of the total blinks observed. Type III blinks represent 9% of the blink total, and 2% are Type I blinks (blinks linked to sudden head movements, hands moving closely by the face). Finally, no Type V blinks (blinks linked to hesitation) were observed in the data. The distribution of blink types at boundaries is very similar for both signers. The blink type most frequently found at boundaries for both signers is Type II followed by Type IV. The absence of Type V blinks may be linked to the preparedness of the text (Stone, personal communication). Only a small number of blinks linked to physiological factors are observed at IP boundaries for both signers.

Sixty-five percent of blinks found at boundaries can be classed as Type II blinks. Examples of Type II blinks are provided below.

<div align="center">b</div>

(3v)   [FRIEND LOOK-STUNNED] IP
         The friend looked stunned.

<div align="center">b</div>

(3w)   [WANT MORE GREEDY NO] IP
         You shouldn't be greedy.

<div align="center">b</div>

(3x)   [BOY LAUGH] IP [GO-AWAY] IP
         The boy laughed. The people left him alone.

In (3v) and (3w) above, a Type II blink occurs towards the end of the IP as the hands return to the signer's lap following the articulation of the final sign. In addition, Type II blinks are observed to occur towards the beginning of a phrase. For example, in (3x) above, a Type II blink overlaps with the onset of GO-AWAY. Specifically, the blink occurs as the hands are clasped and are about to be raised to articulate GO-AWAY. Although the majority of boundaries feature a Type II blink, there are some issues that must be considered. These are discussed following a description of other blink types.

The following examples show the occurrence of Type I blinks at boundaries.

<div align="center">p</div>

(3y)   [TAKE] IP [WHY-NOT] IP [BITE] IP
         'Why don't I just take it' (thought the dog). The dog then tried to snatch the bone.

<div align="center">p</div>

(3z)   [RABBIT RUN-FAST] IP [HOT AWFUL…] IP
         The rabbit ran really fast. It was unbearably hot…

In (3y) above, a blink was observed at a boundary. This blink was classed as a Type I because of the sudden movement of the head which represents the action of the dog snatching the bone. In (3z), a Type I blink was also observed on the first sign in an IP, occurring within the time window assigned to boundaries. This was classed as physiological because of the hand moving close to the face during the articulation of

the sign HOT. In the following examples, instances of Type IV blinks (voluntary blinks) present at boundaries are provided.

                                                        v_____
(3aa)   [WASTE IX TIME PALM-UP] IP [ANGRY] IP
          They were all angry as he had wasted their time

                                                 v_____
(3bb)   [BEFORE ALL-COME] IP [NOW LEAVE-ALONE] IP
          Before they would all come rushing, now they ignored him.

           v_____
(3cc)   [SHOCK WHAT] IP [BEAR BEAR-COME-TOWARD-THEM] IP
          They were shocked to see a bear coming towards them.

In each example above, a Type IV blink was observed to co-occur with an IP boundary. Type IV blinks were found, on average, to be more than twice as long as other blink types and occurred in phrase-final or phrase-initial position (see (3aa) – (3cc) above).[15] It was also observed that the closing and opening phase of a blink was closely aligned with the articulation of the sign with which it co-occurs. For example, the sign ANGRY begins with the two hands held at the signer's torso and then moving quickly upwards. The eyes are closed whilst the hands are held in position during the beginning of the sign. The opening phase begins just as the hands move upwards suddenly (as pictured below).

ANGRY

Figure 3.23: Type IV blink aligned with the production of the sign ANGRY

This is also observed for LEAVE-ALONE in (3bb) and SHOCK in (3cc). That is, the blink is closely aligned with the articulation of the sign. The use of a Type IV blink in each instance provides emphasis on a lexical sign.

---

[15] The average length of a physiological blink was calculated at 0.16 seconds. Similarly, the average length of a boundary blink and blinks linked to head and gaze change was 0.17 seconds.

Finally, an example of a blink linked to head and gaze change (Type III) is provided below.

<div align="center">c b</div>

(3dd)   [WATER-BECOME-CALM] IP
          The water became calm.

In the above example (3dd), a blink linked to head and gaze change is found to co-occur with the IP boundary. This was classed as a Type III blink because of the change in head position when PS tilted his head forward and changed the direction of his gaze from facing the camera to facing the floor in copying the actions of the dog peering into the water (a sequence of constructed action). The blink occurs between the changes in gaze direction and occurs simultaneously with the movement of the head.

There is some difficulty in assigning blink type, particularly when deciding whether a blink is Type II or III. Overall, Type III blinks account for 9% of the overall data but it is possible that the figure reported here could be higher. This is because the majority of Type II blinks (75%) also co-occur with a change in head position or gaze direction as illustrated below.

<div align="center">b</div>

(3ee)   [WILL IX STRANDED WHAT] IP [PALM-UP] IP [HANG-ON WAIT-SEE TRY
        PALM-UP] IP
        'He will be left on his own wondering where everyone has gone' (said the hare).
        'Let me try first' (replied the tortoise).

<div align="center">b</div>

(3ff)   [ALL-OF-THEM TRUE ANGRY PALM-UP] IP [WASTE IX TIME PALM-UP] IP
        Truly, they were very angry. 'You wasted our time' (they cried!).

In (3ee) above, a blink was recorded at the IP boundary and is classed as Type II. This decision was motivated by the temporal location of the blink (i.e. following the last sign at the end of phrase). However, the opening and closing phase of the blink mark a new gaze direction and the blink is also simultaneous with a change in head position. Therefore, this blink could also be linked to these features (and classed as Type III) rather than being classed as Type II. In (3ff), the same issue arises when assigning blink type. Although the location of the blink suggests it is a boundary blink, it also co-occurs with a change in gaze direction and head position. In total,

75% of Type II blinks might be re-analysed as Type III blinks. In these circumstances, it is difficult to determine the underlying nature of these blinks: whether they are performing a linguistic (boundary marking) function or whether they are linked to the physiological need to blink. This issue, and its implications, are returned to in the end of chapter discussion where an alternative table for blinks is proposed (Section 3.6).

When all 481 IP boundaries are examined for blinks, the majority of boundaries feature a blink of some type (268 (56%)). This is true for each signer (PS: 61%, CN: 53%). However, the point made in the previous paragraph concerning the difficultly in assigning blink type with absolute certainty indicates that caution is required before it is possible to conclude whether blinks are a frequent marker of boundary position.

3.5.2.3 Torso

Throughout the narrative data, the use of the upper torso is found to coincide with IP boundaries. Table 3.19 provides an overview of torso activity for both signers. The figures provided represent the number of IP boundaries where torso activity was recorded.

	Torso
PS	68 (40%)
CN	104 (33%)
Total	172 (36%)

Table 3.19: Number of IP boundaries with torso activity

Table 3.19 reveals that, out of 481 IP boundaries examined, 172 IP boundaries (36%) featured torso activity. When figures are considered by individual signer, 40% of IP boundaries in PS's narratives (68/170 boundaries) included a change in torso position compared to 33% in CN's narrative (104/311 boundaries). Overall, the proportion of boundaries where torso activity was observed is similar. In the following table, torso activity is further divided into two categories: torso leans and torso movement. When the term 'torso lean' is used, it refers to a change in torso position. In addition, when the term 'torso movement' is used, it refers to a

completion or the start of a series of movements involving the upper torso. Table 3.20 below shows that more torso leans are observed at IP boundaries than torso movements.

	Torso lean	Torso movement	Total
PS	50 (76%)	16 (24%)	66 (100%)
CN	101 (89%)	12 (11%)	113 (100%)
Total	151 (85%)	28 (15%)	179 (100%

Table 3.20: Type and frequency of torso activity at IP boundaries

As before, the figures in Table 3.20 represent the number of torso activity that can be grouped into each category rather than the actual number of IP boundaries. The proportion of torso activity that can be classed as torso lean is 85%. Both signers show a similar proportion of torso leans (PS: 76%, CN: 89%). In contrast, there are few instances of torso movements observed at boundaries points (15% overall). When the upper torso and its uses in narrative signing are examined, a number of functions can be identified. Torso leans can be used for emphasis as seen in (3gg) and (3hh) below.

                       ____l
(3gg)   [SPECIAL IMPORTANT NEG]
       It was nothing important.

                  _____l
(3hh)   [THINK SELF THOSE PALM-UP]
       They will all think of themselves first.

In the examples above, the duration of the lean can be seen to vary. In (3gg) the lean is on a single sign and in (3hh) the lean was held over three signs. In both cases, the direction of the lean was forwards and served to emphasise the signs they were articulated with. In Figure 3.24 below, a change in torso position represents a shift in character.

WHICH   PLEASE-YOURSELF

_____tl _____tl
[WHICH ARRIVE FIRST] IP [PROVE OKAY] IP [PALM-UP PLEASE-
_____tl
YOURSELF] IP
 'Whoever arrives first will prove it okay?' (said the hare). 'Fine, please yourself'
(said the tortoise).

Figure 3.24: Change in torso position represents a change of character

In Figure 3.24 taken from the Hare and the Tortoise, the first lean is to the signer's left and represents the character of the hare. There is a change in torso position at the IP boundary following OKAY. In the second IP, the signer leans to the right in order to represent the character of the tortoise. In both phrases, the torso is held in position whilst several signs are articulated. The position of the head is also aligned with the torso. Torso leans, however, are not restricted to representing shifts in character but may represent the actions of a character as in Figure 3.25 below.
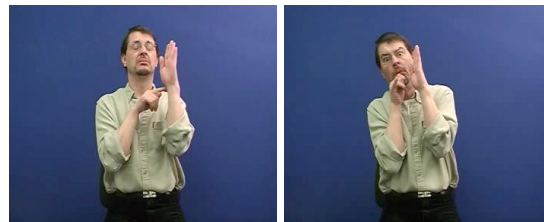
TREE   LOOK BAD

_____tl
[IX FRIEND TREE] IP [LOOK BAD] IP
His friend in the tree looked out in horror.

Figure 3.25: Torso lean represents the actions of a character

In Figure 3.25, the torso lean represents the action of leaning (out of a tree) by the character in the story. The torso returns to a neutral position which co-occurs with an IP boundary. In addition, a repeated movement of the torso can also be used to represent the actions of a character as in Figure 3.26 below. The side-to-side

movement in this figure, which is also articulated using the head, depicts the two men walking casually. The beginning of this activity co-occurs with an IP boundary.
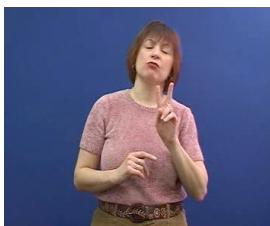
TWO-MEN-WALKING

$$\overline{\hspace{4cm}}^{tm}$$

[TWO-MEN-WALKING TALK DISCUSS] IP
The two men talked as they walked along

Figure 3.26: Torso movement represents the action of a character

In Table 3.21 below, torso leans and movements occurring at IP boundaries are further categorised according to its function (whether it is linguistic or a narrative element).

	Torso lean		Torso movement	
	Linguistic	Narrative	Linguistic	Narrative
PS	10 (17%)	48 (83%)	0 (0%)	16 (100%)
CN	28 (27%)	73 (73%)	0 (0%)	12 (100%)
Total	38 (24%)	121 (76%)	0 (0%)	28 (100%)

Table 3.21: Function and frequency of torso activity at IP boundaries

Table 3.21 shows that the majority of torso leans (76%) observed at IP boundaries have a narrative function (such as marking role or enacting an action by a character in the story) and that all torso movements ending or starting at a boundary have a narrative function also. This is observed for both signers. That is, torso activity frequently performs a narrative function in the BSL narratives analysed here. In all examples above, torso activity corresponds with either the beginning or the end of an IP. However, at some boundaries a torso lean is held across an IP boundary and on to the following IP as in:

(3ii)   [WAIT IX CAN] ɪᴘ [BUT TAKE-IT-EASY IX] ɪᴘ [TWO-OF-US RACE

                                           tl
    TWO-OF-US ALRIGHT] ɪᴘ
    'Wait, I can do this but I prefer to take my time, why don't the two of us have a race?' (said the tortoise).

                                                     tl
(3jj)   [LINE FINISH IX] ɪᴘ [WHO WHICH ARRIVE FIRST] ɪᴘ
     'there's a finishing line over there, who will get there first?' (challenged the hare).

In (3ii), the torso lean to the right is held in position over two IP boundaries and represents the character of the tortoise. Despite no change in torso position, an IP boundary was judged to be present because of a change in head position and a head nod at the first IP boundary. A change in head position was also present in the second IP boundary as was an overall change in facial expression. In (3jj), taken from the same narrative and following on from (3ii), the position of the torso is to the signer's left (representing the hare) and is held over an IP boundary. Again, although there is no change in torso position, an IP boundary was identified because of the presence of a head nod and a change in facial expression (neutral to raised brows marking a question). In (3ii) and (3jj) above, the torso lean represents the character speaking. However, in (3kk) below the torso functions to enact the action of the character and is also held over an IP boundary.

                                                         tl
(3kk)   [POSS BONE LOOK GOOD] ɪᴘ [IX WANT TAKE] ɪᴘ [WHY-NOT] ɪᴘ
      That bone looks really good. Why don't I just snatch it off him?

In (3kk), the signer leans forward to perform the action of the dog peering into the river and this position is held across an IP boundary. An IP boundary was judged to be present because of a change in facial expression and a hold prior to the boundary. Although the function of the torso differs in these instances, nearly all activity which spread over an IP boundary was classed as leans. The table below presents the number of IP boundaries where torso activity spread over a boundary. The results are presented according to type and whether the function of the torso was linguistic or otherwise.

	Torso lean		Torso movement	
	Linguistic	Narrative	Linguistic	Narrative
PS	2 (6%)	30 (94%)	0 (0%)	0 (100%)
CN	2 (5%)	33 (95%)	0 (0%)	3 (100%)
Total	4 (5%)	63 (94%)	0 (0%)	3 (100%)

Table 3.22: Number of IP boundaries where torso activity persisted over a boundary

Table 3.21 shows that more torso leans were held over boundaries than torso movements. Overall, the number of boundaries where a torso lean was held over a boundary is low (14% of total boundaries analysed). An example of a linguistic torso lean held over a boundary is provided in (3ll) below.

<div style="text-align:center">_____tl</div>

(3ll)   [IX HAVE IX] IP [SATISFIED ENOUGH] IP
        You should be satisfied with what you have

In (3ll) the direction of the lean is to the side and marks the moral of the story. However, it can be seen that nearly all leans can be analysed as performing a narrative function (e.g. marking role). In addition, very few instances of torso movements persisting beyond a boundary are reported. Where they are observed, they are also analysed as having a narrative function. As with repeated head movements, they do not continue onto the following phrase but are not precisely aligned with a given boundary point and are completed outside of the time windows assigned to each boundary.

In summary, over a third of the IP boundaries analysed (36%) feature an overall change in torso position. Although it has been noted that the torso can continue over an IP boundary, the number of instances where this is observed is small (15% of total boundary data). In addition, both signers had a similar proportion of boundaries that featured an overall change in torso position.

In the following section, manual features occurring at IP boundaries are discussed. This will be followed by an overview of manual and non-manual features at IP boundaries in the BSL narratives.

3.5.3 Manual features

In this section, we focus on a description of manual markers occurring at IP boundaries: holds, handshape spread, and pauses.

3.5.3.1.1   Holds

In the table below, the number of IP boundaries where a sign was visibly held is given. This is provided for each signer.

	Hold
PS	48 (28%)
CN	97 (31%)
Total	145 (30%)

Table 3.23: Number of IP boundaries with a hold

Out of the 481 IP boundaries analysed, 145 boundaries contained holds (30%). When results are calculated for each signer, holds were observed at 28% of PS's boundaries and at 31% of CN's boundaries. Therefore, the proportion of boundaries featuring holds is similar. Holds were analysed for their relative length in comparison to the average length of a phrase-internal sign. The length of a phrase-internal sign was calculated by adding the length of all lexical phrase-internal signs (excluding classifier constructions, constructed action sequences, fingerspelled signs, and the final sign in an IP) and dividing the total by the number of signs counted. The mean length of signs that were held was then compared. This procedure was repeated for each signer so that idiosyncrasies in signing speed could be accounted for.

	<1.5	1.5x	2x	3x
PS	5 (10%)	13 (27%)	13 (27%)	17 (35%)
CN	31 (32%)	19 (20%)	32 (33%)	14 (15%)
Total	36 (25%)	32 (22%)	45 (31%)	31 (22%)

Table 3.24: Frequency data of the length of a sign with a hold

The table above shows that 75% signs that featured a hold could be analysed as being at least 1.5x the length of phrase-internal signs. Fifty three percent of signs with holds were at least twice the length of a phrase-internal sign.

Examples of holds occurring at IP boundaries are provided below. The sign where the hold is observed is marked with a [h] above the gloss. The extent of the prolongation of the sign is also provided in brackets.

h(1.5)
(3mm) [BEAR IF SEE] IP [LIE-DOWN DEAD] IP
        If the bear sees you lying down dead…

h(2)
(3nn)   [NOT-SURE SUSPECT IX] IP
        I was not sure of him anymore

h(3)
(3oo)   [LOOK LIKE GOING BITE] IP
        It looked like the bear was going to bite him.

h(3)
(3pp)   [TORTOISE PASS FIRST] IP
        The tortoise crossed the finish line first.

In each case, the handshape was held in position towards the end of the sign and the total length of the sign was at least 1.5 times the length of a phrase-internal sign. Overall, holds are present at nearly a third of the boundary data.

3.5.3.2 Handshape spread

In Table 3.25 below, the number of IP boundaries where handshape spread ended is provided.

	Handshape spread
PS	25 (15%)
CN	20 (6%)
Total	45 (9%)

Table 3.25: Number of IP boundaries where handshape spread ended

Table 3.25 shows that the number of IP boundaries featuring a cessation of handshape spread is small (9%). When individual frequency is calculated, both PS and CN show a similar proportion of boundaries featuring the termination of a handshape spread. Handshape spread is frequently observed on the non-dominant hand. In all cases except one, the direction of spreading was rightwards. In the

following examples, handshape spread can be analysed as a phonologically empty unit which is completed at an IP boundary.[16]

                         ‾‾‾‾‾‾‾sp
(3qq)   [IX CAN SLEEP IX]
          I can sleep there.

                         ‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾sp
(3rr)   [SHOCK BAD QUICK LOOK-AT-WATCH]
          He was shocked at how quickly the time went.

In the above examples, the handshapes for QUICK and SLEEP spread beyond its lexically specified sign and up to an IP boundary. However, handshape spread is not always phonologically empty. It can function as an important part of a signed utterance as in (3ss) – (3ww) below. In each case, the handshape spread makes a meaningful contribution to the signed sequence.

                         ‾‾‾‾‾‾‾sp
(3ss)   [PANIC TRUE IX WOLF] IP
          He panicked (and shouted), 'it's true, there's a wolf over there!'

                         ‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾sp
(3tt)   [FRIEND IX TREE] IP [LEAN-OUT BAD] IP [MAN-LIE-DOWN] IP
          The friend in the tree leaned out and looked at the man lying down on the ground.

                         ‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾sp
(3uu)   [CLIMB-UP-TREE OUT-OF-BREATH] IP
          (He) climbed up a tree so quickly it left him out of breath.

                         ‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾sp
(3vv)   [LIE-DOWN NEVER-MIND SLEEP] IP [LITTLE SLEEP FALL-ASLEEP] IP
          The hare lay down (and thought) never mind, I'll have a little sleep as I have plenty of time.

                         ‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾sp
(3ww) [HOLDING-STICK WHAT LOOK-AROUND SAW] IP
          The boy looked around and thought he saw something.

In (3ss), the index (IX) on the non-dominant hand spreads rightwards over the neighbouring sign WOLF and is held until the IP boundary, emphasising the character of the wolf in the signing space. In (3tt) and (3uu), the non-dominant

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[16] Nespor and Sandler (1999) describe non-dominant handshape spread as marking phonological phrase boundaries. However, there are several instances of handshape spread not extended to an IP boundary in the narratives described here. Further analysis is required to determine whether similar conclusions to theirs can be made for BSL.

handshape spread is functioning as a classifier representing the tree in the narrative. For example, in LEAN-OUT, the narrator leans away from the classifier to represent a person leaning out of a tree and looking around. In (3vv), the classifier marks the role of the hare and depicts it lying down. This classifier originates from phrase-initial position and is held over the entire IP. These examples show handshape spreading behaviour of varying length but all ending at an IP boundary. Handshape spread ending at an IP boundary is also observed in sequences of constructed action as in (3ww) above. Again, such spreading can be said to mark role and therefore cannot be analysed as phonologically empty units. In (3ww) above, the handshape spread represents a handling classifier (the boy holding the walking stick) and is held over neighbouring signs. An overview of handshape spreading by signer and its underlying function is provided in Table 3.26 below. In this table, phonological/prosodic spreading refers to non-dominant hand spread as shown in (3qq) and (3rr) where the spread is analysed as a meaningless unit. In contrast, handshape spread analysed as a narrative element refer to spreading originating from a classifier or a constructed action sequence which function as an important reference point in the narrative.

	Phonological/prosodic	Narrative element	Total
PS	7 (28%)	18 (72%)	25 (100%)
CN	5 (25%)	15 (75%)	20 (100%)
Total	12 (27%)	33 (73%)	45 (100%)

Table 3.26: Type of handshape spread at IP boundaries

When handshape spread is analysed according to its function, the majority of handshape spread can be analysed as a narrative element (such as spreading from a classifier or functioning as a discourse marker). When individual results are considered, the distribution of type is very similar. However, in some cases (as seen in the examples above), spreading was observed to continue over an IP boundary. In Table 3.27 below, the number of IP boundaries where handshape spread persisted beyond a boundary is provided. The table is further organised according to signer and the type of spread observed.

	Phonological/prosodic	Narrative element	Total
PS	0 (0%)	11 (100%)	11 (100%)
CN	3 (18%)	14 (82%)	17 (100%)
Total	3 (11%)	25 (89%)	28 (100%)

Table 3.27: Number of IP boundaries where handshape spread persisted beyond a boundary

The table above shows that handshape spread was held over a small proportion of the boundary data (6%). When handshape spread is analysed according to its function, nearly all are analysed as a narrative element (e.g. originating from a classifier). An example of handshape spread that is linguistic is provided in (3xx) below.

<div align="center">_____sp</div>

(3xx)   [BEEN SPEAK WHAT] IP [IX HEAR WHAT] IP
        What did the bear say to you? What did you hear?

In (3xx) above the handshape spread originates from the lexical sign WHAT and is held over two neighbouring signs before it is rearticulated with WHAT. However, the majority of handshape spread can be analysed as a narrative element as in (3yy) below.

<div align="right">_____</div>

(3yy)   [FAR] IP [ALRIGHT] IP [LIE-DOWN BREATHE] IP [LOOK] IP [NOTHING LIE-
        _____sp
        DOWN] IP
        (The hare thought) I'm far away so it's OK. So he lay down and rested. He looked behind him and couldn't see the tortoise.

In (3yy) above, the handshape that is spread originates from the classifier in LIE-DOWN and is articulated on the non-dominant hand. The handshape represents the hare lying down and taking a rest and in doing so marks role. This handshape is held in position over neighbouring signs and beyond the IP boundary shown.

In summary, the number of IP boundaries where handshape spread ended is low (9%). When the function of handshape spread ending at a boundary is considered, at least 70% can be described as a narrative element. There are few cases of non-dominant handshape spread reported in the narrative data analysed here.

3.5.3.3 Pauses

An overview of pauses (periods of no manual activity) at IP boundaries is provided in Table 3.28 below. This is divided into pauses analysed as 'strong' and 'weak'. Pauses were classed as strong when the hands were dropped or clasped between signing. In weak pauses the hands are still raised but are not used in signing (and no meaning can be derived from them).

	Strong	Weak	Total
PS	11 (6%)	7 (4%)	18 (11%)
CN	6 (2%)	10 (3%)	16 (5%)
Total	17 (3%)	17 (4%)	34 (7%)

Table 3.28: Number of IP boundaries with a pause

The proportion of IP boundaries featuring pauses is 7%. For each signer, the number of boundaries featuring pauses is similar (PS: 11%, CN: 5%). Strong pauses were observed at similar locations across narratives. This was typically after the presentation of the narrative title (Figure 3.27), following the completion of the fable before the moral of the story was told (Figure 3.28) and at the end of each narrative (Figure 3.29).

NEVER-MIND   IX   TELL-STORY   strong pause
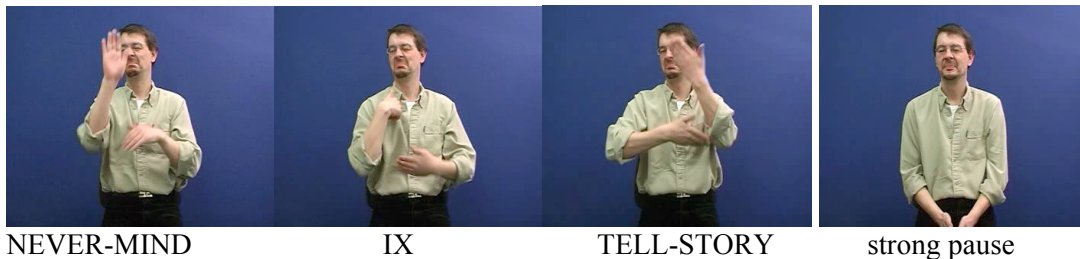
[NEVER-MIND IX TELL-STORY] IP
Don't worry, I'll tell you the story.

Figure 3.27: Strong pause following presentation of fable title

| SAY | PALM-UP | NEVER-MIND | strong pause |
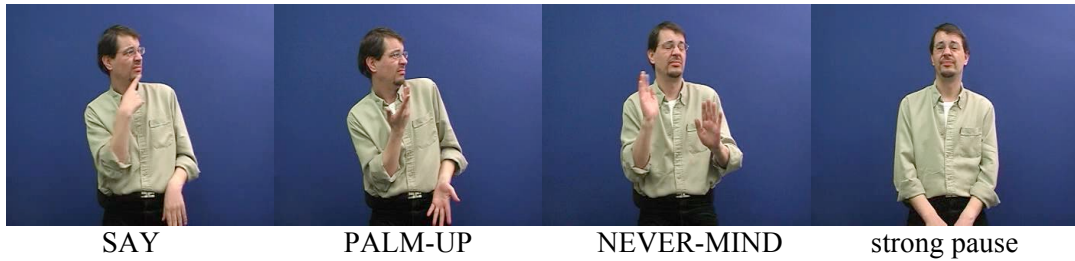
[TORTOISE SAY PALM-UP] IP [NEVER-MIND] IP
The tortoise said to the hare 'there you go'.

Figure 3.28: Strong pause following completion of fable

| TRUE | FRIEND | PALM-UP | strong pause |

[IX KNOW WHO POSS TRUE FRIEND PALM-UP] IP
You'll know who your true friends are.

Figure 3.29: Strong pause following the moral of the story

In contrast to strong pauses, weak pauses were found at points during the narrative where the signer appeared to pause with the hands still raised in signing. However, no clear meaning could be derived from the hands, as they were relaxed and did not resemble a well-formed sign. An example of a weak pause is provided below.

| TALK | DISCUSS | weak pause | SHOCK |
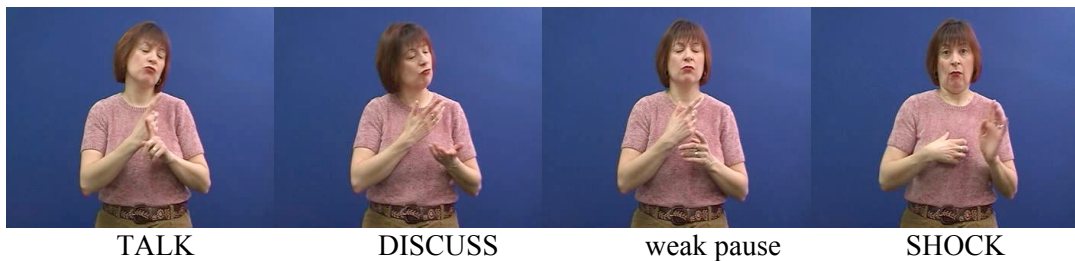
[TWO-MEN-WALKING TALK DISCUSS] IP [SHOCK SAW BEAR BEAR-APPROACH PANIC] IP
The two friends were walking along talking. They were shocked to see a bear coming towards them.

Figure 3.30: Weak pause at an IP boundary (1)

| BOY | LAUGH | weak pause | GO-AWAY |

[BOY LAUGH] IP [GO-AWAY] IP
The boy laughed. (The people) went away.

Figure 3.31: Weak pause at an IP boundary (2)

In Figure 3.30, the hand is raised and held in position over the weak pause. The handshape is similar to that in DISCUSS but has been relaxed slightly. The pausing period (although clearly noticeable) was .03 of a second. In Figure 3.31, the dominant hand is held in position during the weak pause following LAUGH. The handshape is identical to that of LAUGH that had been articulated as a two-handed sign. Rather than being analysed as a hold, this was analysed as a weak pause because other visual markers (such as repetition, facial expression, the non-dominant hand being dropped, a change in head position and a head nod) marked the completion of the sign. Because of these visual markers, the handshape was analysed as a trace of the final sign in the preceding phrase. The handshape held during the pausing sequence is also similar to the handshape in GO-AWAY and may be anticipating the following sign. Therefore it is difficult to determine whether meaning could be derived from the handshape and thus argue against phonological assimilation. Weak pauses also feature periods of hesitation where the signer appears to be forming the first sign in the following phrase but does not complete the sign. This is shown in Figure 3.32 below.
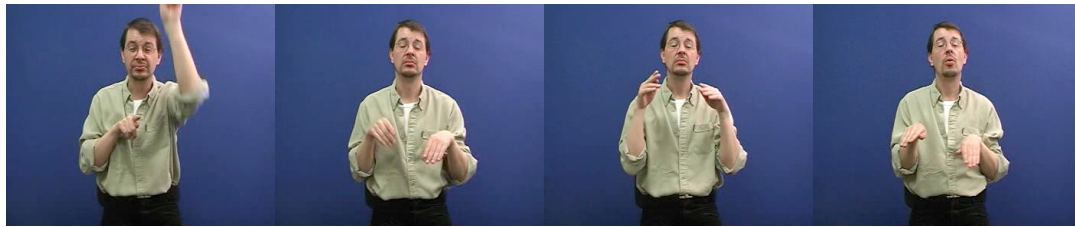
HARE-RACE-AHEAD   TORTOISE(incomplete)   HARE (incomplete) TORTOISE

[HARE-RACE-AHEAD] IP [TORTOISE TAKE-TIME] IP
The hare raced ahead. The tortoise crawled along at a slow pace.

Figure 3.32: Hesitation as a weak pause

In the figure above, PS appears to hesitate during the period identified as a weak pause. The pictures above show the formation of the sign TORTOISE that was not completed (the movement phase of the sign was never initiated). Following this, the hands are raised in the signing space to form the sign HARE but was not completed (handshape and location were not formed). In each case, both attempts were analysed as periods of hesitation and the whole sequence as a weak pause.

Overall, a small proportion of the boundaries analysed feature a pause (7%). In the following section, an overview of all the visual markers found at boundaries is provided.

3.5.4 Overview of visual markers at IP boundaries

An overview of visual markers at IP boundaries in all eight BSL narratives is presented in the table below. This table takes into account all occurrences of visual markers at boundaries regardless of function. Each figure represents the number of IP boundaries (out of a total of 481) that the visual marker in question is associated with in these data. In addition, a figure is provided for each signer so that individual tallies can be seen. In all cases, the percentage of boundaries is provided in brackets.

Visual markers	PS	CN	Number of IP boundaries (over 100% because of simultaneous use of multiple features)
Single head movement	133 (78%)	239 (77%)	372 (77%)
Blinks	103 (61%)	165 (53%)	268 (56%)
Eyebrow movement	96 (56%)	107 (34%)	203 (42%)
Torso	68 (40%)	104 (33%)	172 (36%)
Holds	48 (28%)	97 (31%)	145 (30%)
Repeated head movements	42 (25%)	78 (25%)	120 (25%)
Head nods	33 (19%)	69 (22%)	102 (21%)
Spreading	25 (15%)	20 (6%)	45 (9%)
Pauses	18 (11%)	16 (5%)	34 (7%)

Table 3.29: Overview of visual markers at IP boundaries

When overall results are viewed, the most frequent visual marker at boundaries is a single head movement which account for 77% of boundaries analysed. The next three frequent markers are blinks (56%), brow movement (42%), and the torso (36%). Head nods, holds and pauses, markers strongly associated with IP boundaries in other signed languages, show a low frequency at boundaries in the narrative data (21%, 30%, and 7% respectively). The least frequently occurring markers are pauses (7%) followed by handshape spread (9%). Overall frequency scores also reveal that out of this set of visual markers, non-manual features are generally more frequent at boundaries than manual features where the highest percentage recorded by a manual feature is 30% (holds).

When individual results are viewed, some similarities and differences between signers in boundary marking can be seen. For both signers the most frequent marker present at boundaries is single head movement (PS: 78%, CN: 77%). The next three most frequent markers: blinks, eyebrow movement, and the torso are recorded at least 40% of PS's boundaries (61%, 56%, and 40% respectively). A frequency count of the same markers in CN's boundaries shows lower scores (53%, 34%, and 33%).

Therefore, clear idiosyncratic behaviour can be seen in the narrative data. In general, for both signers the non-manual features analysed here occur frequently at boundaries over manual features. The two least frequent markers in individual boundary data are handshape spread (PS: 15%; CN: 6%) and pauses (PS: 11%, CN: 5%).

In the following table, the frequency of visual markers at IP boundaries in the BSL narratives is again displayed. In contrast to Table 3.29 above, only visual markers that are analysed as linguistic are included here. For example, a boundary featuring a change in brow position that is described as affective is not counted.

Visual markers	PS	CN	Number of IP boundaries (over 100% because of simultaneous use of multiple features)
Single head movement	61 (36%)	159 (51%)	220 (46%)
Holds	48 (28%)	97 (31%)	145 (30%)
Eyebrow movement	39 (23%)	67 (22%)	106 (22%)
Head nods	33 (19%)	68 (22%)	101 (21%)
Blinks	23 (14%)	23 (7%)	46 (10%)
Repeated head movements	6 (4%)	33 (11%)	38 (8%)
Torso	10 (6%)	25 (8%)	35 (7%)
Pauses	18 (11%)	16 (5%)	34 (7%)
Handshape spread	7 (4%)	5 (2%)	12 (2%)

Table 3.30; Overview of linguistic visual markers at IP boundaries

Table 3.30 shows that the most frequent linguistic marker present at boundaries is a single head movement (46%). The second frequent marker is a hold (30%) followed by eyebrow movement (22%) and head nods (21%). The least occurring marker is handshape spread (2%). When individual results are compared, both signers show similarities in the four most frequent markers which are ranked in an identical order (single head movement being the highest and head nods the fourth highest). The low number of boundaries that feature a boundary blink (in contrast to the 56% reported

in the previous table) reflect a revised perspective on blinks discussed in the following section. Overall, the alternative frequency table shows that when only linguistic visual markers are counted, none are present at over half of the boundaries analysed. This is in contrast to the results in Table 3.29 where single head movements combined (regardless of function) are present at 77% of the boundary data.

The results from the frequency data raise some questions about how visual markers can be used to identify boundaries particularly in view of their variability and other factors which must be considered before any conclusions can be made. These points are discussed in the next section.

3.6   Discussion

The data analysed in this chapter confirm that visual markers associated with IP boundaries in other signed languages can also be found at boundaries in the BSL narratives included here. For example, head nods, a change in head position, blinks, brow movement, and holds all indicate an IP boundary in BSL narratives. Other markers such as the torso, pauses and handshape spread also co-occur with these IP boundaries. A further finding in this chapter is that these markers do not occur independently at boundaries but combine simultaneously and sequentially providing evidence of prosodic layering.

However, several important points should be noted. Firstly, the rate at which each marker is observed at the boundaries analysed here do vary. Overall, a change in head position is the most frequent marker (77%) followed by blinks (56%), brow movement (42%), and the torso (36%). In contrast to non-manual features, which occur frequently, manual features show a low frequency at the boundaries analysed in the data. These include holds (30%), spreading (9%), and pauses (7%). The frequency data also reveal that visual markers strongly associated with IP boundaries in studies of other sign languages, such as holds, pauses, and head nods, all occur at low frequency in the BSL data.

As well as considering which visual markers are reliably indicative of boundaries in BSL narratives, it is also important to consider whether the frequency of these visual markers at boundaries may vary from signer to signer. The analysis conducted here has clearly shown this to the case. That is, similarities and differences are observed in the frequency of markers between the two signers analysed in this study (when proportional scores are considered). For both signers a similar proportion of single head movements at boundaries is observed (PS: 78%, CN: 77%) as well as blinks (PS: 61%, CN: 53%), the torso (PS: 40%, CN: 33%) and holds (PS: 28%, CN: 31%). Similarities are also seen in the least frequent markers at boundaries for both signers: handshape spread (PS: 15%, CN: 6%) and pauses (PS: 11%, CN: 5%). However, one difference can be seen in the proportion of boundaries featuring brow movement (PS: 56%, CN: 34%).[17] This analysis shows that individual differences in the occurrence of visual markers at boundaries can be expected. Similar findings have been observed for the use of prosodic cues to indicate boundaries in speaking (e.g. Cutler & Isard (1980) cited in (Warren, 1996)).

However, the frequency results presented above do not take into account the function of each marker occurring at boundaries. In other words, although these markers do co-occur at IP boundaries in BSL narratives, they do not always function as a linguistic boundary marker and therefore their domain is not always the IP. In this chapter, a distinction is made between linguistic uses each markers and use of these same markers as a narrative device (e.g. using the head and the torso to represent role). When only linguistic uses of each marker are counted, it is noted that these markers are not as frequent as one might expect in narrative signing. The most frequent markers observed are single head movements (46%), followed by holds (30%), brow movements (22%) and head nods (21%). This finding has implications for the frequency analysis as a whole. For example, although single head movements in general show a high frequency at IP boundaries, their function is not always linguistic.

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[17] Another possibility that might account for the difference in brow use is the context of the text. That is, PS's interpretation of the narrative might have required more use of the brow than CN's.

Further evidence that these two categories of visual markers (linguistic and narrative) are distinct comes from their alignment with the IP. Whilst they have been shown to correspond with IP boundaries to an extent, narrative use of some markers exhibit a tendency to persist over a boundary. For example, a torso lean and a head tilt to one position can represent one character in the story. This position can be held over an IP boundary and over the following phrase continuing to represent the role of a particular character. This tendency has been noted for other visual markers such as the brows when conveying affect and for handshape spread (functioning as classifiers or part of a sequence of constructed action and therefore an important reference point in the phrase). Although these markers do correspond with IP boundaries in signed narratives when linguistic, they are not always completed at boundaries when performing a narrative function. Except for a few cases, linguistic uses of these markers do not tend to persist beyond a boundary.

In addition, visual markers involving repeated movements (e.g. head and torso movements) are not precisely aligned with IP boundaries. In a few cases, head and torso movements are not completed within the time window assigned to boundaries. Again, it is demonstrated that these movements are not linguistic but are sequences where the signer acts out a character's actions in the story. Furthermore, head movements do not persist onto the following phrase. Two explanations may account for this finding. Firstly, these markers are shown to perform a semantic function in sequences of constructed action (such as portraying the actions of a character). Therefore the onset and offset of head movements are intrinsically linked to a manual sign (or phrase) and its meaning and will not spread onto neighbouring signs or beyond a boundary. The second explanation is phonetic and suggests that visual markers that are static and held in position are more likely to spread beyond an IP boundary in comparison to those involving repeated movements.

Although the previous paragraph states that repeated movements may not persist over a boundary, in one example, the use of the head to depict a character's motion appears to do so. This is shown below:

$$\overline{\hspace{2cm}\text{hm}\hspace{2cm}}\quad\overline{\hspace{3cm}\text{hm}\hspace{3cm}}$$

(3j)   [LAND EXCITING LOOK-AROUND] IP [TWO-FRIENDS-WALKING] IP
The view excited them as they looked around. The two friends walked along.

In both cases the movement of the head is from side-to-side. In the first IP, the side-to-side movement traces the direction of the hand in LOOK-AROUND and represents the character 'looking around'. In the second IP, the side-to-side movement again performs the actions of the characters in the story, this time the action of walking casually. The movements in both cases are highly similar[18] but have been categorised as two separate markers because of a slight backwards movement of the head between the two movements. In addition, an IP boundary was also judged to be present because of a change in facial expression. The use of two similar markers in adjacent phrases could be seen as a narrative device, a way the signer links two phrases together in storytelling. Since the head movements in these phrases represent two different activities, this also provided further justification for analysing these movements as two separate markers. Although this is a single example, the possibility that the narrator may exploit visual markers to link phrases as a stylistic tool should be noted.

In the revised frequency table (Table 3.30), blinks are present at 10% of the boundary data. This differs from the previous table where blinks are said to be present at 56% of the boundary data. The reason for this difference is because it was frequently difficult to determine the underlying nature of blinks occurring at boundaries with absolute certainty. In each (problematic) case, two possibilities exist. The temporal location of a blink (i.e. following the last sign in a phrase) may strongly suggest that the blink in question is a boundary blink (Type II). Alternatively, the co-occurrence of the same blink with movement of the head or with a change in gaze direction may strongly suggest that the blink in question is linked to head/gaze change (Type III). Although blinks co-occuring with a change in head position and gaze direction can be linked to the physiological need to blink in order to minimise disruption to vision, not all changes in head position and gaze

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[18] Additionally, the handshape used in the final sign and in the initial sign of the following phrase are identical although they differ in orientation (and have slightly different movements).

direction are accompanied by a blink. Rather, some changes physiologically require a blink, and some do not. In total, there are 141 instances (47% of total blink data) where the nature of a blink is unclear. The issue of whether blinks can be said to be a consistent marker of boundary position rests on the answer to this question. If these instances can be proven to be Type II blinks, then this blink type accounts for the majority of the blink data (63%). In contrast, if these blinks are Type III, then only 15% of the total blink data is represented by boundary blinks. Therefore, an alternative table has been constructed.

Type	PS	CN	Total
Type I: Physiological blinks	4 (3%)	2 (2%)	6 (2%)
Type II: Boundary blinks	23 (20%)	23 (13%)	46 (15%)
Type III: Head/gaze change	5 (4%)	21 (12%)	26 (9%)
Unclassifiable blinks	46 (40%)	95 (52%)	141 (47%)
Type IV: Voluntary blinks	37 (32%)	41 (23%)	78 (26%)
Type V: Hesitation/false starts	0 (0%)	0 (0%)	0 (0%)
Total	115 (100%)	182 (100%)	297 (100%)

Table 3.31: Revised table detailing the frequency of blink type at IP boundaries

In the above table, an additional category is added: unclassifiable blinks. Unclassifiable blinks represent tokens of blinks where it was impossible to decide on whether they are Type II or Type III blinks. This category accounts for a large proportion of the data (47%) resulting in a low percentage of clear boundary blinks (15% in contrast to the 63% in Table 3.18). As well as Type II and Type III blinks, Type IV and Type I are observed at boundaries. However, Type IV blinks are associated with specific lexical items and as such cannot be said to function as boundary markers. Type I blinks only account for 2% of the blink data and are not linked to boundary marking but are a behavioural response to stimulus (such as the hands moving quickly in front of the face). In sum, although blinks are found at a high proportion of IP boundaries in the narrative data, issues relating to blink classification and their underlying function need to be resolved before they can be classed as a consistent boundary marker.

When viewing the frequency data, it is necessary to discuss the extent to which discourse type has contributed to the results. For example, role-shift occurs more frequently in narrative signing than in other types of signed discourse (e.g. conversational signing) (de Beuzeville, Johnston, & Schembri, in press) and as a consequence, a high frequency in the use of the head and torso to signal a change of role might be expected. Since the head is present at over three quarters of the boundary data and torso activity at over a third, the observed frequency results might be unique to signed narratives. Assuming that a high proportion of Type III blinks are confirmed, this finding might also be related to signed narratives. It has been shown in HKSL that blink rates vary according to discourse type (where differences between signed conversational and monologue data were observed) (Sze 2004) and therefore, similar conclusions relating to the effect of discourse type on the frequency of visual markers might be reached here. Since a change in gaze direction is also linked to role (such as changing gaze direction from the right to left periphery or towards the camera lens (see Earis, 2008)) this would lend further support to the suggestion that blink type can be affected by discourse settings. In addition, the degree to which the narrative is prepared in advance may also contribute to the presence (or lack) of specific markers such as the low occurrence of pauses and the absence of Type V blinks (hesitation blinks). The preparation of the text in advance may in turn lead to fewer tokens of weak pauses where the signer thinks of what is to follow, and a complementary tendency for strong pauses to occur in similar locations across narratives. In addition, the signers included here are experienced story-tellers and are used to retelling stories to a camera. Since the use of certain markers at boundaries may be specific to narratives and the circumstances in which they are filmed, findings presented in the current study cannot be extrapolated to other discourse types.

This chapter has analysed a number of visual markers and the frequency of their occurrence at IP boundaries. However, it is clear that whilst these visual markers coincide with IP boundaries to an extent, they do not always function as prosodic markers but have other functions in signing that coincide with prosodic boundaries.

The low frequency of linguistic visual markers which co-occur with IP boundaries may be expected with signed narratives when one marker can have more than one function. As narrative signing involves role shift to a greater extent and sequences of constructed action then a reduction in the frequency of linguistic visual markers (by the same markers) co-occurring with IP boundaries might be an expected result. In other words, a marker might only be used for one function at a time. In an analysis of rhythmic side-to-side movements of the torso, Boyes-Braem (1999) observes that this type of movement is not observed in specific types of discourse such as pantomimic-like-passages. When the two frequency tables are compared, a big difference can be seen in the frequency of markers such as the head (77% compared to 46% when only linguistic single head movements are considered) and in the torso (36% compared to 7% when only linguistic single head movements are considered). A higher frequency of these visual markers (as linguistic markers to boundaries) may be expected in other types of signed discourse. However, an overlap in function can be seen with some visual markers. This was illustrated in the presentation of head and brow movement. For the head, it was shown that narrators can tilt their head to one side to indicate character and that this can persist over an IP boundary. In one example, to signal the IP boundary, the narrator moved his head back slightly whilst maintaining the original position of the head (tilted to one side) (see (3e) – (3f)). This can be defined as nested head movements (as reported in Stone, 2009). Affective use of the brows to signal an attitude of a character within a story can combine with other uses (such as signalling a new phrase). Therefore linguistic and narrative uses of the same markers can be said to overlap to a certain extent.

An analysis of the type and frequency of visual markers to IP boundaries has not provided a clear answer to how an IP is structured in BSL narratives. Out of the 418 boundaries analysed here, none of the visual markers (when only linguistic markers are considered) are present in over 50% of the boundary data. Although this might imply that BSL narratives do not have a clear prosodic structure, this is not the case. Instead, a thorough investigation into manual rhythm has yet to be conducted. That is, other markers which may better define the IP in BSL narratives need to be

examined. These include looking at the size of the sign (determining whether the size of the sign is larger in phrase final position) and looking at the speed and timing of signs. These avenues are suggested in Chapter 7.

If the status of these visual markers as prosodic can be debated, why are they included here? This is because the discussion on the underlying nature, behaviour and frequency of visual markers at boundaries raises some important issues regarding segmentation of a signed narrative at a superficial level. This includes whether it is necessary to understand the context in which these markers occur in order to determine boundary position or whether these markers can be processed at a superficial level and distinguished from other markers that are identical (e.g. a head nod co-articulated with a lexical sign in the middle of a phrase being distinguished from a head nod at a boundary). Other factors include the frequency with which some markers are observed at boundaries and whether a lack of a consistent marker causes difficulty in identifying all boundaries in a narrative. Furthermore, the extent to which markers might be subject to idiosyncratic variation and how some markers (in other functions) can persist over a boundary might also present problems when attempting to read boundaries at a superficial level. Therefore, an approach that segments a signed stream into phrases at a superficial level might not be successful since an understanding of why and how these markers occur is necessary. This issue is addressed in the following chapters where the perception of boundaries by different groups (with different levels of signing experience) is investigated.

In this chapter, it has been shown that there exists in BSL narratives, a number of visual markers that can be used to identify IP boundaries and that these visual markers vary in frequency. However, this raises the important question of whether frequency of a particular marker is a good predictor of what it is a reliable indicator of IP boundaries. If this were the case, the results from this chapter would suggest that single head movements and blinks are the most reliable marker. However, this is unverifiable in the absence of a good understanding of the occurrence of blinks in narrative signing. In contrast, markers that have been identified as strong indicators

of IP boundaries in other signed languages, such as head nods and holds, have a low frequency in the narrative data. It is difficult to see whether understanding the frequency of markers could bring the investigation closer to determining reliability. Alternative lines of investigation are proposed in Chapter 7.

3.7   Summary

This chapter has shown that there are several visual markers, both manual and non-manual, that can be used to identify IP boundaries. However, linguistic use of these markers occurs with low frequency at boundaries. In addition, although similar markers indicate boundaries in BSL narratives, they can vary by signer and there are also likely to be important differences relating to discourse type.

Chapter 4: Literature review on the perception of prosodic markers in spoken and signed languages

4.1   Introduction

Where the previous chapters have focussed on the production of visual markers at boundaries in signing, this chapter marks a move towards an investigation into the perception of these visual markers by different groups. In this chapter, a review of studies examining the perception of prosodic markers in spoken and signed languages is presented. The aim of this review is to show that language users are sensitive to markers produced (in general) whilst speaking or signing and that these markers may have an important role to play in language processing and communication.

The review will be organised into three main parts. Firstly, a review of the perception of prosodic markers in spoken languages is provided. This is followed by a review of the sign language literature in the same field. Finally, this review will also include research on audio-visual prosody in speech communication. As with other types of prosodic markers, the extent of their contribution and their importance in speech communication will be discussed.

Ultimately, the questions that this thesis will be concerned with are: are prosodic markers *of boundaries* perceived by language users in a reliable way? How effective are these markers in the context of other cues such as those deriving from lexical and grammatical information? Are they simply redundant when other cues are present or do they have an important contribution to make? At the end of this chapter, these points are discussed in the light of the literature presented here.

4.2   Speech prosody

There is a great deal of evidence from perceptual studies which demonstrate that listeners are sensitive to prosody when listening to someone speaking. For example, one study has showed that a string of nonsense sentences is better recalled when presented with the correct sentence morphology and sentence prosody (Epstein 1961 in Cutler et al., 1997) and another study has demonstrated that previously heard

sentences are recognised with greater accuracy on second presentation when spoken with the same sentence prosody as in their first presentation (Speer et al., 1993). Listeners can also be shown to interpret prosodic cues in a reliable way as in Blaauw (1994) where listeners were capable of perceiving the difference between spontaneous and read-aloud speech by using prosodic cues alone. Finally, synthesized speech is often more acceptable when presented with appropriate sentence prosody (Silverman, 1987). Together, these perceptual studies strongly suggest that listeners are sensitive to prosodic markers in speech.

It has also been suggested that prosody has an important role to play in language processing and communication (Cutler et al., 1997; Frazier et al., 2006). For example, it has been shown that utterances with correctly placed and well-formed prosodic boundaries are easier to understand than poorly-phrased utterances (Sanderman & Collier, 1997). In their study, participants listened to synthesized question and answer pairs which were structurally ambiguous. Participants were shown to respond faster to questions followed by an appropriately phrased answer (where the correct item was in focus) than questions followed by a neutrally or poorly phrased answer. This finding led the authors to suggest that prosody facilitates comprehension and aids language processing in that it can help the listener reject other interpretations of an utterance quickly and identify the correct one.

That listeners are also sensitive to prosodic markers of boundaries has also been demonstrated in other studies. For example, participants in a restricted experimental setting were shown to use prosody to differentiate between boundaries that signalled the end of a topic from those that signalled the end of a speaking turn (Geluykens & Swerts, 1994). Even when these sentences and cues were taken out of context and presented in isolation, listeners were still able to indicate the type of boundary marked using cues from prosody. In another study, participants were able to use prosody to reliably predict an upcoming boundary before the utterance was completed (Swerts, Collier, & Terken, 1994). Although these studies make clear that prosodic markers to boundaries are informative, the extent to which these markers

are useful in the context of other cues deriving from lexical and grammatical information is unclear. Prosodic markers may simply be redundant?

In Cutler et al. (1997), several 'click-locator' studies are described which suggest a supporting (rather than leading) role for prosody in language processing. In these studies, sentences were presented to listeners which were either disrupted with a click or switched from one ear to the other. Listeners were then instructed to indicate where the click or switch occurred on a transcript. Results showed that participants exhibited a tendency to incorrectly place the location of a click towards a boundary. This tendency demonstrates that listeners group a string of words into constituents and that 'the perceptual unit tends to preserve its integrity by resisting interruptions' (Cutler et al., 1997:160). Results from click-locator studies which presented utterances where syntactic and prosodic boundaries were in conflict showed that listeners tended to locate clicks at syntactic rather than prosodic boundaries (e.g. Bever, Lackner & Kirk, 1964, Garrett, Bever & Fodor, 1965 reported in Cutler et al.). It was concluded from these studies, that listeners group words according to syntactic and not prosodic structure. In contrast, switch studies have shown that the point of a switch was indicated towards neither syntactic nor prosodic boundaries (e.g. Wingfield & Klien (1971) reported in Cutler et al.). In another click-locator study (Geer 1978, reported in Cutler et al.), recorded sentences with prosodic breaks naturally realised at syntactic boundaries were matched with a second set of identical sentences where syntactic information was absent but had the same number of syllables and placement of prosodic breaks. Click locations migrated towards boundaries that were both syntactic and prosodic in the first instance but were unaffected by the location of prosodic boundaries when syntactic information was absent. Together these studies suggest that syntactic structure is essential for an utterance to be perceived as a unit and that prosody plays a supporting role, reinforcing and enhancing the perception of syntactic structure.

Studies looking at how prosodic cues are perceived in a foreign language have shown that, regardless of other cues to boundary position in the language, cues from prosody can be very informative. For example, it was demonstrated that listeners are

reliably able to predict the occurrence of an upcoming boundary and its strength in a language they do not know (Carlson et al., 2005). In this study using fragmented Swedish utterances of varying length, two groups of participants (speakers of American English and speakers of Swedish) were first asked to predict whether or not a prosodic boundary would follow a utterance fragment and then to rate the strength of that boundary. It is important to note that the test sentences were fragmented so that pauses (a reliable marker in boundary detection) and lexical and grammatical information from preceding phrases were absent. Their results indicate that both groups were able to reliably predict where boundaries would occur and their strength using prosodic markers such as intonation and lengthening. This finding suggests that it is possible to predict boundaries in a reliable way using prosodic markers alone (in the absence of lexical and grammatical information). That no significant differences were observed between the Swedish and English-speaking participants suggest that knowledge of a language is not a prerequisite when perceiving boundaries.

As well as American and Swedish groups, Carlson et al. ran a third group of seven Chinese students as a pilot study. Their results showed similarities in detecting boundaries in longer stimuli but less ability in one word stimuli indicating that linguistic background might influence how prosodic markers are perceived when indicating boundaries. This preliminary finding is supported by an earlier study where a group of French subjects were asked to predict where the end of a sentence might occur whilst listening to a set of English sentences differing in length (Grosjean & Hirt, 1996). English speakers could use prosodic markers in English to differentiate between sentences that stopped, continued for a short while, and continued for a while longer whilst French speakers could only differentiate between sentences that stopped and sentences that continued. In another study it was demonstrated that French speakers found it hard to hear stress placement in English that English speakers hear with no difficulty (Frazier et al., 2006). These studies suggest that the perception and interpretation of prosodic markers rely on language experience to a certain extent.

As this review begins to consider signed languages, several questions arise. Are prosodic markers reliably perceived by signers and to what extent are they informative of boundary position when compared to other cues? Since signed languages are conveyed in the visual-gestural modality and prosody is articulated differently than for speech, can any differences be expected in how they are perceived? These questions are addressed in the following section.

4.3   Sign language prosody

In Chapter 2, it was shown that sign languages have a prosodic system that is comparable to spoken languages, although one that differs in form. Increasingly, studies have shown that sign languages can be structured into prosodic constituents and that these constituents can be marked by a number of non-manual and manual features systematically (Nespor & Sandler, 1999; Sandler, 1999a, 1999b; Sandler & Lillo-Martin, 2006; Wilbur, 1994, 2000). However, studies aimed at understanding how sign language prosody is perceived by its users are rare, particularly for BSL. In this section, a review of sign language studies which examine the perception of prosodic features in signing is provided. These studies contribute to growing evidence of the importance of prosody in sign language communication.

Research on the perception of sign language prosody by native signers has demonstrated that signers do perceive prosodic elements in signing consistently. For example, when asked to indicate a sentence boundary in an ASL interpreted lecture, responses by native ASL signers were shown to cluster frequently at utterance boundaries and in turn, these boundaries were marked by a number of visual markers (Nicodemus, 2009). In another study investigating the production and positioning of phrasal stress, three native ASL signers were asked to verify all the signs that they perceived as stressed in a small corpus of 14 signers and showed consistency and agreement with each other in their readings of stress placement (Wilbur & Schick, 1987). One ASL study has also shown that affective prosody encoded in the hands (when further markers from the face are absent) can also be reliably perceived by native signers of ASL (Reilly, McIntire, & Seago, 1992).

Research into whether sign language prosody is perceived in a reliable way have not always been restricted to one group (i.e. native signers) but have focussed on how these features are perceived by those who do not know a sign language. These studies, whilst further supporting claims that sign language prosody is perceived reliably by its users, can reveal the extent to which language experience is essential for full appreciation of sign language prosody.

An early study on pauses in ASL demonstrated the ability of non-signers to detect pauses in a signed stream (Grosjean & Lane, 1977). The researchers recruited three judges: two who knew ASL and one who did not to assess and measure pause occurrence and length in their sign language data to determine whether knowledge of a sign language was essential for coding pauses. Significant agreement as to whether a pause occurred and the length of that pause was found between the two judges who were native ASL signers and the third judge who lacked knowledge of a sign language, suggesting that knowing a sign language does not affect perception of pauses in signing.

Similar observations have been made in a study of rhythmic perception in signing. A group of native signers were asked to tap out the rhythm in five short ASL narratives (Allen, Wilbur, & Schick, 1991). Two further groups were invited to participate in this investigation: ASL-fluent hearing children, and hearing non-signers. A comparative analysis of the three groups showed that the location of taps coincided with repeated signs, signs with primary stress and phrase-final signs (these signs being crucial to rhythmic structure). However, the non-signers tapped more often to signs with secondary or weak stress than both the ASL fluent groups. This shows that stress and rhythm can be reliably perceived by native signers but by those who do not know ASL. However, the non-signers' tendency to respond more often to signs with secondary or weak stress indicates that experience of ASL is required in order to accurately judge rhythm in signing.

Similar findings to the studies above have been made following research on boundary perception by native signers and those who do not know a sign language.

In the following study, identical sentence pairs (with the exception of one containing an IP break) were presented to two groups: ASL signers and non-signers. All participants were asked to (a) judge whether a sentence break occurred and (b) mark how confident they were in their decision. ASL signers were more accurate in boundary detection than non-signers (86% vs. 76%) and showed less variation in their confidence levels (Brentari et al., 2007). As in other perceptual studies, these results support a strong role for visual markers in the perception of boundaries.

Research on the ability of those who do not know a sign language to perceive prosodic elements in signing has also been extended to affective prosody. In an interesting study on the perception of emotional state in the hands alone, participants who did not know a sign language were shown to reliably perceive emotions such as anger expressed on the hands and the arms in Finnish Sign Language (Hietanen, Leppänen, & Lehtonen, 2004).

The studies described above all show clearly that sign language prosody can be reliably perceived and have, in some studies, highlighted the importance of language experience in being able to do this accurately and confidently (e.g. Allen et al., 1991; Brentari et al., 2007). However, these findings in turn raise further questions as to the effectiveness of a particular marker when viewed in isolation or in combination with other markers (particularly when signed languages are known to layer markers simultaneously and sequentially, cf. Wilbur (2000)).

For example, in Nicodemus' study (2009), clusters of agreement amongst 50 native signers whilst watching an ASL interpreted lecture were shown to coincide with a number of layered visual markers. Following a frequency analysis of these markers, she found that larger articulators (such as hand clasps and body leans) occurred more often at intervals identified by her participants as boundaries and suggests that the choice of larger articulators as boundary markers is driven by the perceptual needs of the viewer (the need to clearly indicate boundary points in an utterance). A further observation was of the low occurrence of markers involving continuous movement

(such as finger wiggling) at boundary points. In general, all markers occurring at boundary points were held in final position.

In their study of affective prosody in ASL Reilly et al. (1992) demonstrated that judgment of emotional states using manual signals alone was improved significantly when ASL signers were allowed to see both the hands and the face (where affective information is also displayed). This suggests that although affective information can be encoded in manual signs, the combination of other markers in signing can enhance the perceptual strength of the signal. This finding also raises the question of how much a viewer has to see in order to reliably interpret prosodic information.

In Brentari et al.'s (2007) study reported above, it was suggested that although ASL signers and non-signers identified sentence breaks at a similar rate, the two groups differed in boundary marking strategies. All sentence pairs presented to participants were analysed for the presence of the following markers: pause, holds, lengthening, blinks and drop-hands. An analysis of responses to each sentence pair showed that whilst ASL signers relied on a single marker to indicate boundaries (pauses), non-signers relied on several markers to indicate boundaries (pauses, holds, and drop-hands). Even though non-signers can be accurate at indicating boundaries, they still perform differently to experienced ASL signers.

This thesis is particularly interested in whether native signers of BSL can perceive boundaries in BSL in a reliable way and the extent to which boundaries can be signalled using visual markers alone. It has been shown in studies of ASL that signers are able to judge the position of a boundary in a reliable way and that their decisions frequently coincide with specific visual markers (e.g. hand clasps and body leans). In addition, the ability of non-signers to indicate boundaries in Brentari et al.'s ASL study suggests that visual markers at boundaries are highly informative of boundary position. However, other studies have indicated that boundary position cannot always be determined using visual markers alone. When considering specific boundaries such as sentence boundaries, it has been suggested in German Sign Language that markers such as blinks, change of gaze, lengthening and transitions

are 'useful but not conclusive for determining these types of boundaries' since they are not exclusive to sentence boundaries but can occur within sentences as well (Hansen & Hessman, 2007). This suggests that segmentation of a signed stream may not always be possible independently of meaning (i.e. using visual markers alone) and must involve an understanding of linguistic structure. This question has yet to be explored with BSL.

Overall, studies on sign language prosody have shown us that signers can perceive a number of features in a reliable way (such as rhythmic structure, stress, affective prosody). Although these visual markers can be seen by those who do not know a sign language, language experience can affect performance and strategies in perception tasks. That is, those who know a sign language can perceive prosodic structure more reliably and confidently than those who do not know a sign language (e.g. Brentari et al., 2007). Although visual markers are highly informative of boundary position, it has been said that other cues such as those deriving from lexical and grammatical information may be important for accurate detection of boundaries (e.g. Hansen & Hessman, 2007).

To an extent, it is not surprising that non-signers are proficient at responding to visual markers in signing. Face-to-face communication is accompanied by movement on the face and the hands which are closely aligned with auditory prosodic cues. In the following section, a literature review on audio-visual prosody is provided. This literature review aims to show that visual markers are strongly aligned with speech prosody, that they have an effect on how speech is perceived and that they make a significant contribution to the identification of boundaries in speaking.

4.4   Audio-visual prosody

Research into audio-visual markers produced during speech has shown that they are aligned with spoken prosody. Head movements have been linked to the production of suprasegmental features of speech such as stress and prominence (Dohen, Loevenbruck, & Hill, 2005; Hadar, Steiner, Grant, & Rose, 1984; House, 2002), and

fundamental frequency (Yehia et al., 2002) and are also synchronized with prosodic boundaries (Graf et al., 2002). Eyebrow raises coincide with pitch accents during speech (Cavé et al., 1996; Flecha-Garcia, 2006; Guaïtella et al., 2009) and eyebrow movements in general can be aligned with the intonational contour (Bolinger, 1983). The timing of body movements (such as the head and the hands) and underlying prosodic structure are closely related (Kendon, 1972; Munhall, Jones, Callan, Kuratate, & Vatikiotis-Bateson, 2004) and co-speech manual gestures coincide with an accented syllable (McClave, 1998; McNeill, 1992). In addition, audio-visual markers can indicate the state of the speaker, such as uncertainty (Swerts, Krahmer, Barkhuysen, & van de Laar, 2003). Studies have illustrated that the use of these markers in production tend to be idiosyncratic in degree or strength but for each case are consistently time-aligned with prosodic features in speech (Dohen et al., 2005; Flecha-Garcia, 2006; Graf et al., 2002; Munhall et al., 2004).

Physiological factors cannot always account for the production of audio-visual markers so they must be linked to some higher communicative function (Granström & House, 2005). For instance, Flecha-Garcia (2006) shows that whilst eyebrow raises correspond significantly with pitch accents, they are also in part determined by the underlying function of the utterance, such as giving an instruction. In other words, not all pitch accents are accompanied by an eyebrow raise, but when eyebrow raises do occur, they tend to be aligned with a pitch accent. Therefore, it is demonstrated that audio-visual markers are not always produced as a consequence of speaking but may have an important function to play in face-to-face communication.

A number of studies have explored the perception of these audio-visual markers in experimental settings. For example, speakers can use head movements to determine which word in a sentence is receiving emphatic stress and to discriminate statements from questions (Bernstein et al., 1998), or use visual markers to indicate which word is in focus (Dohen et al., 2004) which suggests that markers produced during speaking are not redundant but can make important contributions in communication. Furthermore, there is evidence to suggest that people have learned where to direct their attention for markers to different aspects of speech (Lansing & McConkie,

1999). In a visual-only condition, it was found that the upper part of the face is of critical importance for obtaining information on intonation patterns. When monitoring eye-gaze, it was demonstrated that participants spent more time looking at the upper part of the face when making decisions about intonation than they did when making decisions about words being spoken.

Additionally, where audio-visual markers do occur, they not only coincide with spoken prosody but appear to have an effect on the perception of speech. For instance, evidence supporting a multi-modal approach to speech perception (one that integrates visual markers) is provided by the McGurk effect (McGurk & MacDonald, 1976). In this paradigm, participants hearing the syllable [ba] whilst watching someone pronounce [ga] perceive the syllable [da]. Other studies have shown that participants are slower to respond to a stressed word in a sentence when audio and visual cues for prominence are mismatched (House, Beskow, & Granström, 2001; Swerts & Krahmer, 2005). Furthermore, when visual markers are time-aligned with auditory speech cues in experimental settings, this partnership has been shown to improve overall performance and assist in comprehension (Davis & Kim, 2004; Swerts et al., 2003). Finally, just as we have seen that synthesised speech is more acceptable when accompanied with sentence prosody, the inclusion of audio-visual markers can make a significant contribution to the perceived 'naturalness' of embodied conversational agents (Graf et al., 2002).

Some studies have shown that the inclusion of audio-visual markers can improve speech perception when speech is unclear. For example, in a study of head movements produced whilst speaking (Munhall et al., 2004), participants were asked to shadow a sentence mixed with a babble track whilst watching an avatar driven by motion-capture parameters of a real speaker. Results showed that participants performed with greater accuracy when presented with natural head motion, supporting a link between audio-visual prosody and sentence processing. In a different study looking at the effect of head movements on perception when speech is unclear (Davis & Kim, 2006), it was shown that not only does seeing the full face lead to greater speech intelligibility, but a small improvement in intelligibility was

also observed in expressive sentences when only the top of the head was visible. This is supported further in another study which shows that intelligibility of sinewave speech (a "skeletonised" version of speech preserving frequency and amplitude but lacking the acoustic structure of speech) is improved greatly when presented with corresponding facial stimuli (Saldaña, Pisoni, Fellowes, & Remez, 1996).

There is some evidence to suggest that a multi-modal approach to language processing may be beneficial. In one study by Davis and Kim (2004), speakers were found to be more accurate in estimating phrase duration in spoken utterances in an audio-visual condition (where a moving face was presented with speech) than in an auditory-only condition (accompanied with a picture of a still face). In a different study looking at other audio-visual markers, manual gestures produced whilst speaking were highly informative of sentence boundaries and may be used to segment an utterance when speech is unclear, although in normal circumstances (where cues such as pauses are available) they are claimed to be redundant (Eisenstein & Davis, 2005). In another study where placement of pitch accent and eyebrow movement to indicate prominence was varied in a synthesised talking head, both audio and visual prosody were found to have a significant effect on the perception of prominence (Krahmer, Ruttkay, Swerts, & Wesselink, 2002). However, the magnitude of effect was larger for pitch accents alone. The researchers suggest that this difference might be explained by the fact that speakers have learned to pay more attention to cues in speech than on the face. They conclude that speech has a more dominant role in language perception but in cases where audio cues are unclear, visual markers can make a valuable contribution to processing.

Audio-visual markers have also been shown to make a significant contribution to the perception of boundaries (Barkhuysen et al., 2008). In this study, participants were asked to indicate the end of an utterance in three different conditions: audio-only, visual-only, and an audio-visual condition. Participants responded quickest in the audio-visual condition, followed by the audio-only then visual-only condition. In a second experiment, fragmented utterances in all three conditions were presented to

participants who were then asked to indicate whether the fragment marked the end of an utterance. Once again, participants were most successful in the audio-visual condition and least successful in the audio-only condition. The researchers suggest that in the light of variation amongst speakers in the degree to which they produce audio and visual cues, a bimodal presentation enhances perception since more cues are available to the participants in the audio-visual condition.

In summary, there is a great deal of evidence supporting a role for audio-visual prosody in language perception (see also Dohen & Loevenbruck, 2009). Munhall et al. (2004) point out that current inventories of potential cues used in segmentation tasks (at the lexical and sentence level) need to be expanded to include naturally occurring actions of the speaker.

4.5   Discussion

This section includes a brief discussion which brings together studies on perception of prosody in spoken and signed languages. The studies above have reported a general sensitivity to prosodic markers produced whilst speaking and signing and have discussed the status of these markers (in context of other cues) to some extent. However, this thesis is concerned with how these findings specifically relate to the perception of boundaries specifically. It is also of interest whether there are any similarities or differences in the perception of boundaries in spoken and signed languages, particularly when audio-visual markers are considered.

In the review on spoken language prosody, it was shown that speakers are proficient at indicating boundaries using auditory cues (Carlson et al., 2005; Geluykens & Swerts, 1994; Swerts et al., 1994). In addition, visual markers have been demonstrated to align with boundaries in speaking. These include changes in posture at the start and end of a turn (Cassell, Nakano, Bickmore, Sidner, & Rich, 2001), blinks (Doughty, 2001), head nods (Maynard, 1987), and eyebrow movements (Guaïtella et al., 2009). However, a full understanding of these markers and how they are perceived in face-to-face communication has yet to be achieved. In addition, the studies reported above investigate visual markers of boundaries in specific

conditions (e.g. turn taking) and therefore a complete picture of the frequency and type of visual markers at boundaries present in other speech contexts is lacking. Although Barkhuysen et al. (2008) show that a bimodal condition is favoured in the perception of boundaries they note that there is little research which explores how important visual markers are to boundaries when compared to auditory cues. They say '…it is still an empirical question as to how possible visual boundary markers relate to the auditory ones, which of the two have stronger cue value, whether or not the two modalities may reinforce each other, or whether observers are helped or rather distracted when they focus on two rather than on a single modality in their finality judgements' (Barkhuysen et al., 2008:2).

Research on sign language prosody is at a similar stage. For example, whilst it has been clearly demonstrated that visual markers are aligned with boundaries in signing (e.g. Nespor & Sandler, 1999; Nicodemus, 2009; Sandler & Lillo-Martin, 2006; Wilbur, 1999, 2000) and that these boundaries are clearly perceived by sign language users in ASL (Brentari et al., 2007; Nicodemus, 2009) it is not yet clear how these markers compare with one another and with other information from lexical and grammatical structure. Nicodemus' (2009) study shows that markers involving larger articulators are more frequent at boundaries perceived by ASL signers, suggesting that these markers may be more successful at cueing boundaries. More studies are needed that investigate how boundaries are perceived and the extent to which different visual markers and other cues available to the observer can contribute to the signal (particularly when signed languages are demonstrated to layer markers sequentially and simultaneously at boundaries).

Interestingly, studies on audio-visual markers of boundaries show that similar markers are available as in spoken and signed languages (such as the head movements, body posture, blinks, and eyebrow movements). Studies which focus on audio-visual prosody in general have shown that speakers are sensitive to audio-visual markers produced whilst speaking (Barkhuysen et al., 2008; Graf et al., 2002; Swerts et al., 1994). These studies suggest that speakers have experience in interpreting information in manual and non-manual gestures. Therefore, to what

extent will this experience aid non-signers in the segmentation of a signed utterance? This question has only been addressed in one study. Brentari et al. (2007) showed that non-signers were able to identify sentence breaks at a similar level of accuracy to signers providing further evidence for the claim that non-signers are not gesturally naïve but can interpret visual markers accurately even in a signed language that they do not know. How these findings transfer to a study on narrative signing which includes BSL is a topic which will be considered in the following chapters.

4.6   Summary

Prosody is a crucial component in basic human communication. Studies of the perception of prosody in general have shown that observers are sensitive to prosodic elements produced in both spoken and signed languages. These studies lead to an investigation into the perception of boundaries using visual markers alone and in combination with other cues (such as lexical and grammatical information). The experiments reported in the following chapters aim to address these areas of interest.

Chapter 5: The perception of boundaries by signers and non-signers

5.1   Introduction

Chapter 5 marks a shift away from examining the production of visual markers at IP boundaries in sign language and instead focuses on the perception of boundaries by two main groups: native signers of BSL and hearing non-signers. This chapter attempts to answer questions concerning the perception of boundaries by using an experimental approach. This chapter will be structured as follows: in 5.2, the aims and objectives of the chapter are set out. In 5.3, the research questions for the current chapter are explained and the hypotheses outlined in 5.4. This is followed by the methodology in 5.5 where the research design is explained. In 5.6, the results section is divided into two parts, presenting a quantitative and qualitative perspective of the data collected in this chapter.

5.2   Aims and objectives

The principal aim of this chapter is to show whether native signers of BSL are able to agree on where the boundaries lie in a signed BSL narrative. At present, there is a lack of research focused on how BSL is segmented into phrases by native signers and the current study aims to address this. An additional aim is to investigate whether visual markers that coincide with boundaries play an important role in segmentation tasks. That is, to determine the extent to which they are reliable as boundary markers in the absence of other types of cues deriving from the grammar.

These aims will be achieved using data collected from online segmentation experiments where native signers of BSL are asked to make boundary decisions whilst watching someone signing a narrative. The addition of a second group, comprising hearing non-signers, will allow for a detailed discussion on the usefulness of visual markers in indicating boundaries at a superficial level for segmentation tasks.

5.3 Research questions

In this section, the research questions for this chapter are outlined. These questions follow on from the issues discussed in Chapter 3 and 4, in particular, the importance of dividing an utterance string (spoken or signed) into segments in language communication and the extent to which different types of cues can contribute to this task. In this chapter, the term 'boundaries' refer to the set of boundaries identified here (unless stated otherwise) and 'visual markers' refer to the categories of non-manual and manual features discussed in Chapter 3. Information deriving from grammatical structure refers to information that comes from knowing the language, for example, being able to draw meaning from each sign in an utterance string and understand how signs are related (grammatically) to each other (such as being able to identify the subject and its predicate).

Despite advances in sign language research, very little is known about how boundaries in signed languages are perceived by signers. In the previous chapter, it was reported that ASL native signers were able to agree on the location of boundaries in a lecture interpreted into ASL (Nicodemus 2009) and, in a separate study, were successful at indicating whether a break is present in a set of ASL utterances (Brentari 2007). However, it is not clear whether these findings can be extended to BSL and whether this holds true for other signing contexts (e.g. narrative signing). To address this, BSL signers were invited to take part in an online segmentation experiment. Individual responses made during this experiment were then assessed according to its placement and the extent to which it agreed with responses by other participants. A second group comprising of non-signers were also invited to participate and responses by this group were then compared to the BSL signers. It is hoped that the findings from this experiment will shed light on the research questions listed below.

- *To what extent do native signers of BSL agree on the location of boundaries in a BSL narrative?*

When asked to indicate where the boundaries lie in a BSL narrative, to what extent do native signers of BSL agree on the (temporal) location of boundary regions? Do they assign boundaries in a less predictable and coherent manner? How successful are native signers at indicating boundaries in a real-time experiment? The investigation will be limited to responses occurring at a set of boundaries identified using the criteria set out in Section 5.5.4.

- *What kind of visual markers coincide with participants' responses?*

Sign language literature has focused on the many visual markers that are aligned with different prosodic boundaries (such as the boundaries of phonological and intonational phrases) but our understanding of which visual markers native signers use in segmentation tasks is limited. In Chapter 3, it was demonstrated that visual markers (although not always prosodic) are aligned with boundaries and that these markers can be layered simultaneously and sequentially. Since BSL exhibits a varied marking system at boundaries, is it possible to observe a pattern in the type of visual marker used by BSL signers to recognise boundaries in a signed narrative? That is, do signers tend to focus on a specific visual marker or do they attend to several markers? Is one visual marker more successful at indicating boundary position when compared to others?

- *Can visual markers reliably indicate boundaries on their own (in the absence of cues deriving from the grammar)?*

Research in spoken language segmentation has discussed the contribution of lexical and grammatical cues as well as prosodic cues in indicating boundaries in a spoken utterance (Cutler et al., 1997). In addition, other studies have supported a multi-modal approach to speech segmentation by demonstrating the effectiveness of audio and visual cues in indicating utterance boundaries when combined (Barkhuysen et al., 2008). For signed languages, the relationship between different types of cues and

their effectiveness (whether independently or in combination with other cues) in segmentation is not clearly understood. To promote a better understanding of how sign language segmentation works, this thesis aims to clarify whether the visual markers investigated here are able to indicate boundaries in the absence of cues relating to lexical and grammatical structure. For instance, it has been demonstrated that listeners are able to predict the presence of a boundary in an unknown language and the strength of that boundary using auditory cues from prosody alone (Carlson et al., 2005). A similar line of investigation is adopted in the current study through the inclusion of hearing non-signers (discussed in the following paragraph).

- *Are non-signers able to identify boundaries in a signed language?*

Since non-signers do not know BSL, they would be unable to use cues deriving from lexical and grammatical structure and, as a consequence, can only rely on visual markers. This raises two questions: firstly, whether these visual markers can be reliably perceived by non-signers at a superficial level; and secondly, whether, in the absence of cues from grammatical structure, visual markers alone can be used to detect boundaries in signed languages in a reliable way? Non-signers have to attend to a wide range of markers to locate boundary position and, since these markers are not always functioning as a prosodic marker, can only interpret these markers at a superficial level. The inclusion of a group of non-signers allows the thesis to address the question of what is sign language specific knowledge and what can be recognised by those who do not know a sign language. This in turn bears on questions of the relationship of elements of sign language to gestural elements in face-to-face spoken communication.

- *How do native signers of BSL and non-signers compare when segmenting a BSL narrative into sentences?*

Do native signers of BSL and non-signers agree on the location of boundaries in a signed BSL narrative? The BSL signers can segment a BSL narrative using both their knowledge of BSL's grammatical structure, and visual markers that coincide with boundaries. In contrast, the non-signers can only base their boundary decisions

on visual markers. Since the groups differ in their approach to segmentation, it is possible that they will differ in identification of boundary locations.

- *How do native signers of BSL and non-signers compare when both segment an unknown sign language?*

When watching a signed narrative in an unknown sign language, neither group will have access to cues deriving from knowledge of lexical and grammatical structure and will therefore be relying on visual markers alone to indicate boundaries. How do these groups compare when indicating boundaries in a narrative signed in a language unknown to both? Will the two groups agree more on boundary position in comparison to responses when watching BSL narratives, where the two groups may be using different sets of cues? An alternative hypothesis is based on the observations discussed in Chapter 2, that signed languages show limited cross-linguistic variation in grammatical structure (Meier, 2002), and those of Chapter 3, where an analysis of visual markers at prosodic boundaries in BSL narratives showed that markers occurring at these boundaries are similar to those reported for other unrelated signed languages. These findings would predict that native signers might have a 'modality/typology advantage'. By understanding how sign languages (in general) structure and mark their constituents, they are able to use this language experience when segmenting an unknown language.

In order to answer these questions, a group of native BSL signers and a group of non-signers were asked to indicate where 'the end of a sentence' lay in two narratives, one in BSL and the other in SSL, during an online experiment. Participants had to make their decisions as to where the sentence boundaries were situated whilst watching the video of the narrative with little time to think about their decisions. This experiment thus focusses on the real-time sensitivity to potential boundaries by the two groups.

Analysis focusses on responses occurring within time windows associated to each boundary. It is predicted that, when watching the BSL narrative, native signers will be better at identifying boundaries that coincide with the end of a sentence, since

they can access cues deriving from the grammar (and will then be able to determine if a sentence is 'complete') as well as using visual markers that coincide with boundaries. By contrast, non-signers are unable to define a sentence using cues deriving from the grammar. Assuming that visual markers are not reliable cues to boundary position, it is expected that the non-signers will respond to boundaries in general and not show a preference for boundaries coinciding with the end of the sentence. However, if non-signers are able to correctly indicate boundaries that co-occur with sentence boundaries, this would not only suggest that these boundaries are marked differently to other boundaries (those that do not coincide with the end of a sentence) but that visual markers are very informative of boundary position.

The SSL narrative is introduced to the study to investigate whether language experience can account for differences (if any) between the two groups. Although both groups can only use visual markers to indicate boundaries in the SSL narrative, the BSL signers may have an advantage over the non-signers because they know another language conveyed in the visual-gestural modality (their native language). That is, limited cross-variation in structure and boundary marking in signed languages along with language experience may give the BSL signers an advantage over non-signers when segmenting an unknown sign language.

5.4   Hypothesis

The hypotheses for the BSL condition are set out as follows:

Hypothesis 1a (null hypothesis): Both groups are unable to indicate boundaries in a signed BSL narrative at a level greater than chance.

Hypothesis 1b: Both the native signers and non-signers are able to indicate boundaries in a BSL narrative at a level greater than chance. The groups do not differ significantly from each other when results are compared.

Hypothesis 1c: The native signers indicate boundaries in a BSL narrative at a significantly more accurate level than that of the non-signers.

For the SSL condition, the hypotheses are as follows:

Hypothesis 2a (\null hypothesis): Both groups are unable to indicate boundaries in a SSL narrative at a level greater than chance.

Hypothesis 2b: Both the signers and non-signers are able to indicate boundaries in a SSL narrative at a level greater than chance. The groups do not differ significantly from each other when results are compared.

Hypothesis 2c: The signers indicate boundaries in a SSL narrative at a significantly more accurate level than the non-signers.

5.5   Methodology

In this section, the methodology for the experiment is presented. Two signed narratives from the ECHO corpus were selected and a linguistic analysis was conducted to determine the location of boundaries. Participants from the two groups were then invited to undertake an online boundary detection experiment involving two signed narratives. Analysis of the data comprised of (a) exploring the consistency of participants' boundary decisions (intra-participant reliability), (b) the extent to which participants' responses agreed with target boundary locations identified via linguistic analysis and (c) qualitative analysis of specific boundaries that attracted a high or low number of responses from participants.

5.5.1   Participants

This experiment involved two groups of participants: deaf native signers of BSL and hearing non-signers. Each group comprised six participants (four females in each group). Four of the native signers have two signing parents and the remaining two native signers have one signing parent. Only native signers of BSL who did not know SSL were selected for the study. The hearing non-signers had no signing experience prior to testing. Ethical consent for the experiment was obtained from the UCL Graduate Studies Committee; written consent was obtained from all participants before testing.

5.5.2 ECHO Corpus

Four fables were taken from the ECHO corpus (mentioned in Chapter 3) for the present experiment: two fables were in presented in BSL and the remaining two were presented in SSL. Each fable was signed by a different narrator. Details relating to filming were obtained from the ECHO corpus website and are described in Chapter 3. Two additional fables from each language were used for practice and were not used for analysis.

In order to ensure that the signers would have no access to the lexical content of the SSL narrative, a different fable to the BSL narrative was selected. The BSL narrative featured a male signer retelling the fable, 'The Tortoise and the Hare'. This was timed at 86 seconds. The SSL narrative featured a male signer retelling the fable, 'Two Friends and the Bear' which was timed at 88 seconds. A glossed transcript for each fable is available in Appendix 1.

5.5.3 Instructions for the task

Each participant was asked to segment two narratives: one in BSL and one in SSL. Before each narrative, a practice run was held (one in each language) so that participants were able to prepare themselves for the experiment. The narrators and the fable in each of the practice narratives were different from the narratives used for the experiment to avoid familiarity with the narrators and the fables. Participants were asked to watch each narrative on a desktop computer and to press the 'enter' key on the keyboard when they saw 'the end of a sentence'. No attempt was made to define a 'sentence' to participants. This was so that participants would not be drawn to a particular visual marker that the investigator may have used when providing an example and so as not to inadvertently provide a definition of a sentence boundary. Participants were notified that the video would not stop playing once the task started and were encouraged to respond as quickly as possible. The order of tasks was

randomized for each participant. The total running time for the experiment was approximately 20 minutes.[19]

Responses from participants were recorded using ELAN (the software described in Chapter 3), which allows users to view a video file linked with an annotation file. A novel use of existing ELAN software in this study enabled 'on-the-fly' segmentation, allowing users to mark points on the annotation viewer in real-time whilst watching the video files. During testing, the annotation viewer was hidden from view so that participants were unable to see any previous segmentation attempts. For analysis purposes, each participant was assigned a tier (for each run) on the annotation viewer so responses could be directly compared with others to assess agreement. This can be seen in Figure 5.1 below which provides a snapshot of the annotation viewer in ELAN; responses from each participant can be seen on their individual tiers.
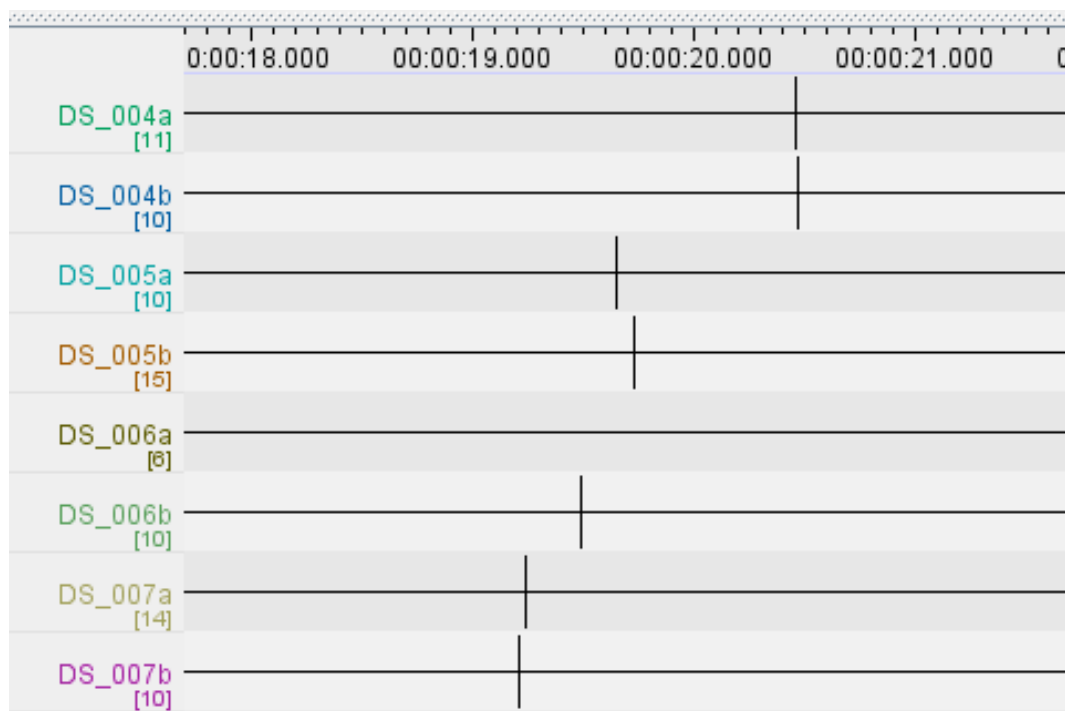
Figure 5.1: Participants' responses as seen in the ELAN annotation viewer

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[19] A third condition was included in this experiment. All participants were asked to segment a spoken English narrative with the sound removed. The results from this condition are not included here and have been left to future research.

The eight tiers pictured in Figure 5.1 are named according to participant type (signers (DS) or non-signers (HN)), participant number (1-6), and whether it was their first or second run ('a' or 'b' respectively). Therefore, the code DS4a (given in the first tier) displays responses by a fourth native signer on their first run. The vertical lines represent a single response by the participant to a specific point in the narrative. This is indicated by the time-line (in seconds) at the top of the annotation viewer in Figure 5.1.

Participants were asked to segment each narrative twice so that intra-participant (within-subject) reliability could be assessed by comparing responses on the two runs of each narrative. This analysis was required to ensure that participants were making a motivated response to the stimulus and were not randomly pressing the button. By offering the participants two opportunities to segment the narratives, it was possible to see clearly whether responses were accidental or misjudged. Responses from separate runs could also provide strong evidence for each participant's ability to identify boundaries in signed narratives. The principles for pairing responses are discussed in detail in section 5.5.5.2.

5.5.4 Identifying boundaries

In the analysis, participants' responses were assessed according to whether they coincided with a set of boundaries. As a first step, boundaries in both the BSL and SSL narrative were identified using a cue based approach and were then verified further in consultation with other sign language linguists.[20]

This cue based approach for identifying boundaries in the signed narratives was based on current sign language literature. That is, a change in head position, blinking and an overall change in facial expression were used to locate boundaries in both narratives. These visual markers associated with boundaries were identified using

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[20] This segmentation of the narrative data is based on an earlier analysis of the data and differs from the analysis presented in Chapter 3. A prosodic analysis that identifies boundaries at the IP level and the U level indicates that the majority of these boundaries correspond to the level of U. An analysis that considers participants' responses in relation to these prosodic boundaries is provided in 5.6.4.3.

the annotation files already available for the narratives.[21] To provide further support for these decisions, the tentative boundaries were then verified by an experienced sign linguist (one for each language). In each case, the linguist was asked to intuitively confirm whether or not a break in the narrative was present at the boundaries identified. In all cases it was agreed that a break was present.

As mentioned in previous chapters, it is important to remember that most of the literature is based on data from other signed languages (such as ASL and ISL) and involves other types of signing (i.e. not narrative signing), so care was taken to be aware of other possibilities.

5.5.5 Principle for associating responses

There is a need to apply a strict principle to coding responses of participants whilst watching the signed narratives so that responses can be analysed as coinciding with boundaries or not. In addition, a further principle is required to ensure that responses made by individual participants over two runs can be said to be in agreement with each other or not. These principles are outlined below.

5.5.5.1 Time windows

The principle for associating a response with a specific boundary is given in Figure 5.2 below.

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[21] The ECHO corpus contains a transcription file for each signed narrative which features annotations by linguists of non-manual and manual features

0.5 seconds ← | → 1 second
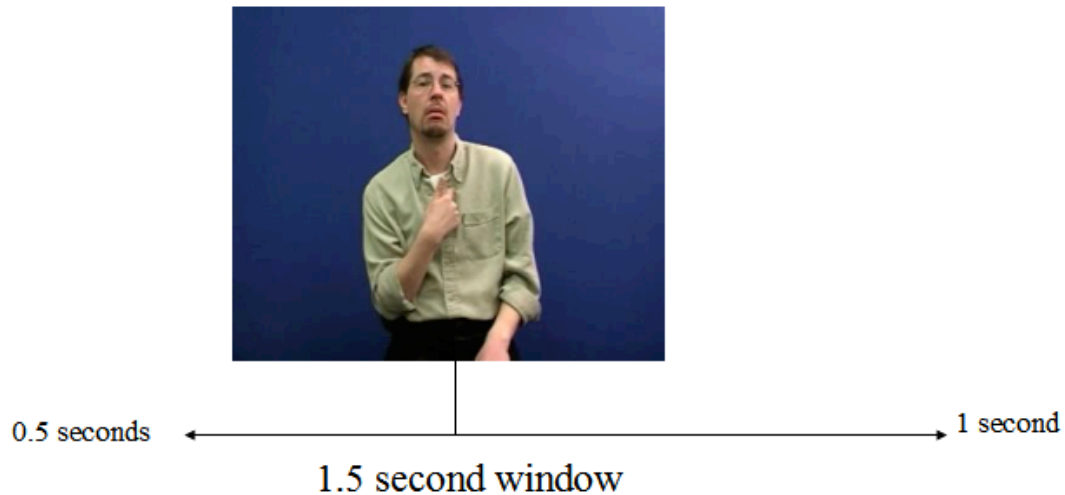
1.5 second window

Figure 5.2: Length of time window assigned to all boundaries

Each boundary was assigned a response time window lasting 1.5 seconds.[22] In order for a response (from a participant) to be associated with a particular boundary, the response must have occurred inside this time window. The reference point for this time window is at the last frame where the handshape of the final sign in a given phrase is held. The time window begins 0.5 seconds before this reference point and is completed one second following it. Once the start and end points of all time-windows had been established, any responses made by participants occurring in these time windows were considered responses to a boundary. Responses by each participant and by groups could then be analysed to see if a pattern could be observed.

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[22] The length of the time window was determined by examining the experimental data several times. Firstly, a two second window (one second before and after the boundary) was applied to all boundaries and the location of participants' responses was counted to see if they coincided with this window. In addition, it was observed that responses occurred more frequently following the boundary. The time window was then shortened to 1.5 seconds (0.75 seconds before and after the boundary) and the differences in the level of responses was calculated. Finally, a one second window was applied (0.5 seconds before and after the boundary) and the differences were counted again. It was found that, for responses occurring before the boundary point, there was little difference in the number of responses between the largest and smallest window. In contrast, the number of responses occurring up to one second after the boundary showed a greater difference when a shorter window was applied. Therefore, based on this finding, the 1.5 second time window was applied to all boundaries in order to accurately represent the distribution of responses.

5.5.5.2 Intra-participant reliability

Intra-participant reliability was assessed by comparing responses made in the first and second run. Responses were paired according to whether a single response on the first run was within 1 second of a single response on the *second* run. These pairs are viewed as responses 'in agreement with each other'. As well as pairing responses, a non-parametric test of significance was used to compare the total number of responses made by each group in the first and second runs. This was to determine whether participants produced a significantly different number of responses on the two runs.

5.6   Results

The results section is divided into two parts: quantitative and qualitative. In the quantitative section, results from each signed narrative will be discussed separately. The results will first present the extent to which participants were in agreement individually (intra-participant reliability), followed by the extent to which participants' responses agreed with the boundaries using the analysis set out in 5.5.4. This is followed by the qualitative analysis which examines the type of markers present at boundaries with high or low levels of agreement.

5.6.1 BSL narrative: a quantitative analysis

In this section, the results from the BSL narrative will be presented first, followed by the results from the SSL narrative in Section 5.6.2. In each case, the quantitative data will be viewed in three different ways: responses from the first run, responses from the second run, and responses that are in agreement (responses that occurred within one second of another response). An overview of responses made in general (i.e. not restricted to boundaries) will be presented before the detailed analysis of responses at boundaries. This will be repeated for each group.

5.6.1.1 Overview of responses

The total number of responses made by the native signers whilst watching the BSL narrative is presented in Table 5.1. Table 5.1 also provides individual scores for each of the six participants in this group. The table is divided so that data from the first run, second run, and for responses in agreement can be seen.

BSL Narrative	1st run	2nd run	In agreement	Total
DS01	20	20	14 (70%)	40
DS02	17	18	12 (69%)	35
DS03	11	11	9 (82%)	22
DS04	11	16	8 (59%)	27
DS05	7	11	2 (22%)	18
DS06	15	11	8 (62%)	26
Total	81	87	53 (63%)	168

Table 5.1: Total number of responses by signers watching the BSL narrative

The results provided in Table 5.1 are not restricted to responses occurring at boundaries but represent responses made across the entire BSL narrative. Intra-participant reliability was assessed using a two-related samples test (Wilcoxon Signed Rank test); no significant difference between the responses in the first and second run was found ($W = 2.5$, $Z = -.92$, $p = .36$). The total number of responses in the first run that occurred within one second of a response in the second run is given in the 'in agreement' column. The actual score in this column represents the number of pairs (one response from the first and second run) and the percentages indicate the proportion of responses in agreement when compared to the total number of responses (responses from the first and second run added together). For each participant (except DS05), it can be seen that the majority of responses were consistent. As a group, 63% of responses recorded were consistent across the two runs.

In Table 5.2, the results from the non-signers watching the BSL narrative are presented:

BSL Narrative	1st run	2nd run	In agreement	Total
HN01	9	12	8 (76%)	21
HN02	15	13	10 (71%)	28
HN03	13	14	7 (52%)	27
HN04	9	11	8 (80%)	20
HN05	14	17	7 (45%)	31
HN06	13	10	9 (78%)	23
Total	73	77	46 (65%)	150

Table 5.2: Total number of responses by non-signers watching the BSL narrative

Once again, these figures show the total number of responses across the entire BSL narrative. To assess intra-participant reliability a two-related samples test (Wilcoxon) was applied and no significant difference in the number of responses recorded from the first and second runs was found (W = 7.5, Z = -.64, p = .52). Like the signers, the non-signers did not differ in the number of responses in the first and second runs. The 'in agreement' column gives the number of pairs found when responses from the first and second runs are compared and the proportional score for each participant and the group. For all non-signers (except HN05), the majority of their responses are consistent. When responses are considered as a group, the proportion of responses consistent across the two runs is 65%.

When overall performance of the two groups is compared, Table 5.1 and Table 5.2 show that the total number of responses is very similar. An independent samples test (Mann-Whitney) was applied to the following pairs: 1. signers and non-signers 1st run; 2. signers and non-signers 2nd run; and 3. signers and non-signers consistent responses. In each case, no significant differences were observed (1. U = 14.5, Z = -.56, p = .60; 2. U = 14.5, Z = -.57, p = .60; 3. U = 13.5, Z = -.74, p = .49).

For this experiment, signers and non-signers do not differ in the number of times they respond (in general) whilst watching a BSL narrative. Nor is a difference observed between the number of responses in the first and second runs for each group. When individual responses are added together, the majority of responses by both groups are consistent across the two runs: 63% for the signers, 65% for the non-signers. However, these figures do not represent the number of responses that occurred at boundaries. This is discussed in the next section where responses made in the first and second runs as well as responses consistent across the two runs are re-examined according to whether they occur at the boundaries identified or not.

5.6.1.2 Responses at boundaries
Linguistic analysis of the BSL narrative revealed 26 boundaries. Each boundary was assigned a 1.5 second window and responses occurring inside these time windows

were associated with a specific boundary. Table 5.3 below presents the number of responses at boundaries for the signers.

BSL Narrative	1st run	2nd run	In agreement	Total
DS01	16	14	13	30
DS02	12	12	12	24
DS03	5	5	5	10
DS04	9	11	8	20
DS05	6	8	1	14
DS06	12	9	8	21
Total	60 (74%)	59 (62%)	47 (88%)	119 (71%)

Table 5.3: Total number of responses at boundaries by signers watching the BSL narrative

As in Table 5.1 and Table 5.2, the numbers in the 'in agreement' columns represent the number of pairs recorded. The group totals for the number of responses at the boundaries identified together with the percentage of the total number of responses made elsewhere in the narrative are provided in each instance. So, for the signers' first run, 74% of responses occurred at a boundary and 26% occurred elsewhere in the narrative. For their second run, 62% of responses occurred at a boundary and 38% occurred elsewhere. A paired sample test (Wilcoxon) revealed no significant differences in the number of responses at boundaries in the first and second run (W = 4, Z = -.38, p = .71). In each column, the majority of responses by the signers occur at the boundaries identified. Of all the percentages recorded, the highest is seen for consistent responses in the two runs. 88% of responses by signers in agreement on the two runs occurred at a boundary in the BSL narrative.

In Table 5.4, responses at boundaries by the non-signing group are presented. As in Table 5.3, the percentages are provided along with the actual figures in the final row.

BSL Narrative	1st run	2nd run	In agreement	Total
HN01	8	11	6	19
HN02	9	9	8	18
HN03	9	7	4	16
HN04	6	8	6	14
HN05	9	12	5	21
HN06	7	5	5	12
Total	48 (65%)	52 (67%)	34 (69%)	100 (66%)

Table 5.4: Total number of responses at boundaries by non-signers watching the BSL narrative

No significant differences were observed between responses in the first and second run (Wilcoxon) (W = 4, Z =-.97, p = .33). In addition, the majority of responses from the non-signers occurred at the boundaries identified. The highest majority observed was for responses in agreement. That is, 69% of responses in agreement occurred at a boundary and 31% occurred elsewhere in the narrative.

When overall performances at boundaries by the two groups are compared, Table 5.3 and Table 5.4 show that the total number of responses is very similar between groups. An independent samples test (Mann-Whitney) was applied to the following pairs: 1. signers and non-signers on the first run; 2. signers and non-signers on the second run; and 3. signers and non-signers in agreement. In each case, no significant differences were observed (1. U = 13, Z = -.82, p = .49; 2. U = 13.5, Z = -.72, p = .49; 3. U = 11, Z = -1.14, p = .31).

When responses at boundaries in the BSL narrative are viewed in isolation, responses from the signers and non-signers are strikingly similar, although the signers (as a group) record a higher total than the non-signers in each instance. In addition, their percentage scores are higher than those of the non-signers, particularly for responses in agreement (88% for signers compared to 69% for the non-signers). However, the non-signers are clearly able to make the majority of their responses at the boundaries identified in this study and no significant differences from the signers are observed.

5.6.1.3 Level of agreement within and between groups

Analysis of responses at boundaries so far has not revealed the number of responses for each individual boundary. Although responses at boundaries in general are revealed to be similar, the number of responses counted at each boundary is not consistent. Rather, they vary between no responses to a unanimous response for each group. What is of interest here is whether the variation in responses is similar across runs and within groups.

To investigate this, the number of responses by a group to each boundary was classed according to whether three participants or more responded (strong), or whether two participants or fewer responded to that boundary (weak). Then boundaries were compared in each run according to whether these categories matched. If a given boundary was classed as 'strong' for both runs, this was identified as a match. If a specific boundary was classed as 'weak' for both runs, this was also identified as a match. However, if a boundary was classed as 'strong' on the first run and 'weak' on the second run (or vice-versa), it was termed 'no match'. All 26 boundaries in the BSL narrative were compared across runs and results for both groups are displayed below.
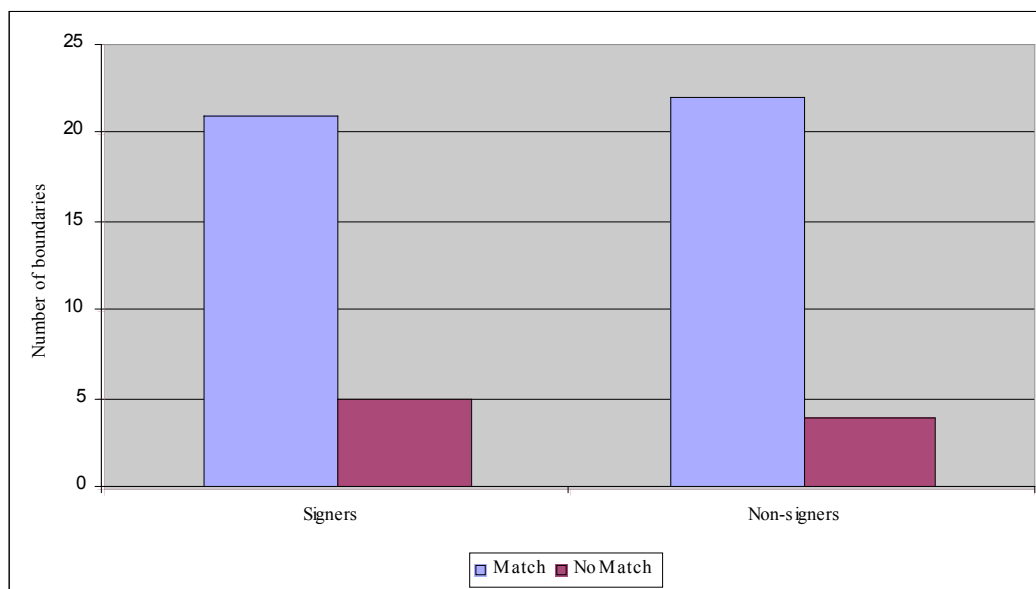
Figure 5.3: Number of matches in the level of agreement within groups (BSL narrative)

In Figure 5.3, the graphs show that level of response at boundaries was similar across runs for both groups. In general, if a given boundary was classed as either strong or weak by one group in the first run, a similar level of response was observed in the second run by the same group. In a few cases (5 boundaries out of 26 for the signers and 4 boundaries out of 26 for the non-signers), the level of responses did not match. For matched boundaries, the number of 'strong' matches is fewer than the number of 'weak' matches (8 out of 21 matches are strong boundaries for the signing group and 6 out of 22 matches for the non-signing group). Therefore only a small number of boundaries featured a high level of agreement on both runs overall.

To see whether the level of agreement is similar between groups at all boundaries, this analysis was repeated this time comparing the level of responses by groups in both runs. If a specific boundary was classed as 'strong' for both groups on the same run, it was labelled a match. Similarly, if another boundary was classed as 'weak' for both groups on the same run, it was also labelled as a match. If a boundary was classed as 'strong' for one group and 'weak' for the other group, this was labelled as 'no match'. The results are provided in Figure 5.4 below for each run.
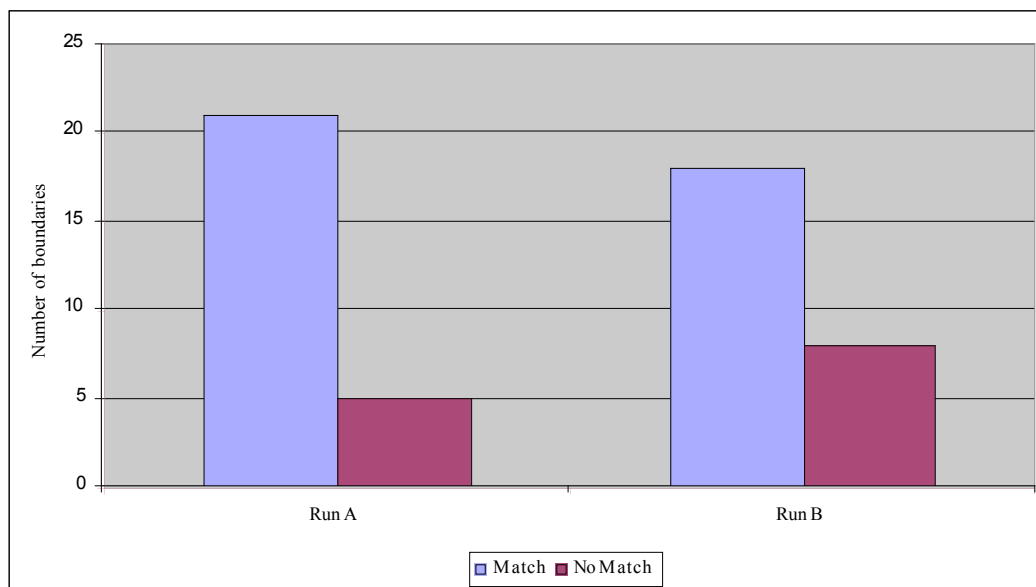
Figure 5.4: Number of matches in the level of agreement between groups (BSL narrative)

Figure 5.4 shows more 'matches' than 'no matches' in both runs. In general, if one group showed a high level of agreement at one boundary, the other group also logged a high level of agreement at the same boundary. If one group showed a low level of agreement to a boundary, this was also observed for the second group. Again, there are fewer matches involving strong boundaries (7 out of 21 boundaries in the first run and 5 out of 18 boundaries in the second run).

Although the results from this section are too small to make any definite conclusions, they suggest that there is consistency in the level of agreement to boundaries within and between groups. In other words, boundaries that were identified by three or more participants in the first run were also identified by a similar number in the second run. Additionally, boundaries that received a low number of responses in the first run also received a low number in the second run. This patterning was also observed between groups. Therefore, it can be suggested that the non-signers are responding in a similar way to the signers. Boundaries that record a high or low level of agreement between the non-signers also record a similar level of response by the signers. Finally, a high level of agreement is seen at a small number of boundaries.

5.6.1.4 Compared against simulated data

Since the length of time windows added together represent a large proportion of the BSL narrative, random pressing of the keys could have coincided with boundaries simply by chance. Therefore, responses from both groups were compared to simulated data to determine whether either group responded to boundaries at a level significantly higher than that predicted by random pressing. The simulated data was generated by recreating the set-up of the experiment in Excel. To better reflect the variation in responses between groups, two conditions of simulated group data were created: signers watching the BSL narrative, and non-signers watching the BSL narrative.

Firstly, the number of 1.5 second time windows contained within the narrative was calculated (length of narrative divided by 1.5 seconds). An Excel spreadsheet was

then was created where X number of columns represented X number of time windows. Secondly, the average number of responses for each group watching the narrative in question was calculated. Using an Excel spreadsheet, each row of randomly distributed data (across X numbers of columns representing time windows) represented one subject. For each row the average number of button presses (according to the group in question) was randomly distributed across the number of time windows (or columns). For each spreadsheet, simulated data involving 300 'participants' was created. So, each condition had a spreadsheet of 300 rows containing randomly distributed data representing 300 'participants'.

Since analysis of the data involved examining the number of responses at boundaries, the next step was to determine the likelihood that responses would occur in a specified number of columns (or time windows). To do this, X number of columns (or time windows) were selected at random (using the =(RAND) and 'sort' function in Excel) to represent boundaries. The total number of 'responses' that randomly occurred at these time windows and the average number of responses occurring within the specified set were then calculated for all rows.

When the above procedure is applied to the BSL narrative, two Excel spreadsheets with 57 columns (or time windows) representing the full length of the BSL narrative are created. For each spreadsheet (one for each group), the average number of responses for each group was calculated (14 responses on average per participant in the signing group and 13 responses on average per participant in the non-signing group) and distributed randomly within each of the 300 rows. Following random distribution, 26 columns were chosen at random from 57 columns (using the =(RAND) and 'sort' function in Excel) to represent boundaries and the number of responses that occurred at these intervals was counted. Since responses tended to cluster at particular boundaries (called 'strong' boundaries), a further 13 boundaries (from the 26 already selected) were chosen at random to represent boundaries where there was a high level of agreement. The number of responses that fell at these intervals was then counted. Analysis of the simulated data revealed an identical average for both groups. That is, an average of 6 responses per participant occurred

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at time windows representing all boundaries by chance, and at 'strong' boundaries, an average of 3 responses per participant occurred at these intervals. These constitute a chance level of response for all and strong boundaries respectively.

In order to test whether responses at boundaries in general were occurring at a level above chance, a non parametric between-groups test (MannWhitney) was applied to the following pairs: 1. random group vs. signers and 2. random group vs. non-signers. For random group vs. signers, a significant difference was found for responses occurring at all 26 boundaries on the second run only (1. $U = 9$, $Z = -1.6$, $p = .18$ (1st run); $U = 6$, $Z = -2.05$, $p = .04$ (2nd run)). For random group vs. non-signers, responses were significantly higher than chance level on the first run only (2. $U = 3$, $Z = -2.7$, $p = .01$ (1st run); $U = 6$, $Z = -2.06$, $p = .07$ (2nd run)). When responses at 'strong' boundaries are compared to random data, a significant difference is observed for the signers (for the 1st and 2nd runs: $U = 0$, $Z = -3.08$, $p = .002$) and the non-signers ($U = 0$, $Z = -3.09$, $p = .002$ (1st run); $U = 0$, $Z = -3.1$, $p = .002$ (2nd run)). Overall, responses at boundaries were not always above chance level. However, responses to 'strong' boundaries were consistently at a significant level above random pressing for both groups.

5.6.1.5 Summary of results

Analysis of responses made by the signers and non-signers whilst watching the BSL narrative reveal no significant differences. In addition, intra-participant assessment revealed no difference in the responses in the first and second runs for both groups. For both groups the majority of responses were in agreement (63% for the signers and 65% for the non-signers). Analysis showed that for both groups the majority of responses were made at boundary points in both runs, with the highest level of intra-subject consistency found in the signer group (88% of signers' responses and 69% of non-signers' responses). The two groups do not differ in the number of responses at boundaries when statistical tests are applied to the data. Further analysis of the results was carried out against simulated data in order to determine if results occurred at a level significantly greater than chance. Responses occurring at a specific set of boundaries (boundaries exhibiting a high level of agreement) were

found to be significant for both groups consistently. This result was seen for both the first and second run. In summary, responses by the signers and non-signers are very similar.

5.6.2 SSL Narrative: a quantitative analysis

In this section, data collected from participants watching the SSL narrative will be reported. Firstly, responses by both groups will be described in general and presented in the same format as in the BSL narrative results section. Secondly, results for responses at boundaries will be presented and compared against random group data. Finally, results for both groups watching the SSL narrative will be summarised.

5.6.2.1 Overview of results

Responses by the signers when watching the SSL narrative are presented in Table 5.5 below. Table 5.5 displays the number of responses for the first and second runs, responses occurring in agreement, and the total number of responses recorded (first and second runs added together). As in earlier tables, individual scores for each of the six participants are provided.

SSL Narrative	1st run	2nd run	In agreement	Total
DS01	15	19	11 (65%)	34
DS02	11	13	9 (75%)	24
DS03	11	11	6 (55%)	22
DS04	14	15	10 (69%)	29
DS05	14	9	7 (61%)	23
DS06	10	11	5 (48%)	21
Total	75	78	48 63%)	153

Table 5.5: Total number of responses by signers watching the SSL narrative

The figures displayed here represented the total number of responses occurring across the entire SSL narrative and not just those occurring at boundary points. No significant differences were observed between the number of responses in the first and second runs when intra-participant consistency was assessed (Wilcoxon, W = 5, Z = -.68, p = .50). Native signers of BSL made a similar number of responses in the first and second runs whilst watching the SSL narrative. Figures in the 'in

agreement' column represent pairs of responses in the same location observed for each participant. Except for one participant (DS06), the majority of BSL signers' individual responses could be paired. When responses as a group are considered, the majority of responses are recorded as being in agreement (63%).

Responses by the non-signers whilst watching the SSL narrative are displayed in Table 5.6 below:

SSL Narrative	1st run	2nd run	In agreement	Total
HN01	6	9	5 (67%)	15
HN02	11	12	8 (70%)	23
HN03	10	7	7 (82%)	17
HN04	13	13	12 (92%)	26
HN05	22	22	8 (36%)	44
HN06	15	13	11 (79%)	28
Total	77	76	51 (67%)	153

Table 5.6: Total number of responses by non-signers watching the SSL narrative

A paired samples test found no significant differences between responses in the first and second runs (Wilcoxon, W = 5.5, Z = -.18, p = .85). In other words, the total number of responses made by non-signers in the first and second runs is similar. For all non-signers (except HN5) the majority of responses were consistent across the two runs. When responses as a group are considered, the proportion of paired responses is 67%.

When responses by the non-signers were compared to the BSL native signers, no significant differences were observed. An independent samples test (Mann-Whitney) was applied to the following pairs: 1. signers and non-signers 1st run; 2. signers and non-signers 2nd run; and 3. signers and non-signers in agreement. In each case, no significant differences were observed (1. U = 17, Z = -.16, p = .94; 2. U = 16.5, Z = -.24, p = .82; 3. U = 15.5, Z = -.4, p = .70).

However, the results presented in Table 5.5 and Table 5.6 does not consider only those responses occurring at boundaries but are for responses occurring at any point

in the SSL narrative. Responses occurring at boundaries will be discussed in the next section to determine whether any differences between groups can be seen.

5.6.2.2 Responses at boundaries

Linguistic analysis of the SSL narrative revealed 21 boundaries. Each boundary was assigned a 1.5 second window in which responses had to occur in order to be associated with that particular boundary. In this section, responses made by both groups at these 21 boundaries are presented and analysed.

Table 5.7 displays the number of responses at boundary points made by signers.

SSL Narrative	1st run	2nd run	In agreement	Total
DS01	10	10	9	20
DS02	9	10	7	19
DS03	3	6	3	9
DS04	8	9	7	17
DS05	9	7	6	16
DS06	7	10	5	17
Total	46 (61%)	52 (67%)	37 (77%)	98 (64%)

Table 5.7; Total number of responses at boundaries by signers watching the SSL narrative

In the final row, the actual figures and the percentage of responses at boundaries out of the total number of responses made in the SSL narrative (Table 5.5) are provided. A paired samples test found no significant differences between responses occurring in the first and second run (Wilcoxon, W = 3, Z = -1.23, p = .22). That is, signers do not mark a different number of boundaries in the first and second run. In each case, when overall scores are considered, the majority of responses made by signers occur at boundaries. The highest figure is observed with paired responses (77%).

The number of responses at boundaries made by the non-signers whilst watching the SSL narrative is provided in Table 5.8 below.

SSL Narrative	1st run	2nd run	In agreement	Total
HN01	3	7	3	10
HN02	7	9	7	16
HN03	10	7	7	17
HN04	9	10	9	19
HN05	14	11	10	25
HN06	7	7	5	14
Total	50 (64%)	51 (67%)	41 (80%)	101 (66%)

Table 5.8: Total number of responses at boundaries by non-signers watching the SSL narrative

As in Table 5.7, the total figures and percentages (when figures are compared to Table 5.6) are provided in the final row. A paired samples test found no significant differences in the total number of responses made in the first and second run (Wilcoxon, W = 7, Z = -.14, p = .89). Non-signers do not differ in the number of boundaries identified in the two runs. In each case, the majority of responses made by non-signers occur at a boundary. As seen with the signers, the highest percentage is observed with responses occurring in agreement with each other (80%).

When responses at boundaries by the non-signers are compared to the signers, no significant differences are observed. An independent samples test (Mann-Whitney) was applied to the following pairs: 1. signers and non-signers on the first run; 2. signers and non-signers on the second run; and 3. signers and non-signers in agreement. In each case, no significant differences were observed (1. U = 17, Z = -.16, p = .94; 2. U = 17.5, Z = -.16, p = .94; 3. U = 14.5, Z = -.57, p =.60).

Again, responses in the first and second run and for those in agreement are very similar for both groups. That is, no significant differences can be seen between groups when responses at boundaries are considered. On a whole, the number (and location) of responses made by both groups whilst watching the SSL narrative are very similar.

5.6.2.3 Level of agreement within and between groups

To determine whether groups respond in a similar way to the same boundaries in both runs, the number of responses to each boundary was compared (as outlined in

5.6.1.3). Firstly, boundaries were classed according to whether they were 'strong' (featured three responses or more) or 'weak' (two responses or fewer). The same boundary was compared across runs for each group to determine whether the level of agreement matched (the same boundary on separate runs was either both 'strong' or both 'weak) or did not match (the same boundary on separate runs was both 'strong' and 'weak').
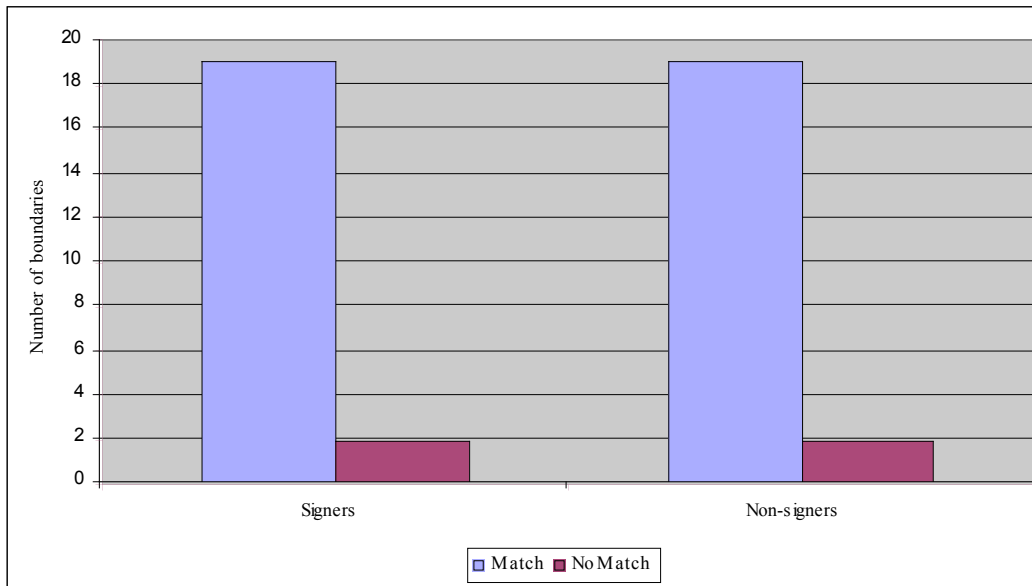
Figure 5.5: Number of matches in the level of agreement within groups (SSL narrative)

Figure 5.5 above shows the number of matches and no matches for each group's responses to boundaries in the first and second run are compared. For both groups, the number of matches exceeds the number of 'no matches'. If a group responded to a boundary at a high or low rate in the first run, they will respond to the same boundary in the second run at the same rate. In general, responses to boundaries within groups across the SSL narrative can be said to be consistent. The number of 'strong' matches is 8 out of 19 overall for both groups. In other words, only 8 boundaries in the SSL narrative showed a high level of response from both groups separately. This analysis is repeated below but this time comparing the level of responses between groups in each run.
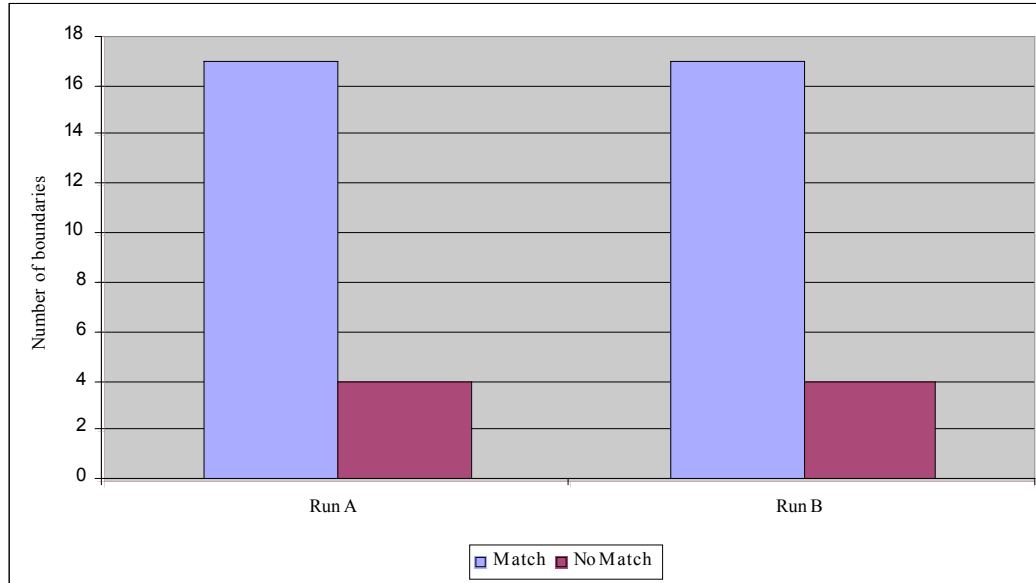
Figure 5.6: Number of matches in the level of agreement between groups (SSL narrative)

Figure 5.6 above shows the number of 'matches' exceeds the number of 'no-matches' when responses between groups are compared. This finding is replicated for both runs. In other words, where a high or low number of responses to a given boundary are recorded by one group, it is likely that the second group will respond in a similar way. Less than half of matched boundaries (7 out of 17) were paired as 'strong'. These results suggest that the signers and non-signers respond to the same boundaries in a similar way whilst watching the SSL narrative. The findings in this section are further verified by the comparison to simulated data below.

5.6.2.4 Comparison to simulated data

To establish whether the responses of both groups are significantly more accurate than would be found with random pressing, random group data was created in Excel for both groups and statistical tests were carried out (as for the BSL narrative).

Partitioning of the SSL narrative created 59 time windows (length of narrative divided by 1.5 sec time windows). The average number of responses in general for each group was the same (13) so only one random group was created. 300 rows (representing 'participants') were created in an Excel spreadsheet and 13 responses were randomly distributed in each row (using the =RAND and 'sort' function in

Excel). Since analysis of the SSL narrative revealed 21 boundaries, 21 columns from 59 columns were chosen at random in each spreadsheet to represent boundaries and integers that occurred in these columns were then counted. A further 12 columns (from the 21 columns already selected) were chosen at random to represent 'strong' boundaries. The number of integers occurring in these columns was also counted. Following creation of simulated data, it was calculated that an average of 5 responses per participant occurred at 21 boundaries and 3 responses on average occurred at 'strong' boundaries. These figures represent the chance-level of a response at all boundaries and at 'strong' boundaries respectively.

To test for significance, all data were subjected to a non-parametric between-groups test (Mann Whitney): random data vs. signers and random data vs. non-signers. For random data vs. signers, a significant difference was not observed for responses occurring at (a) all 21 boundaries but was observed at (b) 'strong' boundaries for the first run ((a) $U = 6$, $Z = -2.06$, $p = .06$; (b) $U = 3$, $Z = -2.68$, $p = .02$). A significant difference for responses in the second run at all boundaries ($U = 0$, $Z = -3.1$, $p = .002$) and at 'strong' boundaries only ($U = 0$, $Z = -3.09$, $p = .002$) was found. For random data vs. non-signers on the first run, a significant difference was not observed for responses at all 21 boundaries ($U = 6$, $Z = -2.06$, $p = .07$) but was observed at 'strong' boundaries ($U = 3$, $Z = -3.1$, $p = .002$). For the second run, responses at 21 boundaries (a) and at 'strong' boundaries (b) were significantly different to chance pressing ((a) $U = 0$, $Z = -3.1$, $p = .002$ (b) $U = 0$, $Z = -3.11$, $p = .002$). Although responses to boundaries in general are mixed, this is not true for responses to 'strong' boundaries. That is, signers and non-signers consistently perform at a level above that which would be observed by random pressing.

5.6.2.5 Summary of results

Signers and non-signers do not differ in the total number of responses whilst watching the SSL narrative as a whole and at specific boundaries. In addition, no differences are seen for either group when the number of responses in the first and second run is compared. For both groups the majority of responses in the first run occur within one second of a response in the second run (63% for the signers and

67% for the non-signers). For each group, the majority of responses coincided with a boundary in the SSL narrative. The highest percentage of responses recorded at boundaries was for responses in agreement (77% for the signers and 80% for the non-signers). When responses at boundaries are compared, there are no significant differences between groups. In addition, when compared to simulated data, a significant difference from chance pressing is observed for responses during the first and second runs. That is, responses recorded at strong boundaries occurred at a level significantly higher than chance for both groups. In sum, responses between groups whilst watching the SSL narrative are very similar.

5.6.3 Discussion of quantitative analysis

The results from the quantitative analysis indicate that the narratives and the partitioning of the narratives may not reveal a simple relationship between participants' responses and the boundaries identified for the purposes of this study. The number of time windows (1.5 seconds) that represent boundaries is about half of the total number of possible time windows present in each narrative: 26 intervals out of a possible 53 in the BSL narrative and 21 out of a possible 59 in the SSL narrative. Thus, a significant difference from chance-level is not always observed when analysing responses occurring at all boundaries (as seen when responses at boundaries in general for the BSL narrative are compared to simulated data). However, a significant difference from chance-level is observed when boundaries showing a high level of agreement amongst participants are isolated. This group of boundaries for both the BSL and SSL narratives differs significantly from simulated data. That is, the totals at boundaries showing a high level of agreement could not have occurred by random button-pressing whilst watching the signed narrative but were motivated responses.

Several important conclusions can be made here. Firstly, BSL signers agree on where the boundaries lie in a signed BSL narrative. Their responses coincided with the linguistic analysis and subsequent partitioning of the BSL narrative. In addition, the proportion of paired responses (where participants marked the same points on both runs) at boundaries in general was high (88%). Non-signers also showed

themselves to be able to correctly indicate boundaries in the BSL narrative, with the majority of their paired responses occurring at boundaries in general (69%). Comparative analysis of the number of responses at boundaries in general for their first and second runs and of paired responses by the two groups showed no significant differences overall. In this experiment, native signers of BSL and non-signers are shown to respond in a similar way when segmenting a BSL narrative in real time. This suggests that although the two groups have access to different sets of cues when marking boundaries, there are no differences in their identification of boundaries. The experiment thus suggests that visual markers are highly informative since they can be used in a reliable way to indicate boundaries by those who do not know the language.

The observations made in the previous paragraph are further supported by the results from the SSL narrative experiment. Both the BSL signers and the non-signers produced a large number of paired responses, with the majority of these paired responses at boundaries (77% for the signers and 80% for the non-signers). In addition, when the groups are compared (the total number of responses at boundaries in the first and second runs and the total number of paired responses), no significant differences are observed. In this experiment, signers and non-signers respond in a similar way when both watch a narrative in an unknown sign language. This implies that signers do not have an advantage over non-signers when segmenting an unknown sign language. That is, their language experience and knowledge of how signed languages are structured in general does not help them when asked to indicate boundaries in an unknown signed narrative in real time. Furthermore, the high percentage of alignment of responses with boundaries in the SSL narrative indicates (together with results from the BSL narrative) that visual markers are highly informative of boundary position since they can be used in a reliable way by both groups to parse a narrative.

Although a significant value has been obtained for response at strong boundaries, it is important to remember that the number of participants to each group is small and therefore the statistical power (the probability that the tests will correctly reject the

null hypothesis) of the between group tests is low. Therefore, the experiment needs to be tested with a large number of participants to further verify the claims made here. Some suggestions are made in Section 7.4 on how to adjust the research design to achieve the desired statistical power.

Although thus far responses at boundaries in general have been examined, it must be remembered that participants were not asked to identify all breaks in signing but rather to indicate sentence boundaries. The results show that responses tended to cluster at some boundaries (those that might have coincided with the end of a sentence). This tendency was also observed amongst the non-signers. Since non-signers rely on visual markers alone to indicate boundaries, this raises questions about the characteristics of markers at boundaries that attracted a high level of responses. What type of markers can be seen at these boundaries that make them more prominent than others? These questions will be answered in the following section where a qualitative analysis of boundaries is conducted.

In conclusion, when the hypotheses set out at the beginning of this chapter are revisited, the null hypothesis has been disproved for both conditions. In the BSL and SSL narratives, responses by both groups of participants cluster at a specific subset of boundaries at a level greater than that which would occur with random button-pressing. Furthermore, this experiment has shown no difference between signers and non-signers in the rate at which both groups indicate boundaries in both narratives and therefore can be said to fit Hypotheses 1b and 2b. Finally, Hypotheses 1c and 2c have not been supported. Native signers do not out-perform non-signers in this experiment.

5.6.3.1 Summary

When the frequency of responses at boundaries whilst watching the BSL and SSL narratives are compared, signers and non-signers do not differ significantly. This experiment shows that although the two groups may be using different sets of cues to identify boundaries, signers and non-signers respond in a similar way. This suggests that visual markers are highly informative of boundary position.

5.6.4 Qualitative analysis

This section is divided in two parts: an analysis of the type of boundary identified by participants and a presentation and discussion of the types of visual markers found at boundaries with different levels of agreement in both narratives.

In the previous section, it was shown that some boundaries attracted a high number of responses from both groups in comparison to other boundaries. What makes these boundaries different from others so that they can be identified correctly by those who do not know the language? Since non-signers are unable to use cues deriving from grammar, the answer must lie in the type or number of visual markers coinciding with these boundaries. In this section, an in-depth analysis of visual markers present at boundaries that attracted a high or low level of agreement will be presented. In addition, the qualitative analysis will also attempt to determine the type of boundary identified by participant. Specifically, the analysis will determine whether the boundaries identified frequently coincide with a prosodic constituent at a certain level (e.g. intonational phrase or phonological utterance) or may be better characterised as a discourse boundary.

To strengthen the analysis, this section will only focus on paired responses, that is, boundaries that each participant responded to twice. If a boundary was identified on both runs by three or more subjects in a group, it was classed as a boundary with a high level of agreement. These amounted to 7 boundaries (out of a possible 26) for the BSL narrative and 9 boundaries (out of a possible 21) in the SSL narrative. In the following section, boundaries classed as weak boundaries - at which there were no paired responses from either group - will also be examined in order to determine the differences between strong and weak boundaries.

5.6.4.1 Strong boundaries

In the following example from the BSL narrative, a boundary is marked by a change in torso and head position (the parentheses reflect the location of the boundaries as identified for the experiment reported in this chapter).

| TWO-OF-US | OKAY | HARE | LAUGH |

[TWO-OF-US RACE TWO-OF-US OKAY] [HARE LAUGH TWO-OF-US RACE TRUE LAUGH OKAY]

'Say, let's have a race okay?' The hare laughed out loud. 'Are you serious?' (he asked). 'Okay then, let's have a race

Figure 5.7: Change in torso and head position marks a boundary in the BSL narrative (1)

As well as a change in torso and head position, this boundary is also marked by a head nod on OKAY and a blink. The head nod occurs just before the change in head and torso position and the blink is synchronous with the change in head position. This boundary is marked with a high level of agreement by both groups: 4 pairs by the signers and 3 pairs by the non-signers. The change in torso and head position is also a narrative device marking a change in role, from the tortoise to the hare. The initial position of the torso (to the narrator's right), which marks the role of the tortoise, began with the start of the fourth boundary in the BSL narrative and was held over a fifth boundary before ending at the sixth boundary, shown above in Figure 5.7. Interestingly, no paired responses were observed at the fifth boundary from either group where torso and head position spread over the boundary (see the section on weak boundaries below). When the narrator changes position (to his left), the new position of the torso and head mark the role of the hare and coincide with the following boundary, as illustrated in Figure 5.8 below.

| FIRST | PROOF | OKAY | PALM-UP |
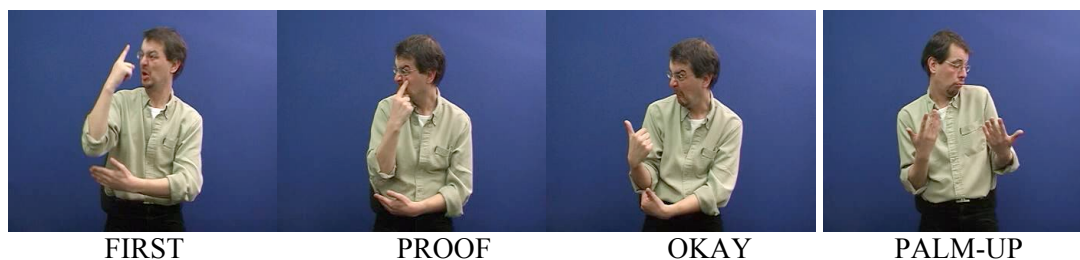
[BUT LET-KNOW OVER-THERE LINE FINISH IX WHO WHICH ARRIVE
FIRST PROOF OKAY] [PALM-UP PLEASE-YOURSELF]
*'Over there is the finish line. Whoever gets there first is the winner okay?' 'Okay, if
you please!' (said the tortoise).*

Figure 5.8: Change in torso and head position marks a boundary in the BSL narrative (2)

As well as a change in torso and head position, this boundary was also marked by a
head nod, a blink, a change in brow position and a hold on OKAY. These visual
markers occurred both simultaneously and sequentially at the boundary above. For
example, the head nod is articulated over the hold on OKAY. Following the nod and
hold, the change in head, torso, and brow position are all articulated simultaneously.
This boundary attracted a high level of agreement from both groups: 5 pairs by the
signers and 5 pairs by the non-signers. The position of the torso and head have their
onset in the example given in Figure 5.7 and were held over a boundary before a
change in position after OKAY in Figure 5.8. The boundary over which the torso
and head position were held produced no paired responses (see weak boundaries
below). Responses can therefore be shown to co-occur with changes in position
corresponding to these two (large) articulators. The same observation can be made
for the SSL narrative, as in Figure 5.9 below.[23]

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[23] Examples taken from the SSL narrative will be presented with the English gloss provided by the
annotation files from the ECHO project (Bergman & Mesch, 2004).

| TO-YOU | EAR | PALM-UP | NO |

[SEEM IX TELL SOMETHING SECRET TO-YOU EAR PALM-UP] [NO NOT SPECIAL]
He must have told you a secret?' (asked the friend) 'No, it was nothing really' (replied the friend).

Figure 5.9: Change in torso and head position marks a boundary in the SSL narrative

In Figure 5.9, a boundary in the SSL narrative is marked by a change in torso and head position moving from the narrator's right to the left. Other visual markers that coincide with this boundary are a change in brow position and a blink at the end of the phrase. As in the BSL narrative, the change in torso and head position marks a change in role (from one friend to the other in the story). This boundary was identified with a high level of agreement: 5 pairs of signers and 3 pairs of non-signers. However, torso leans were infrequent in the SSL narrative when compared to the BSL narrative (only 7 instances of torso activity in total).

In Figure 5.10 below, a change in head position marks a boundary in the SSL narrative.

| HEART-BEAT | LAY-SILENT | BEAR | BEAR-APPROACHES |

[HEART HEART-BEAT WISH SILENT IX HEART-BEAT LAY-SILENT]
[BEAR BEAR-APPROACHES]
He wished his heart wouldn't beat so loud. The bear came up…

Figure 5.10: Change in head position marks a boundary in the SSL narrative (1)

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This boundary is also marked by a change in eyebrow position and a hold on the final sign in the phrase (lay-silent) which was 1.5 times longer than a phrase-internal sign. There is no change in torso position. In this example, the initial position of the head represents an action by the character - the act of lying down on the ground. The head is returned to a neutral position following the boundary and remains in position over the sign BEAR. The change in head position can be said to represent a change in role (from the character in the story to the narrator role). This boundary is marked with a high level of agreement: 3 pairs by the signers and 5 pairs by the non-signers.

At strong boundaries, not all changes in head position mark a change in role as seen in Figure 5.11 below.

| CLIMB-DOWN | OUT-OF-BREATH | SEE | BEAR |
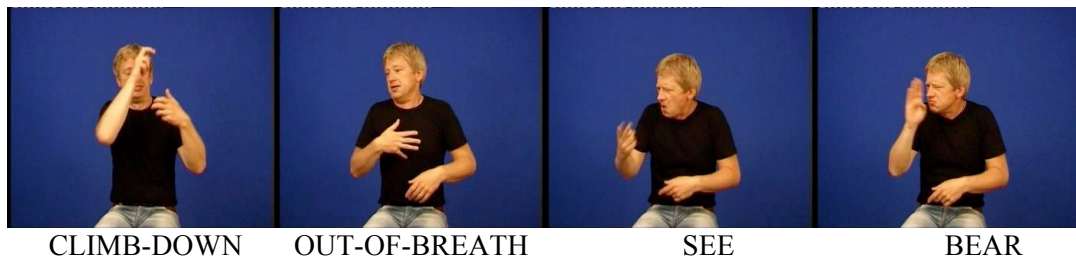
[IX CLIMB-DOWN OUT-OF-BREATH] [IX SEE BEAR NOSE-SNIFF POSS EAR]
The friend came down from the tree 'I saw the bear sniffing close to your ear' (he said).

Figure 5.11: Change in head position marks a boundary in the SSL narrative (2)

Following the boundary, the head is brought down and slightly forward in the second phrase. This boundary is also marked by a hold on the last sign OUT-OF-BREATH and a change in brow position. There is no change in torso position. This boundary attracted a high level of agreement: 2 pairs from the signers and 4 pairs from the non-signers. The change in head position does not indicate a change in role but a change in the attitude of the character to an interrogative state. As well as a change in head and torso position, other visual markers (such as a change in facial expression) can be shown to occur at strong boundaries. These also include pauses and lengthened signs which are discussed below.

A recurring visual marker present in boundaries with a high level of agreement is a strong pause where there is no signing and the hands are returned to the narrator's lap or joined together. In the following example from the BSL narrative, a boundary is signalled by a strong pause. This was classed as a strong pause because the hands were dropped to the lap at the end of the phrase.

| NEVER-MIND | IX | TELL-STORY | drop-hands |
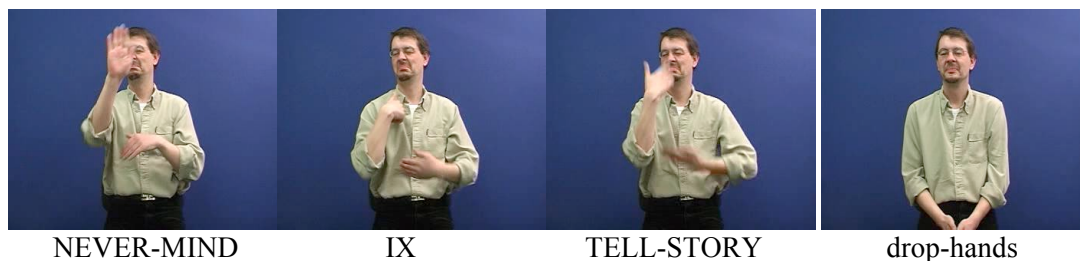
[NEVER-MIND IX TELL-STORY]
Don't worry, I'll tell you the story.

Figure 5.12: Strong pause marks a boundary in the BSL narrative (1)

Other markers present at this boundary are a head nod and a boundary blink. Four paired responses from the signers and 2 pairs from the non-signers were found. This marker (a strong pause with drop-hands) is also present at a second boundary in the BSL narrative (the final boundary in the narrative). This can be seen in Figure 5.13 below.

| TAKE-EASY | ACHIEVE | PALM-UP | drop-hands |

[AS-YOU-GO TAKE-EASY ACHIEVE PALM-UP]
… take your time and you'll achieve your goal.

Figure 5.13: Strong pause marks a boundary in the BSL narrative (2)

This boundary was also marked by a boundary blink, and a change in head position. There was also a hold on the PALM-UP sign which was 1.5 times longer than a phrase-internal sign. This boundary also attracted a high level of agreement from

both groups: 3 pairs from the signers and 6 pairs from the non-signers. In addition, the same marker, a strong pause with drop-hands, can be found at boundaries in the SSL narrative as below:

| FRIEND | AND | BEAR | drop-hands |
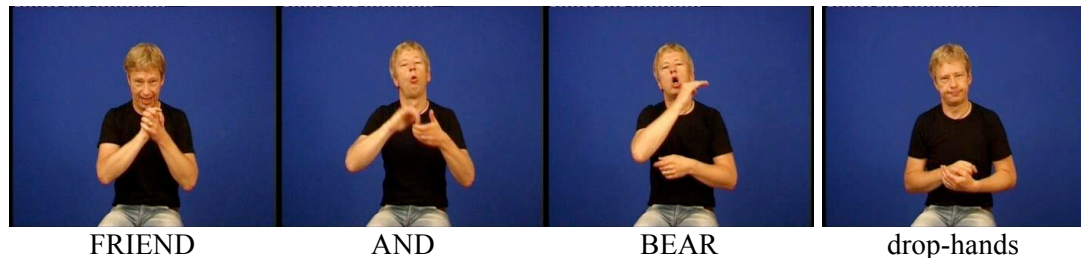
[TWO FRIEND AND BEAR]
...two friends and the bear.

Figure 5.14: Strong pause marks a boundary in the SSL narrative

This boundary also featured a head nod and a boundary blink. As in the BSL narrative, this boundary attracted a high level of agreement within both groups: 5 pairs from the signers and 5 pairs from the non-signers. This marker is also present in the final boundary in the SSL narrative and is also marked by a high majority of participants in both groups: 5 signers and 6 non-signers.

However, it is not always the case that participants' responses are aligned with strong pauses. In Figure 5.15 below, a strong pause follows a boundary in the BSL narrative.

| …TORTOISE | SAID | PALM-UP | drop-hands |

[TORTOISE SAY PALM-UP]
The tortoise said to the hare 'there you go'.

Figure 5.15: Strong pause follows a boundary in the BSL narrative

In Figure 5.15, the boundary is marked first by a hold on PALM-UP followed by a return to a neutral torso position and finally a strong pause. The hold on PALM-UP

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was three times longer than a phrase-internal sign. This boundary recorded a high level of agreement for both groups: 4 pairs by signers and 5 pairs by non-signers. However, all responses were made before the onset of dropping the hands to the lap which followed the articulation of the sign PALM-UP. This example illustrates that visual markers marking boundaries often occur sequentially and that it can be difficult to determine which marker is the primary trigger of a response.

Signs that are lengthened also feature frequently amongst boundaries with a high level of agreement, as seen in Figure 5.15 above. Again, this can be observed in the SSL narrative below:

NEVER	ATTACK	SOMEONE	DEAD
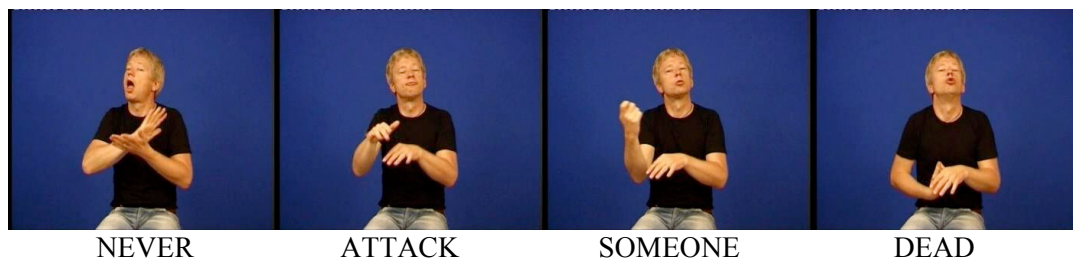
[BEAR NEVER ATTACK SOMEONE DEAD]
  …that bears won't attack a dead body.

Figure 5.16: Hold marks a boundary in the SSL narrative

A hold is observed on DEAD, which was twice as long as a phrase-internal sign. As well as a hold on the final sign, this boundary is also marked by a head nod, a change in brow position and a blink, and attracted a high level of agreement: 5 pairs from the signers and 5 pairs from the non-signers.

Holds represent one type of lengthened signs that can occur in phrase-final position. In the following example taken from the BSL narrative, the final sign is lengthened by extending the path of the sign and the number of repetitions.

| TORTOISE-CRAWL | IX | TORTOISE-CRAWL | ARRIVE ----- |

[TORTOISE-CRAWL IX TORTOISE-CRAWL ARRIVE]
The tortoise was crawling along at a slow pace and saw the hare asleep by the side of the track. Crawling along he neared the finish line.

Figure 5.17: Lengthened sign marks a boundary in the BSL narrative

As well as the lengthened sign ARRIVE, this boundary was also marked by a head nod and a blink. The lengthened sign was 3 times longer than a phrase internal sign. This boundary attracted a high level of agreement: 4 pairs from the signers and 2 pairs from the non-signers. Other examples featuring holds and lengthened signs, occurring at boundaries suggest that signers and non-signers attend to the temporal organisation of a signed utterance. This is discussed at the end of this chapter.

In addition to visual markers coinciding at boundaries, other markers that have not been considered in detail can be indicative of boundary position. One such example are list buoys (as explained in 2.5.2). In Figure 5.18 below, taken from the SSL narrative, a list buoy occurs in phrase-initial position.

| IX (buoy) | FRIEND | FLEE |
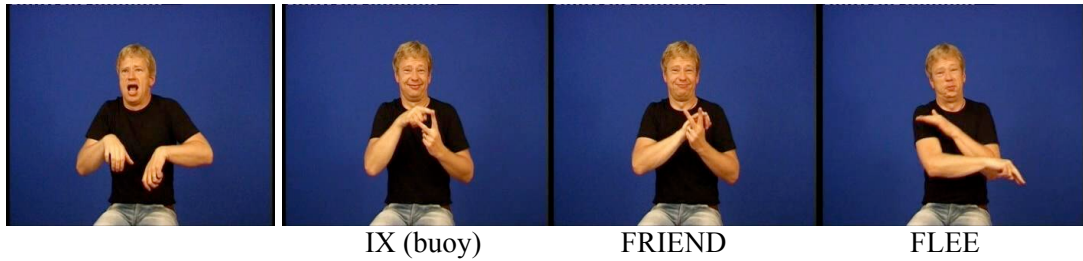
[CATCH-SIGHT-OF IX BEAR BEAR-CRAWL BEAR-APPROACH] [IX FRIEND IX FLEE…]
...when suddenly they saw a bear coming towards them. One of the men ran to the nearest tree and quickly scrambled up it.

Figure 5.18: List buoy marks a boundary in the SSL narrative

A boundary was judged to be present, identified by a change in head[24] and eyebrow position, a blink and a hold on the final sign. The list buoy appears in phrase-initial position and represents one character in the story. This boundary is marked with a high level of agreement: 4 pairs from the signers and 3 pairs from the non-signers. In addition, the list buoy occurs a second time in the following phrase, again in phrase-initial position, and that boundary also exhibits a high level of agreement: 3 pairs from the signers and 4 pairs from the non-signers. This represents a different type of cue to those discussed in this thesis: a manual sign as opposed to the markers discussed in Chapter 3 and in this section, suggesting further possibilities available to participants for segmentation judgments.

5.6.4.2 Weak boundaries

Not all boundaries are marked with a high level of agreement. Some boundaries did not lead to paired responses from either group. Five such boundaries in the BSL narrative and five in the SSL narrative will be discussed here. Two of these weak boundaries in the BSL narrative have been mentioned previously (where torso and head position were held over these boundaries).

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[24] The change in head position directed gaze at the list buoy.

| TAKE-EASY | IX | TWO-OF-US | RACE |
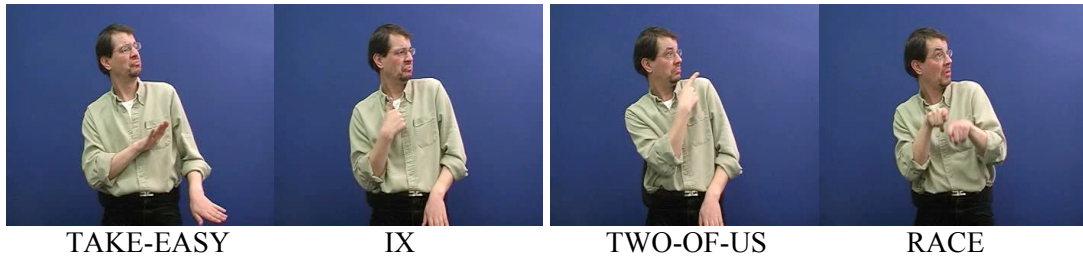
[TORTOISE WAIT-A-MINUTE IX CAN BUT TAKE-IT-EASY IX] [TWO-OF-US RACE TWO-OF-US OKAY]
'Hang on a minute' said the tortoise, 'I can go faster but I'm taking it easy'. 'Say, let's have a race okay?'

Figure 5.19: Torso and head position are held over a boundary in the BSL narrative

In the example above, the torso lean to the signer's right can be seen clearly. The position of the torso and direction of the head represent the character of the tortoise. Despite this spreading, a break was judged to be present because of the change in eyebrow position (from furrowed to raised) and a brief backwards thrust of the head. However, no paired responses from either group were observed at this boundary. A similar observation can be made at a second boundary in the BSL narrative where the torso position, this time representing the role of the hare, was held over a boundary. This is presented in Figure 5.20 below.

| REALLY | OKAY | LET-YOU-KNOW | OVER-THERE |

[HARE LAUGH TWO-OF-US RACE TRUE LAUGH OKAY] [BUT LET-KNOW OVER-THERE LINE FINISH IX WHO WHICH ARRIVE FIRST PROOF OKAY]
The hare laughed out loud. 'Are you serious?' (he asked). 'Okay then, let's have a race.' 'Over there is the finish line. Whoever gets there first is the winner okay?'

Figure 5.20: Torso position is held over a boundary in the BSL narrative

Although the torso lean was held in position over a boundary, this boundary was signalled by a head nod, a change in brow position and a slight change in head position (tilted backwards slightly). Again, this boundary evoked no responses from

either group. However, not all weak boundaries featured torso and head spreading as shown below.

| HARE-RUN-FAST | SWEAT | BAD | HOT |
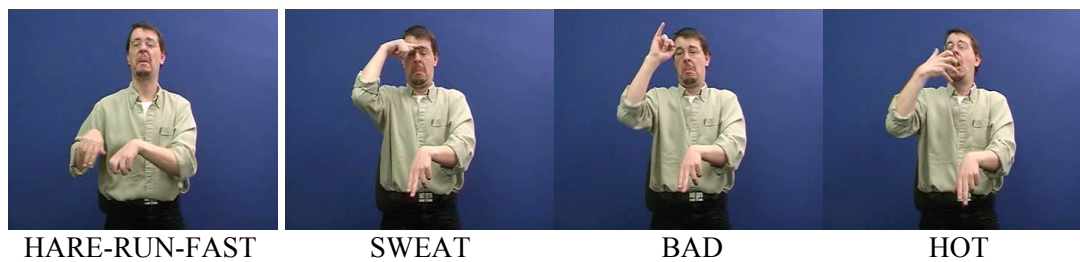
[HARE HARE-RUN-FAST] [HOT AWFUL HOT SUN HARE-SLOW-DOWN]
The hare ran really fast. The weather was so hot and the hare started to get tired.

Figure 5.21: Weak boundary in the BSL narrative (1)

In Figure 5.21, this boundary is marked by a lengthened final sign (using repeated movement) and a completion of head and torso movement. The lengthened sign was judged to be 3 times the length of a phrase-internal sign. The movement of the head and torso is side-to-side, which depicts the movement of the hare and is completed at the boundary. In the example above, the non-dominant hand performs an important narrative function in marking the role of the hare. This handshape is held in place over a boundary which, received no paired responses from either group, and is held over the following two boundaries (continuing to mark the role of the hare). These can be classed as weak boundaries in that only one paired response is observed at each boundary.

Not all weak boundaries can be characterized in this way, as shown in Figure 5.22 below.

| MEAN | QUICK | WAIT | TAKE-IT-EASY |
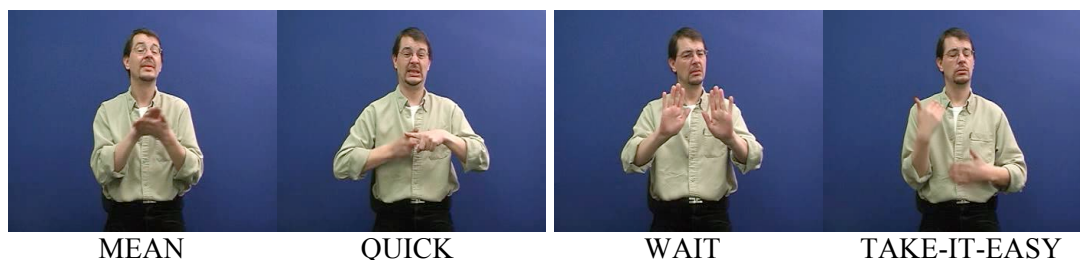
[MEAN QUICK WAIT] [AS-YOU-GO TAKE-EASY ACHIEVE PALM-UP]
This means, don't go too quickly, take your time and you'll achieve your goal.

Figure 5.22: Weak boundary in the BSL narrative (2)

A boundary was judged to be present because of the change in head and eyebrow position and a lengthened sign (repetition) which was twice the length of a phrase-internal sign. No spreading activity was observed over this boundary. In addition, no paired responses by either group were observed.

Similar observations can be made for the SSL narrative. The example in Figure 5.23 shows a weak boundary.

| OPPORTUNITY | PALM-UP | REMEMBER | AGREE |
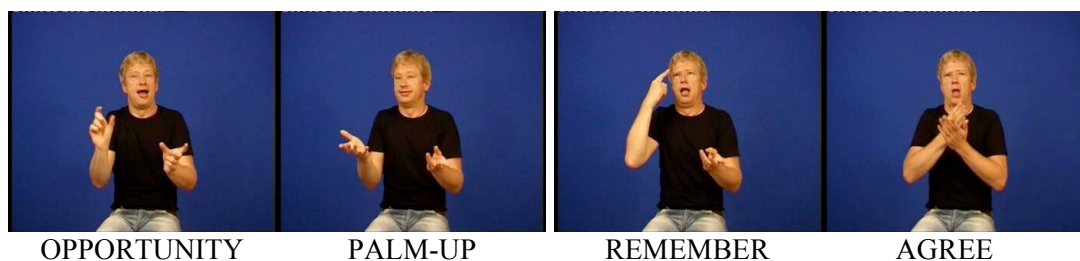
[IX PALM-UP HOW PALM-UP HAVE-NOT OPPORTUNITY PALM-UP]
[REMEMBER AGREE HEAR]
The other saw that he had no chance, but then he remembered…

Figure 5.23: Weak boundary in the SSL narrative (1)

In Figure 5.23, this boundary is marked by a change in eyebrow position and a slight change in head position. In addition, the handshape of the penultimate sign, OPPORTUNITY, in the first phrase is held over the boundary on the non-dominant hand. The final sign in the phrase, PALM-UP, was no longer than a phrase-internal sign. The presence of the markers justified the decision to mark this juncture as a boundary. However, no paired responses were observed at this boundary from either group. A further example from the SSL narrative is provided below.

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| AGREE | HEARD | nod | BEAR |
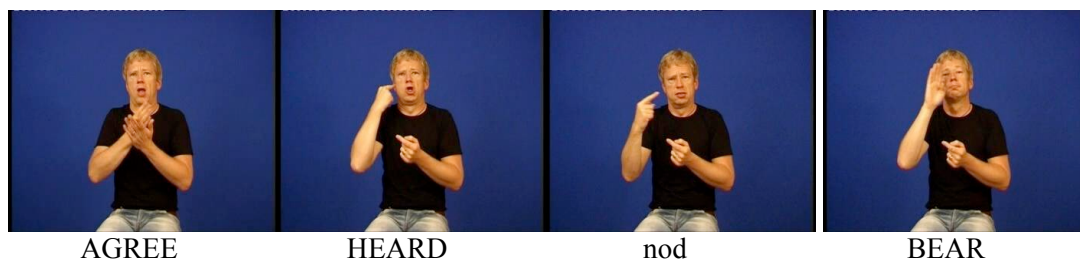
[REMEMBER AGREE HEAR] [BEAR NEVER ATTACK SOMEONE DEAD]
...but then he remembered, that bears won't attack a dead body.

Figure 5.24: Weak boundary in the SSL narrative (2)

In Figure 5.24, a boundary was judged to be present owing to the occurrence of a head nod, a change in brow position and a change in head position (tilted back slightly) in the following phrase. In addition, the position of the non-dominant hand was held over the boundary as can be seen clearly above. Again, no paired responses were made by either group at this boundary.

5.6.4.3 Type of boundaries

Up to this point, boundaries that attracted a high or low-level of agreement have been analysed according to the type and combination of visual markers present at that boundary. However, it is not clear what type of boundary was identified by participants in this experiment. That is, do these boundaries represent a specific prosodic constituent or are they better explained as marking a higher discourse unit? As in 5.6.4.1, only boundaries that attracted a high number of paired responses (three or more) will be discussed here.

To determine the level of constituent that was identified by participants, the BSL and SSL narrative was reanalysed to identify the location of IP boundaries (using the approach explained in Section 3.4.7) and U boundaries (see Section 6.6.4.1). In addition, the possibility that the boundaries identified by participants represented a higher discourse unit was also considered. In the following example taken from the BSL narrative, a signed sequence is segmented as follows.

(5a) [[HARE]ᵢₚ[TORTOISE]ᵢₚ]ᵤ [[NEVER-MIND IX EXPLAIN]ᵢₚ]ᵤ
The hare and the tortoise. Let me tell you the story.

This string was segmented into a sequence of four IPs which in turn are nested inside two Us. In the analysis reported in this chapter, only responses to the boundaries that coincide at the level of the U in this example were counted. In other words, the partitioning of the narrative using the approach set out in 5.5.4 meant that only paired responses that coincided with or followed either TORTOISE or EXPLAIN were counted. When responses at these boundaries are compared, the boundary following EXPLAIN received twice as many responses than the boundary following TORTOISE. This second U boundary is classed as a 'strong' boundary whilst the first is not. However, what is signed in (5a) gives the impression of being linked as a single unit from a discourse point of view. That is, the signs HARE and TORTOISE mark the theme of the narrative (the title of the story) and the second U conveys the narrator's intention to tell the story he has just named. This is further evidenced by the absence of a noun phrase in the second U. That is, the story the narrator will tell is the story named in the first U. In the following examples, taken from the BSL narrative, two 'strong' boundaries are present. Again, the text is reanalysed and divided according to the location of IP and U boundaries.

(5b)   [[TORTOISE WAIT-A-MINUTE]IP [IX CAN]IP [BUT TAKE IT-EASY IX]IP]U
        [[TWO-OF-US RACE TWO-OF-US OKAY]IP]U
        'Hang on a minute' said the tortoise, 'I can go faster but I'm taking it easy'. 'Why don't we have a race okay?'

(5c)   [[HARE LAUGH TWO-OF-US RACE TRUE]IP]U [[LAUGH OKAY]IP]U [[BUT INFORM OVER-THERE]IP [LINE FINISH IX]IP]U [[WHO WHICH ARRIVE FIRST] [PROOF OKAY]IP]U
        The hare laughed, 'are you serious?' (he asked). 'Okay, let's race. Over there is the finish line. Whoever gets there first is the winner okay?'

In the BSL narrative, the signed sequence shown in (5b) is immediately followed by the signed sequence shown in (5c). The final boundary in both examples (following OKAY in both (5b) and (5c)) is analysed as a strong boundary based on the number of paired responses by participants. No other boundary in either sequence is judged as a 'strong' boundary. Therefore, a high number of paired responses do not appear to correspond to all IP or U boundaries. What is of note here is that both sequences correspond to the role of a character in the story. In (5b), the sequence is signed in the role of the tortoise and in (5c); the sequence is signed in the role of the hare. This

observation leads one to conclude that this sequence represents a single discourse unit. This conclusion is reinforced by the introduction of the 'theme'. In discourse analysis, this term refers to the left-most sentential constituent which represents the starting point of an utterance (Brown & Yule, 1983). What follows the theme consists of what the speaker states in relation to that utterance's starting point. Therefore, in (5b), the tortoise has been thematised (with the articulation of TORTOISE) and the remaining sequence is read from the point of view of the tortoise. In (5c), the hare is thematised (with the articulation of HARE) and the remaining sequence is read from the point of view of the hare. Further evidence that these signed sequences can be viewed as a single cohesive unit can be seen in the use of pronouns and reference. As the tortoise is thematised in (5b), the use of the first person pronoun in the second and third IP is understood to refer to the tortoise. In addition, the dual pronoun (TWO-OF-US) moves between two locations in space, the first location (the signer's chest) being intrinsically linked to the tortoise and the second location (in the periphery of the signing space) to another character in the narrative (the hare). In (5c), the dual pronoun TWO-OF-US is again articulated but as it follows a new theme, the hare, the meaning of this pronoun is modified. That is, the initial location of the dual pronoun is now intrinsically linked to the hare and its second location refers to the tortoise. In the second U (again in (5c)) the final location of the verb INFORM is modified so that its final location corresponds with a location associated with the tortoise. The agent of this verb (the hare) is not explicitly named having been established in the preceding U. In the final U, WHICH moves between two locations in space. The first location, the signer's chest represents the hare whilst the second location represents the tortoise. Since the hare is thematised at the start of this unit, this sequence is read with this in mind. These points reinforce the idea that the sequence given in (5b) and (5c) can be combined to form a single discourse unit. A high number of paired responses can be associated with the final boundary in these examples which mark an important point in the narrative where a new theme (and a change in role) is established.

In the SSL narrative, similar conclusions can be made as in the BSL narrative. That is, responses frequently coincided with boundaries representing a larger discourse unit. In the following example, a similar signed sequence to that given in (5a) is provided.

(5d)   [[TITLE]IP [TWO FRIEND AND BEAR]IP]U
         The title of this story is 'Two Friends and the Bear'.

In the sequence given in (5d), a high-level of paired responses was recorded at the second boundary (following BEAR). This was not observed at the IP break (following TITLE). Although the sequence represents a single U, it can also be analysed as a single discourse unit in that the theme of the sequence is named first (TITLE) and the remaining sequence is read in that context (in this case, what follows is understood to be the title of the story). In the sequence immediately following that given in (5d), a new theme (the two friends) is foregrounded marking the start of a new discourse unit. Other 'strong' boundaries in the SSL narrative illustrate that the boundaries participants frequently responded to correspond to a discourse, rather than prosodic, unit. These are included below.

(5e)   [[IX PALM-UP]IP [HOW PALM-UP HAVE-NOT OPPORTUNITY PALM-
         UP]IP]U [[REMEMBER AGREE HEAR]IP [BEAR NEVER ATTACK SOMEONE
         DEAD]IP]U
         The other saw that he had no chance. But then he remembered that he heard bears
         won't attack a dead body.

In (5e), a signed sequence is divided into four IPs which, in turn, can be joined together to form two Us. The theme of this sequence is established with the first sign IX (immediately following a strong boundary) which represents a point to a list buoy on the non-dominant hand. This buoy signifies that the theme of this sequence is the second friend and the remaining string explains the predicament of this character. A 'strong' boundary is found following DEAD (the last sign in this sequence). In contrast, a high number of responses are not observed at the first U boundary (following PALM-UP). The placement of responses suggests that boundaries identified by participants watching the SSL narrative correspond to a unit at a discourse level since a high number of responses do not occur at both U boundaries.

The sequence presented in (5e) can be viewed as representing a single unit with reference to its meaning. The first constituent presents the problem (the friend is unclear what to do in this situation) and the second constituent presents its solution (to play dead). In the signed sequence that follows (5e) above, a change in role is not observed.

(5f)   [[PERSON-LAY PLAY DEAD PERSON-LAY]IP]U [[SLEEP]IP [BREATHE SILENT BREATHE]IP]U [[HEAR HEART-BEAT]IP [WISH SILENT IX HEART-BEAT]IP]U
The man lay down playing dead and held his breath.

The above sequence continues in the role of the friend as established in (5e). However, this sequence represents a new stage of the narrative where the action contemplated in (5e) (playing dead) is carried out. This action is staged in the first U and the remaining sequence comment on this action (the difficultly in playing dead). Further justification for the separation of (5f) from (5e) comes from prosodic markers at the end of (5e). There is a hold on DEAD which is twice as long as a phrase internal sign. This hold in signing creates the impression of a stronger boundary when compared to boundaries that attracted a low number of paired responses (or U boundaries that do not coincide with a discourse boundary). In (5f), a high number of paired responses are not observed at all U boundaries but at the last U boundary only (following HEART-BEAT). Again, paired responses do not occur with all U boundaries but appear to correspond to a higher discourse unit. Immediately following (5f), a new theme (the bear) is established and marks the start of a new discourse unit.

When boundaries that attracted a high number of responses from participants are analysed to determine what level of constituent participants identified, it is clear that this constituent correspond to a discourse unit. That is, it has been shown that prosodic constituents, the IP or the U, do not always attract a high number of responses from participants. Instead, discourse units which begin with the introduction of a theme and a signed sequence that says something in relation to the theme show the 'best fit' with the boundaries identified by participants here.

5.6.5 Discussion of qualitative analysis

The qualitative analysis carried out here has shown that all boundaries feature visual markers layered both sequentially and simultaneously. That is, more than one visual marker is observed at all boundaries. Since the total number of boundaries is low, particularly when considering different levels of agreement (e.g. boundaries with high level agreement do not represent the majority of boundaries identified in either narrative), it is not possible to make any definite claims about boundary-marking strategies, if any, for either group. In addition, since visual markers are layered at boundaries, it is difficult to say with certainty whether a single marker motivated a response from participants. Therefore, the claims in this section need to be tested further against a larger sample. However, the issues arising here can provide a working hypothesis for further studies.

Results from the experiment on perception of boundaries indicated varying levels of agreement amongst boundaries. An analysis of boundaries which attracted a high number of responses from participants shows that a number of visual markers are associated with these boundaries. Manual markers such as strong pauses and lengthening, and non-manual cues such as a change in torso and head position, occur at these boundaries. Strong pauses are further characterized by drop-hands, where the hands are returned to the signer's lap or joined. These all involve larger articulators in comparison to blinks and eyebrows, and may be more salient in indicating boundary position. Torso and head position appear to function as domain markers but also have a semantic role, indicating which character is 'speaking'. Therefore, they do not always return to a neutral position at the end of a phrase, but instead can be held over more than one phrase. It was shown that responses coincide to a large extent with changes in torso position, suggesting that larger articulators may be favoured as cues by both signers and non-signers when segmenting a signed narrative.

In addition, an analysis of weak boundaries revealed a high incidence of spreading. In the BSL narrative, both manual and non-manual spreading were observed at boundaries with a low level of agreement. The torso and head positions, marking

role, were held over a boundary on two occasions. In addition, handshapes (representing role) were held in place over several lexical signs and over several boundaries. These boundaries attracted few responses from participants. In contrast, strong boundaries show no spreading. For example, when the hands return to the signer's lap there is a visible break in signing with no spreading elements present.

An analysis of the type of boundaries identified by participants reveal that the level of constituent identified by participants is best understood from a discourse perspective. For example, a sequence that introduce a theme (e.g. the hare) can consist of a string of two or more Us which can be joined together to form a larger discourse unit. In contrast, U boundaries that occurred away from a discourse boundary did not attract a high number of paired responses. These discourse boundaries frequently coincided with an important juncture in the narrative such as a change in role or the start of a new action that moved the story forward. The view that the type of boundary identified by participants is a discourse boundary is strengthened by the type of visual marker frequently present at strong boundaries: a change in head and torso position representing a change in role. These changes are mimetic in that they mark a character's 'voice' and are not considered prosodic markers to boundaries in the same way a rhythmic head nod may be prosodic. Therefore, the qualitative analysis of markers and constituent boundaries suggests that participants' responses coincide with boundaries at a discourse level.

In addition, this qualitative analysis has shown that similar markers are available for the segmentation tasks in the BSL and SSL narrative. For example, the SSL narrative feature a conversation between two speakers and as in the BSL narrative, the orientation of the signer's head is used to mark role. Other markers that are present in both narratives are segmental lengthening, head nods, changes in brow position and blinks. Therefore, it is likely that participants use similar markers for segmentation regardless of whether they know the language or not.

However, since both BSL and SSL are able to layer visual markers simultaneously and sequentially at boundary points, an analysis that attempts to tease apart any

differences in visual markers is beyond the scope of the experiment. For instance, participants may either use a specific marker or attend to a broad range of markers when segmenting a narrative and this may vary across the two groups. Any pattern in the choice of visual marker used cannot be observed clearly in this real-time experiment since a single response cannot be attributed to a single cue without considering a number of confounding variables (e.g. reaction times and number of cues present at boundaries). If there is a difference between the two groups, then the difference is too subtle for the current experiment to make clear. Further studies aimed at investigating this are suggested in Chapter 6.

5.6.5.1 Summary

The qualitative analysis of boundaries with varying level of agreement has shown that different visual markers are observed at these boundaries. Strong boundaries are typically marked with a change in head and torso position and by the hands returning to the lap. Low level boundaries feature spreading of markers such as the head and the torso which are held over a boundary. Boundaries that attract a high level of agreement have no spreading. An analysis which segments the narratives into prosodic and discourse units reveal that boundaries identified by participants is best understood from a discourse perspective.

Chapter 6: The perception of boundaries by four different groups

6.1   Introduction

In this section, a second experiment is described which had the aim of clarifying and confirming further the conclusions of the previous chapter. This chapter is organised as follows: firstly, the aims and objectives of this chapter are set out in 6.2 and issues arising from the previous chapter which are addressed in this thesis are outlined in 6.3. This is followed by the research questions in 6.4 that the chapter will be primarily concerned with and the hypotheses in 6.5. In 6.6, the methodology and changes in the format of the experiment from the previous chapter will be explained. The results from this experiment will be presented in 6.7. In addition, results from questionnaires given to participants following testing will be discussed in 6.8.

6.2   Aims and Objectives

The aims of this chapter are to clarify and confirm conclusions made in the previous chapter by undertaking a modified version of the experiment, with important changes to the methodology. These changes include the following: an increase in the number of participants in each group, the inclusion of two groups of signers fluent in languages unrelated to BSL, an additional signed narrative (which allows for a three-way analysis), and a post-experiment questionnaire designed to elicit further information from participants. Decisions to alter the methodology in the experiment reported in this chapter follow on from issues arising from the previous chapter which are explained below.

6.3   Issues arising from Chapter 5

In Chapter 5, responses made by participants were shown to coincide with boundaries in a signed narrative. However, because of the length of the narrative and the number of boundaries contained within, a result occurring above chance level was not always observed. That is, the total number of intervals was not much greater than the number of boundaries identified which meant that it remained a possibility that results observed occurred by chance pressing. However, whilst this is unlikely when considering paired responses, it is an aim of the chapter to strengthen these

findings by increasing the number of participants taking part. It is hoped that the greater number of participants will lead to more 'hits' at boundaries in general and thereby increase the level of significance. In addition, the increase in the number of participants may reveal more specific differences between the groups.

The previous chapter featured native signers of BSL and non-signers making boundary judgments on an unknown sign language (SSL). Although responses by both groups coincided with boundaries, it remained unclear how both groups would compare to native signers of SSL who would not only be able to use visual markers as cues to boundary position but cues at the lexical and grammatical level to segment a SSL narrative and who might therefore differ from BSL signers and non-signers. To answer this question, a group of native SSL signers took part in the experiment reported in this chapter. Any similarities between groups in the distribution of responses will provide further evidence for the tentative claims put forth earlier in the thesis. To test this question further, a fourth group of native signers of ASL were included and a third narrative signed in ASL was added to the experiment.

In the previous experiment it was reported that the responses of a group of non-signers did occur at boundaries and no differences from native signers of BSL could be observed. Non-signers are included in the current chapter to test whether this finding is replicated when tested against native signers of SSL and ASL, particularly when the number of participants in each group is increased. In addition, the inclusion of three different sign language groups means that the results from non-signers can be tested against more than one group. For example, when viewing the BSL narrative, non-signers can be compared to those who know the language (native signers of BSL) and those who know a different sign language (native signers of ASL and SSL) so that any similarities in results, depending on the outcome, can be verified in three ways.

Because of the length of the narratives used in the previous experiment and the number of boundaries, it was not always possible to see a difference in boundary marking strategies between groups (as reported in Brentari 2008). The presence of a

large number of visual markers that layer simultaneously and sequentially at boundaries makes this task more difficult. In the experiment reported in this chapter, a post-experiment questionnaire is introduced which directly asks participants how they decided where boundaries were positioned. In addition, the questionnaire will also ask how they felt they had performed in each task. Through the use of a questionnaire, an alternative perspective to boundary marking strategies by each group is sought.

6.4   Research Questions
In sum, the questions that the chapter aims to answer are:

- *Are signers able to segment a narrative in an unknown sign language with a similar level of accuracy to native signers of that language?*

- *Does experience in knowing how signed languages work in general give signers an advantage over non-signers?*

European (including ASL) signed languages have been noted to be typologically similar in a number of ways (at the phonological, morphological and syntactic level) and it would not be unrealistic to assume that visual markers indicating boundaries might exhibit a great deal of similarity on a typological cross-linguistic scale (as discussed in Chapter 2). In Chapter 5, the majority of responses made by native signers were shown to coincide with boundaries (layered with visual markers) suggesting that native signers of BSL are able to indicate boundaries in a narrative in an unknown sign language (SSL) accurately. However, is this finding replicated in general? That is, can the same conclusions be reported for a different group of signers (in an unrelated signed language) watching a different signed narrative?

Furthermore, might typological similarity give native signers an advantage over non-signers when both segment an *unknown* sign language? Comparative analysis of signed language and face-to-face communication have reported some similarities (such as in facial expressions in yes/no and wh-questions (see Chapter 4)). It was reported in Chapter 5 that no differences were observed when native signers' and

non-signers' performances were compared. However, the current chapter asks whether this finding can be replicated in further conditions. When additional groups and narratives are included for testing and comparison, is a similar result observed? One possibility is that the level of agreement will vary between groups depending on the narrative viewed. Native signers watching their own language may be expected to perform better than other groups. Hearing non-signers may be expected to perform at a comparable level of competence across all conditions but not at a superior level to other (signing) groups.

6.5   Hypotheses

The following hypotheses are proposed which take into account the possible outcomes when results from all conditions are grouped together.

Hypothesis 1a (null hypothesis): No clear pattern for responses at boundaries is observed when all groups are asked to indicate boundaries in a signed narrative. Groups do not show a preference for boundaries at all.

Hypothesis 1b: The group watching their native language will indicate boundaries at a superior level to other groups. There will be no difference between the remaining groups in the rate they indicate boundaries.

Hypothesis 1c: The signing groups will indicate boundaries at a superior level to the non-signers. There will be no difference between the signing groups in boundary detection rate.

Hypothesis 1d: There is no difference between groups at all when responses at boundaries are analysed. All groups show an ability to detect boundaries at a level above that observed by random pressing.

6.6   Methodology

In this section, the methodology for the current experiment is outlined. Although the experiment is very similar to the previous chapter, several important changes have been made. These changes are described in detailed here and the motivations behind

them are explained. The following diagram provides an overview of the groups and narratives in the experiment which are explained in the following section.
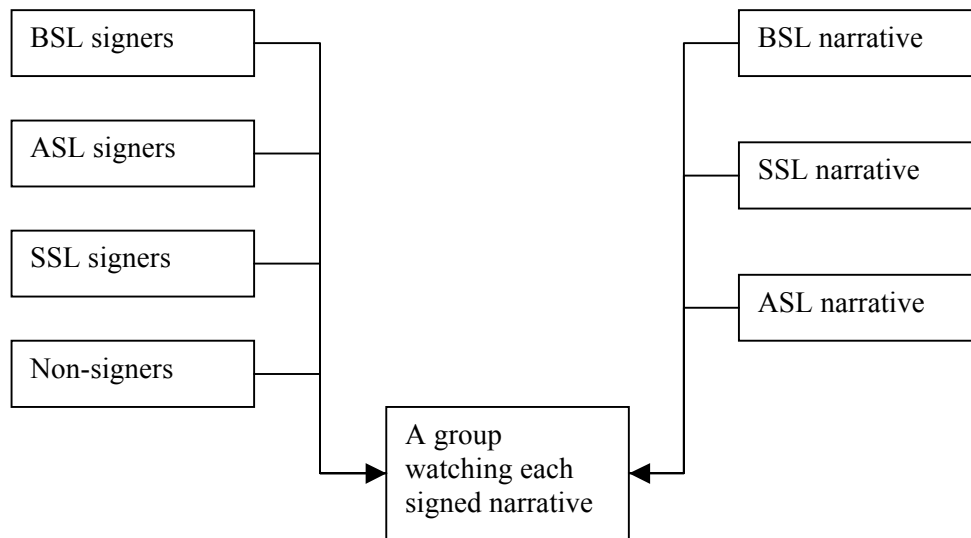
Figure 6.1: Overview of the experiment design in Chapter 6

6.6.1   Participants

Four different groups of ten participants were created for this section. These were native users of BSL, native users of SSL, native users of ASL, and hearing non-signers. As in the previous experiment, the hearing non-signers had no prior experience with sign language at the time of taking part. All the hearing non-signers were born in Britain.

A further condition for all the signing groups was that they did not know the other sign languages in the experiment. For instance, participants in the BSL group were chosen because they did not know SSL and ASL at the time of participating in the experiment. This requirement presented problems when recruiting BSL and SSL participants since it was more likely that they had come into contact with ASL. As was the case when testing the SSL group, two subjects were recruited who were

near-native signers (they had learnt signing before the age of five). In all cases, written consent was obtained before testing.

In the ASL group, there were four males and six females. In the BSL group, there were three males and seven females. In the SSL group, there were three males and seven females. And finally, in the non-signing group there were six males and four females.

6.6.2 Narratives

Three signed narratives were selected for the current experiment and are described below. In addition, the reasons behind selection of these narratives are explained.

Both the BSL and SSL narrative were taken from the ECHO corpus as in the previous chapter. The BSL fable is titled 'The Dog and the Bone' and the SSL fable is titled 'Two Friends and the Bear'. A different BSL fable was selected for this experiment because the fable used in the previous experiment had a high occurrence of role shift and it was possible that reliance on the visual markers associated with role shift could account for a number of responses at boundaries. In addition, in the post-experiment interview, participants commented on the speed of the narrator in comparison to the SSL narrator and mentioned that this made it harder to segment. In 'The Dog and the Bone', which featured a different narrator, there are no dialogues between two characters (unlike 'The Tortoise and the Hare') and the fable was told by a different narrator, whose speed of signing was judged to be slower.

The ASL narrative did not come from the same source as the BSL and SSL narrative. Instead, a video was selected and edited for use in the current experiment. This video was selected because the layout was similar to the BSL and SSL narrative (i.e. the narrator was in front of a blue screen) and because it comprised a signed narrative ("Ansaldo and the Cats"). Unlike the ECHO stories, the narrator did not sign the story in one go but told the story in segments, returning his hands to his lap at the end of each segment. Two adjacent segments were chosen for the experiment because they could stand alone as a story. However, there was one visible break after the signer had dropped his hands to his lap. It was decided that this break could be

included but ignored, since it occurred during a period of no signing and would not contribute to an upcoming prediction.

The ASL narrative was timed at 1 minute 51 seconds, and the BSL narrative was timed at 1 minute 57 seconds. The SSL narrative was 1 minute 28 seconds long. Both the ASL and SSL narratives were told by a male signer and the BSL narrative was told by a female signer. All signers were chosen for their storytelling abilities.

6.6.3   Changes in format

Several changes were made to the structure of the experiment following feedback from participants in Chapter 5. These changes are outlined here.

A major change to the structure of the experiment was that all participants were allowed to view each narrative once before attempting segmentation. This allowed participants to familiarise themselves with each narrative first and decide in advance where they would place their responses. Before the main experiment, signing participants were assigned two practice tasks: segmenting a narrative in their native sign language and segmenting a narrative in an unknown sign language (a narrative in NGT from the ECHO corpus).[25] Non-signers were assigned two practice tasks (one in BSL and one in NGT). As in the previous experiment, participants were asked to segment each narrative twice.

A further change was made in the wording of the instructions given to participants. In the previous task participants were asked to push the button when they saw 'the end of a sentence'. In this task, participants were asked to push the button when they saw a place where they would put a full-stop. This wording simplified the instructions and, in contrast to the previous experiment, there were no requests for a definition of 'sentence boundary'.

For the ASL and SSL conditions, assistants fluent in those languages explained the task to participants in their native language. Since the experiment involved

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[25] A female narrator signed the NGT narrative, 'The Tortoise and the Hare'. The narrative was chosen because of the similar layout and because the content of the story was different from the ASL, BSL, and SSL narratives.

participants with no experience of BSL, it was essential to make sure the task could be explained clearly to them. The assistants were deaf people who used ASL/SSL as their first and preferred language.

Immediately following each of the three tasks, participants were given a questionnaire to find out how they rated their own performance. They were asked to indicate how difficult they found the task and to compare (where possible) the tasks to their performance in the other signed narratives. For the SSL participant, a copy of the questionnaire in Swedish was provided. A copy of this questionnaire is included as Appendix 3.

As mentioned previously, the number of participants to a group was increased from 6 to 10 in order to see clearly any differences in distribution between groups. The frequency of responses to specific boundaries was then compared to random data as in the previous chapter and a statistical analysis was conducted. However, the statistical power (the likelihood that the test will correctly reject the null hypothesis) of the test is limited due to the small sample size and results should be viewed bearing this in mind. This issue is discussed further in 7.4 where a discussion on how to improve statistical power along with further suggestions to the research design in this thesis is presented.

6.6.4 U boundaries

This section outlines how U boundaries were identified for each narrative and describes the categories assigned to these boundaries. As in the previous chapter, responses had to occur in a 1.5 second time window to be associated with a particular boundary (see Figure 5.2 in Chapter 5).

6.6.4.1 Identifying boundaries

Responses by all participants were considered according to whether they occurred at a U boundary or not. To determine the location of U boundaries, IP boundaries in all three narratives were first identified using a similar method outlined in Chapter 3 (see Section 3.4.7). That is, IP boundaries were identified by examining the rhythm of the hands (e.g. looking for signs that were held or repeated) as well using

meaning to determine which signs logically went together. Following this, the next step was to identify the prosodic constituent at the next level in the hierarchy: U. As well-formed prosodic constituents are nested inside each other (a U consists of one or more IPs and an IP consists of one or more phonological phrases), it follows that the IPs identified will join with adjacent phrases (where possible) to form a U. As given in Nespor and Vogel (1986), the definition of a U is as follows: all the IPs corresponding to X^n in the syntactic tree. Therefore, phrases were grouped together using meaning to determine 'completeness' as well as prosodic markers (such as a pause). This is illustrated in the following examples taken from the SSL narrative.

(6a)   [[TITLE]IP [TWO FRIEND AND BEAR]IP]U
          The title of the story is 'Two Friends and the Bear'.

In the first example, a signed sequence is divided into two IPs. The first IP represents the topic (i.e. the title) and the second IP provides the comment (i.e. what the story is called). That these IPs join together to form one complete unit is further justified by prosodic markers. For instance, the hands are returned to the lap following the articulation of BEAR and are part of a longer pause than is present between the previous IP break (between TITLE and TWO). The presence of a stronger pause reinforces the decision that these phrases combine to form a single prosodic unit. In the following example from the ASL narrative, two IPs are joined together to form a single U.

(6b)   [[INDEX ISLAND]IP [[HAVE KING]IP]U
          This island has a king

In the above excerpt, *the island* is understood to be the subject of the sentence, and the second IP forms the predicate (describing an inhabitant of the island). In addition, if only the first phrase in this sequence was signed it would seem truncated and incomplete. Therefore, according to the definition set out above, both IPs can be joined together to form the prosodic constituent U. This procedure was applied to all three narratives. Once completed, the boundaries were confirmed by linguists researching that language. These linguists were asked to confirm if a break was

present but not to confirm its status (whether it was also a U boundary). A transcript for each narrative is available in the appendix.

6.6.4.2 Strong and weak boundaries

In the previous chapter, it was observed that some boundaries attracted more responses than others and that these boundaries corresponded to important changes in the narrative. For example, strong boundaries featured a change in role (e.g. from the tortoise to the hare) or a change in the setting and direction of the story. In this chapter, U boundaries are further categorised as 'strong' or 'weak' boundaries. These 'strong' boundaries represent a higher discourse unit above the level of the phonological utterance and group phrases together primarily on meaning. For the purposes of this study, constituents are grouped together according to thematic structure (see Brown & Yule, 1983). Specifically, strong boundaries represent the introduction of a new theme to the narrative and the signed sequence that follows it is understood in reference to the theme. Themes may represent a new character in the story or instances where a previously mentioned referent is brought to the foreground. They may also refer to a change in the setting of the story (e.g. alternating from the ground where a friend is playing dead to a tree where a second friend is hiding from the approaching bear). Themes can also be inanimate (e.g. a bone in the story 'Dog and the Bone') or may be a time-adverbial (e.g. 'a long time ago'). For simplicity, these 'strong' boundaries can be thought of as narrative boundaries in that they represent an important change or juncture in the narrative. Using the examples taken from the ASL narrative, this procedure is explained in detail. As set out in the previous section, the examples are segmented according to the location of IP and U boundaries and U boundaries are marked according to whether they were strong or weak.

(6c) [[[ANSALDO TOUCH]IP [DECIDE GIVE TWO CAT]IP]U]NU
    Ansaldo was touched and decided to give (the king) her two cats.

The example given above marks the introduction of a new theme (ANSALDO) and the remaining sequence is read in reference to this theme (so the agent of the verb DECIDED is Ansaldo for example). A body lean which marks role characterises the

entire sequence reinforces the decision that this be viewed as a single unit. For the purposes of this experiment, the U boundary following CAT is labelled strong.

(6d)   [[[KING WOW THANK-YOU ANSALDO]IP]U [[KIND-OF IX SAVE POSS ISLAND]IP]U [[LIKE FEEL LIKE M.I.R.A.C.L.E KIND-OF]IP]U [[WOW THANK-YOU]IP]U]NU
The king was amazed and thanked Ansaldo for saving his island.

This example marks the introduction of a new theme, the King, and the remaining sequence is signed from the King's perspective.[26] This sequence also marks role although with a different degree of complexity than (6c). The first U is told in the role of the King (established through KING in phrase-initial position) and the second and third Us are told whilst in the role of the narrator. This is evidenced by the possessive pronoun (POSS) being directed to a location in space associated with the King rather than being directed to the chest (for first person reference) which would be expected if the sequence was signed from the King's viewpoint. The final U in (6d) is signed in the role of the King. Although this sequence changes role twice, it is regarded as a single narrative unit. This is evidenced by the absence of a new theme throughout the sequence. When the signer switches back to the role of the King, he does so without re-establishing the King in the narrative. According to the criteria set out here, the U boundaries following ANSALDO, ISLAND, KIND-OF are labelled weak whilst the boundary following THANK-YOU is labelled strong.

(6e)   [[[IN POSS HOME]IP]U [[WOW FANCY HALL H-A-L-L HALL]IP [WITH MIRROR MIRROR-ALONG-WALL]IP]U]NU [[MIRROR FRAME]IP [AROUND-FRAME G-O-L-D ALL-AROUND ON-WALL-CEILING]IP [BEAUTIFUL]IP]U]NU
They went inside his home. There was a fancy hall with mirrors all around. The mirrors were framed in gold and hung along the walls and ceiling.

In (6e) above, a signed sequence is segmented into two narrative units. These units demonstrate that the theme is not necessarily an animate being. In the first U, the setting for the narrative unit is provided (IN POSS HOME). This represents the theme for the first narrative unit in (6e) and the remaining sequence is understood with reference to this theme. In the second narrative unit, a previously mentioned

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[26] This is not the first time the King is mentioned or thematised in this narrative, so themes need not be 'new' in the sense that they have not been mentioned before.

referent, MIRROR, is foregrounded and thematised. This foregrounding marks the beginning of a new narrative unit. For the purpose of the experiment, the U boundary following HOME is labelled weak and the boundary following 'cl-mirror' and BEAUTIFUL are labelled strong. All U boundaries in all three narratives were analysed according to whether they coincided with a larger discourse unit. A gloss for each signed narrative segmented according to the location of U boundaries as well as detailing which were identified as strong or weak is provided in Appendix 2. Once these boundaries had been categorised, the number of responses that coincided with these boundaries was then counted.

6.6.5 Intra-participant reliability

Intra-participant reliability was assessed using the same principle as outlined in the previous chapter (see section 5.5.5.2). That is, two responses on different runs were paired if they were less than one second apart. However, there was difficulty in applying this principle to the data reported in this chapter when responses on different runs occurred too close together. This is outlined below in Figure 6.2.
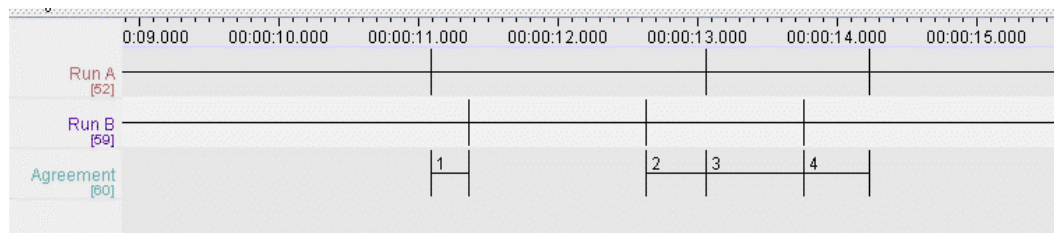
Figure 6.2: Grouping responses together in ELAN annotation viewer (1)

In Figure 6.2 above, the second and third responses on both runs pose problems in grouping entries together since three possibilities exist (labelled here as 2, 3, 4 on the agreement tier). In order to avoid overestimating levels of agreement in these clusters, responses were only grouped once (with the closest occurring response). Figure 6.3 shows the amended analysis:
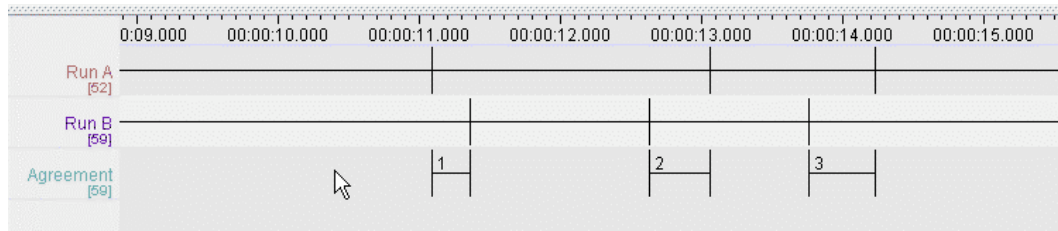
Figure 6.3: Grouping responses together in ELAN annotation viewer (2)

In total, the number of pairings with alternative readings in all signed narratives is 5 pairs in the ASL narrative (1.5% of total paired responses in this condition), 7 pairs in the BSL narrative (2.1% of total paired responses in this condition), and 8 pairs in the SSL narrative (2.1% of total paired responses in this condition). Therefore, these cases represent a small proportion of the paired data. In each case, responses on the first run were paired with the closest occurring response on the second run.

One participant in the ASL group was excluded from the analysis since the number of responses by that participant was high. That is, responses by this participant in the first and second run occurred at regular one second intervals and made a meaningful pairing of responses (to obtain responses occurring in agreement) impossible. In addition, one participant in the SSL group was also excluded in the BSL condition for the same reason (although responses made by the same participant whilst watching the SSL and ASL narrative were kept). The decision to exclude these participants was based on the impossibility of deciding which responses could be paired together.

6.6.6 Creation of random data

To determine whether responses were occurring at a level above chance, responses were compared to random data. As in the previous chapter, the random data were constructed by recreating the conditions of the experiment in Excel and distributing a fixed number of integers using the =RAND and sort functions. Random data was created for each individual group watching each narrative so that differences in the length of the narratives and the average number of responses for each group were always maintained. In addition, a fixed number of columns were chosen at random to represent strong and weak boundaries. For each condition, 1000 rows of data

(where one row = one 'participant') were created and the average number of 'hits' observed at strong and weak boundaries was calculated. As well as calculating the random scores for strong and weak boundaries in each narrative, the random score for responses occurring elsewhere in the narrative was calculated. In this way, responses made elsewhere (i.e. not at U boundaries) by participants could be compared to a random number of responses, which had not been considered in the previous chapter.

6.7 Results by narrative

In this section, the quantitative results from the current experiment will be presented. The section is divided into three parts with responses discussed in relation to each narrative. As in the previous chapter, an overview of responses at all points in the narrative during the task is presented before examining responses occurring at U boundaries. This procedure is repeated for each narrative. Following this section, results by group will be presented.

6.7.1 BSL narrative

Raw frequency scores for each group watching the BSL narrative are presented in Table 6.1 below. As in the previous chapter, the frequency scores for the first and second runs as well as the total number of pairs in agreement are provided. In this condition, there are nine participants in the ASL and SSL group and ten participants in the BSL and non-signing groups.

BSL Narrative	1st run	2nd run	In agreement	Total
BSL signers	154	154	96 (62%)	308
ASL signers	147	139	83 (58%)	286
SSL signers	184	189	123 (66%)	373
Non-signers	149	134	75 (53%)	283
Total	634	616	377 pairs	1250

Table 6.1: Total number of responses by all groups watching the BSL narrative

Intra-participant reliability was assessed using the Wilcoxon Signed Rank test. No significant differences were observed (BSL: W = 25, Z = -.26, p = .80; ASL: W = 11.5, Z = -1.32, p = .19; SSL: W = 7.5, Z= -.63, p = .53; NS: W = 17, Z = -1.08, p = .28). That is, participants did not differ in the number of responses during the first

and second runs. The highest number of responses in the first and second runs was by the SSL group. The remaining three groups display a similar total of responses. However, this similarity does not entail that responses were made in the same place on the second run. When paired responses were examined, for all groups the majority of responses occurred within one second of a response on the other run. The highest number of paired responses was in the SSL group (123 pairs) who produced 27 more pairs than the BSL group (96 pairs). The non-signers produced the lowest number of paired responses (75 pairs).

In Table 6.2, the data are restricted to responses occurring at the 40 U boundaries in the BSL narrative. As in earlier tables, responses for all groups are provided.

BSL Narrative	1st run	2nd run	In agreement	Total
BSL signers	110	103	78 (81%)	213 (69%)
ASL signers	102	87	68 (82%)	189 (66%)
SSL signers	119	128	98 (80%)	247 (66%)
Non-signers	94	94	63 (84%)	188 (66%)
Total	425	412	307 pairs	837

Table 6.2: Total number of responses at boundaries by all groups watching the BSL narrative

Using the Wilcoxon Signed Rank test, no significant differences were observed between the number of responses at all boundaries on the first and second run for all groups except the ASL signers (BSL: W = 13, Z = -.7, p = .48; ASL: W = 3, Z = -2.13, p = .03; SSL: W = 12.5, Z= -.78, p = .44; NS: W = 21, Z = -.67, p = .51). Except for the ASL group, all groups marked a similar number of boundaries in both runs. The ASL signers (or six participants in this group) made fewer responses on the second run. The SSL signers produced the highest number of responses at boundaries for both runs. The lowest number of responses was by the non-signers on their first run and by the ASL signers on their second run. When the number of paired responses in each group is considered (i.e. responses on two separate runs occurring in the same place), the SSL signers log the highest number of pairs at boundaries and the non-signers the lowest. However, when the proportion of paired responses is considered for all groups, at least 80% of paired responses occur at U boundaries.

When boundaries are further divided into strong and weak boundaries, the distribution of responses can be considered. That is, did responses occur at strong or weak boundaries (as defined in Section 6.6.4.2) and how did this vary by group? This is illustrated in Table 6.3 below. Data from all groups are included in this table.

BSL Narrative	Strong boundaries		Weak boundaries		Other	
	1st run	2nd run	1st run	2nd run	1st run	2nd run
BSL signers	69	56	41	47	44	51
BSL chance level	*30*	*30*	*40*	*40*	*70*	*70*
ASL signers	61	54	41	33	45	52
ASL chance level	*36*	*36*	*36*	*36*	*72*	*72*
SSL signers	68	72	51	56	65	61
SSL chance level	*51*	*51*	*63*	*63*	*108*	*108*
Non-signers	48	51	46	43	55	40
NS chance level	*30*	*30*	*40*	*40*	*70*	*70*

Table 6.3: Distribution of responses by all groups watching the BSL narrative

In Table 6.3, the distribution of responses is considered according to three categories: strong boundaries, weak boundaries, and 'other'. 'Other' represents all other points in the BSL narrative excluding U boundaries. It is important to remember that each category is not equally represented in terms of length. For example, if the length of the BSL narrative (1 minute and 58.5 seconds) is analysed in terms of time windows (1.5 seconds, giving a total of 79 time windows): then the 18 strong boundaries account for 26 seconds of the BSL narrative, 22 weak boundaries account for 33 seconds of the total narrative, and 'other' represents the remaining 39 windows (58.5 seconds of the BSL narrative).

As well as individual group data, Table 6.3 provides chance-level data for each sign language (provided in the shaded rows). This represents the total number of responses that would be seen in that subset of the narrative if button-pressing occurred at random. Using the Mann-Whitney independent samples test, each group was compared to chance-level to assess whether the observed distribution was significantly different from chance. When responses at strong boundaries are assessed, all groups but for the SSL group on the first run and the non-signers on the second run were found to be significantly above chance level (BSL both runs: U =

10, $Z = -3.24$, $p = .002$; ASL 1st run: $U = 4.5$, $Z = -3.51$, $p = .001$; ASL 2nd run: $U = 13.5$, $Z = -2.62$, $p = .01$; SSL 1st run: $U = 22.5$, $Z = -1.75$, $p = .11$; SSL 2nd run: $U = 9$, $Z = -2.98$, $p = .003$; NS 1st run: $U = 15$, $Z = -2.93$, $p = .007$; NS 2nd run: $U = 30$, $Z = -1.71$, $p = .143$). In general, responses by all groups tend to occur at strong boundaries at a significantly higher rate than that which would have been observed by random pressing.

In contrast, when responses at weak boundaries are compared, no significant differences were observed for all groups except for the SSL group on the first run (BSL 1st run: $U = 40$, $Z = -.81$, $p = .48$; BSL 2nd run: $U = 45$, $Z = -.41$, $p = .74$; ASL 1st run: $U = 31.5$, $Z = -.87$, $p = .44$; ASL 2nd run: $U = 36$, $Z = -.43$, $p = .73$; SSL 1st run: $U = 18$, $Z = -2.13$, $p = .05$; SSL 2nd run: $U = 36$, $Z = -.46$, $p = .73$; NS 1st run: $U = 40$, $Z = -.93$, $p = .48$; NS 2nd run: $U = 45$, $Z = -.46$, $p = .74$). In these cases, responses at weak boundaries do not differ from random button-pressing. For the SSL group on the first run, the actual number of responses is seen to be lower than chance level. Therefore, responses by all groups at weak boundaries do not exceed what can be expected from random pressing.

Interestingly, when the total number of responses in the 'other' category is compared to the random data, all groups (except the non-signers on the first run and the ASL group on the second run) have a significantly *lower* response rate than would be found with random pressing (BSL 1st run: $U = 20$, $Z = -2.44$, $p = .02$; BSL 2nd run: $U = 10$, $Z = -3.24$, $p = .002$; ASL 1st run: $U = 18$, $Z = -2.13$, $p = .05$; ASL 2nd run: $U = 27$, $Z = -1.36$, $p = .26$; SSL 1st run: $U = 9$, $Z = -2.98$, $p = .004$; SSL 2nd run: $U = 4.5$, $Z = -3.49$, $p = .001$; NS 1st run: $U = 30$, $Z = -1.71$, $p = .14$; NS 2nd run: $U = 0$, $Z = -4.05$, $p = .001$). While no significant differences are observed between the ASL and non-signers group data (for the second and first run respectively) and the random data, the actual figures for responses at 'other' show them to be below chance (ASL group: 52 responses, chance level: 72 responses).

The distribution of paired responses by all groups is provided in Figure 6.4 below. Paired responses are used because although statistical tests on individual attempts

provide comparisons with chance level, they do not capture whether responses occurred in the same places on both runs. Paired responses enable us to see more clearly which responses are deliberate (particularly for 'other' where some responses may be accidental).
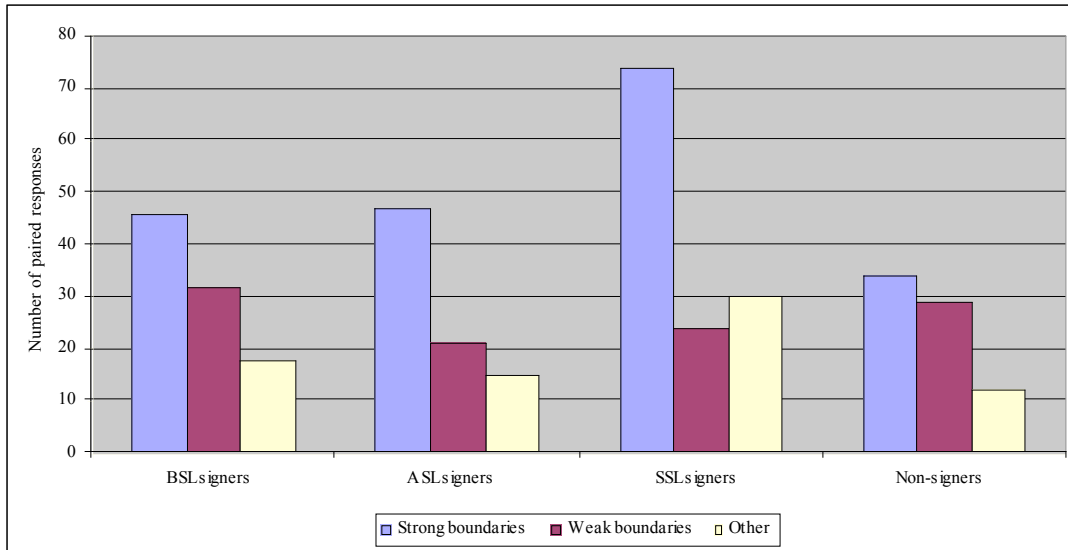
Figure 6.4: Distribution of paired responses by all groups watching the BSL narrative

Figure 6.4 shows that the distribution of paired responses is generally similar for all groups, who have the highest number of paired responses at strong boundaries. The SSL signers produce the highest number of paired responses at strong boundaries (74 pairs) and the non-signers the lowest (34 pairs). The BSL signers produce the highest number of paired responses at weak boundaries (32 pairs) and ASL signers the lowest (21 pairs). The SSL signers also produced the highest number of pairs not occurring at an boundary ('other') (30 pairs) and the non-signers the lowest (12 pairs). A Kruskal-Wallis non-parametric one-way analysis of variance was applied to the following data: (a) all groups at strong boundaries, (b) all groups at weak boundaries, (c) all groups at 'other'. No significant differences were found in each case ((a) H = 6.25, 3 df, p = .1; (b) H = 4.33, 3 df, p = .28, (c) H = 4.08, df 3, p = .25). Overall, the distribution of responses by each group is similar. Figure 6.4 clearly illustrates that all groups can identify strong boundaries accurately when placement of responses are analysed.

6.7.1.1 Summary of results from the BSL narrative

All groups are similar in the number of responses at the first and second attempts at segmentation and the majority of their responses can be placed at prosodic boundaries. When the distribution of responses is considered, responses occur at strong boundaries in the BSL narrative at a greater than chance-level for all groups. Furthermore, when the distribution of responses by each group is compared, no significant differences are found. In summary, when all four groups watch a BSL narrative, they all respond in a similar way.

6.7.2 SSL narrative

Data collected from participants watching the SSL narrative are reported in this section. Firstly, in Table 6.4, an overview of responses for each run and responses in agreement for the SSL narrative is provided. One participant in the ASL group was excluded (see Section 6.6.5 above).

SSL Narrative	1st run	2nd run	In agreement	Total
BSL signers	126	127	93 (74%)	253
ASL signers	119	116	82 (70%)	235
SSL signers	177	179	128 (72%)	356
Non-signers	131	131	87 (66%)	262
Total	553	553	390 pairs	1106

Table 6.4: Total number of responses by all groups watching the SSL narrative

The Wilcoxon Signed Rank test was applied to each group to test for possible differences within groups between the first and second runs. In each case, no significant differences were observed (BSL: $W = 21$, $Z = -.18$, $p = .86$; SSL: $W = 9.5$, $Z = -.21$, $p = .83$; ASL: $W = 6.5$, $Z = -.85$, $p = .40$; NS: $W = 13$, $Z = -.17$, $p = .86$). That is, within each group, there was no difference in the number of responses recorded in the first and second runs. The figures presented in the 'in agreement' column reflect the number of paired responses and their proportional value. The highest number of paired responses in the first and second runs was by the SSL group (35 more pairs than the BSL group in second place) and the lowest by the ASL group.

In Table 6.5, the total number of responses at boundaries in the SSL narrative is presented. Again, the results are presented by group.

SSL Narrative	1st run	2nd run	In agreement	Total
BSL signers	89	99	86 (92%)	188 (74%)
ASL signers	90	86	74 (90%)	176 (75%)
SSL signers	116	123	102 (80%)	239 (67%)
Non-signers	105	106	80 (92%)	211 (81%)
Total	400	414	342 pairs	814

Table 6.5: Total number of responses at boundaries by all groups watching the SSL narrative

Intra-participant reliability was assessed using the Wilcoxon Signed Rank test. No significant differences were observed between the level of responses in the first and second run for each group (BSL: $W = 8.5$, $Z = -1.34$, $p = .18$; ASL: $W = 10$, $Z = -.68$, $p = .47$; SSL: $W = 17$, $Z = -.66$, $p = .51$; NS: $W = 16.5$, $Z = -.21$, $p = .83$). That is, all participants indicate a similar number of boundaries in each run. In both runs, the SSL signers produced the highest number of responses at boundaries and the ASL signers the lowest. Each group produced the majority of their responses at the 21 boundaries. The BSL signers produced the highest number of paired responses at boundaries and the ASL signers the lowest. When percentages of responses are considered, all groups produce the majority of paired responses at boundaries although the SSL signers have the lowest proportion (80% compared to 90% by the ASL signers).

Following division of boundaries into strong and weak boundaries according to the criteria set out in section 6.6.4.2, the distribution of responses can be considered. Results are presented in Table 6.6 below for all groups. As described for the BSL narrative above, the percentage of the total narrative occupied by each category is unequal. Counting the number of time windows for each category (where one time window equals 1.5 seconds), there are 9 time windows representing strong boundaries (13.5 seconds of the narrative), 16 time windows representing weak boundaries (24 seconds of the narrative) and 34 time windows representing 'other' (51 seconds of the narrative). Chance-level data for each group are provided below in the shaded rows.

SSL Narrative	Strong boundaries		Weak boundaries		Other	
	1st run	2nd run	1st run	2nd run	1st run	2nd run
BSL signers	61	64	27	35	37	28
BSL chance level	*20*	*20*	*40*	*40*	*70*	*70*
ASL signers	58	57	32	29	29	30
ASL chance level	*18*	*18*	*36*	*36*	*63*	*63*
SSL signers	62	70	54	53	61	56
SSL chance level	*30*	*30*	*50*	*50*	*100*	*100*
Non-signers	57	57	48	49	26	20
NS chance level	*20*	*20*	*40*	*40*	*80*	*80*

Table 6.6: Distribution of responses by all groups watching the SSL narrative

Using the Mann-Whitney between-groups test, responses at strong boundaries were compared to chance levels in each group. All groups were at significantly higher than chance level (BSL 1st run: U = 0, Z = -4.05, p = .001; BSL 2nd run: U = 0, Z = -4.05, p = .001; ASL 1st run: U = 0, Z = -3.84, p = .001; ASL 2nd run: U = 4.5, Z = -3.51, p = .001; SSL 1st run: U = 0, Z = -4.05, p = .001; SSL 2nd run: U = 0, Z = -4.06, p = .001; NS 1st run: U = 0, Z = -4.06, p = .001; NS 2nd run: U = 0, Z = -4.06, p = .001). In general, there is a significantly higher rate of response at strong boundaries than would be found by random button-pressing. When group responses at weak boundaries are compared to chance level, no significant differences are found (BSL 1st run: U = 30, Z = -1.71, p = .14; BSL 2nd run: U = 50, Z = 0, p = 1; ASL 1st run: U = 27, Z = 0, p = .26; ASL 2nd run: U = 18, Z = -2.263, p = .05; SSL 1st run: U = 40, Z = -.81, p = .48; SSL 2nd run: U = 50, Z = 0, p = 1; NS 1st run: U = 40, Z = -.86, p = .48; NS 2nd run: U = 0, Z = -.81, p = .48). In general, responses at weak boundaries do not significantly exceed what would be observed through random pressing.

As in the previous section, when responses made not at boundaries but elsewhere in the narratives ('other') are compared to the random data, all group results were significantly lower than chance level (BSL 1st run: U = 5, Z = -3.73, p = .001; BSL 2nd run: U = 0, Z = -4.06, p = .001; ASL 1st run: U = 13.5, Z = -2.64, p = .01; ASL 2nd run: U = 9, Z = -2.98, p = .004; SSL 1st run: U = 15, Z = -2.9, p = .007; SSL 2nd run: U = 20, Z = -2.56, p = .02; NS 1st run: U = 0, Z = -4.05, p = .001; NS 2nd run: U

= 0, Z = -4.06, p = .001). That is, for all groups, responses elsewhere in the SSL narrative do not exceed the total number which would be found with random button-pressing.

As responses in the first and second runs are not always aligned, the distribution of paired responses whilst watching the SSL narrative is provided in Figure 6.5. Paired responses indicate that participants are making a conscious decision to respond to a specific point in the narrative.
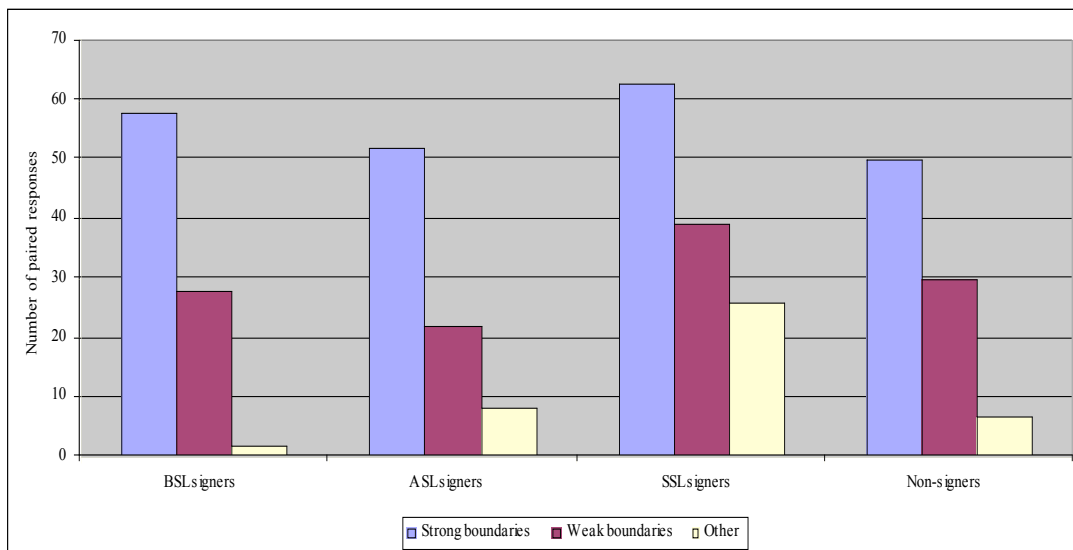
Figure 6.5: Distribution of paired responses by all groups watching the SSL narrative

Figure 6.5 indicates that the highest number of paired responses occurred at strong boundaries for all groups. The SSL signers produced the highest number of pairs at strong boundaries (63 pairs) and the non-signers the fewest (50 pairs). The highest number of pairs at weak boundaries was by the SSL group (39 pairs) and the lowest by the ASL group (22 pairs). The highest number of responses at 'other' was by the SSL group (26 pairs). The lowest number of responses at other points in the narrative was by the BSL signers (2 pairs). A non-parametric analysis of variance (Kruskal-Wallis) was applied to the following data: (a) all groups at strong boundaries; (b) all groups at weak boundaries; and (c) all groups at 'other'. Results show that there no significant differences between groups at strong and weak

boundaries ((a) H = 2.1, 3 df, p = .55, (b) H = 2.91, 3 df, p = .41) but a significant difference for responses at other points in the narrative ((c) H = 9.26, 3 df, p = .03). When the SSL group is excluded from this test, no significant differences between the BSL and ASL groups, and the non-signers are observed (H = .02, 2 df, p = .99). The SSL group made more responses at other points in the SSL narrative when compared to the other groups (although these responses were found to be below what would be expected via random pressing).

6.7.2.1 Summary of results from the SSL narrative

All groups can be seen to be responding in a similar way when segmenting the SSL narrative. The majority of their responses occur at strong boundaries at a significant level above chance and the distribution of their responses is very similar.

6.7.3 ASL narrative

Responses from participants to the ASL narrative are reported in this section. In Table 6.7 below, an overview of the number of button presses is presented for each group. Data from all participants except one ASL signer (see above, section 6.6.5) are included here.

ASL Narrative	1st run	2nd run	In agreement	Total
BSL signers	131	142	80 (59%)	273
ASL signers	160	148	106 (69%)	308
SSL signers	218	221	156 (71%)	439
Non-signers	132	124	74 (58%)	256
Total	641	635	416 pairs	1276

Table 6.7: Total number of responses by all groups watching the ASL narrative

Table 6.7 shows that in each instance, the SSL group produced the highest number of responses whilst watching the BSL narrative. The lowest number of responses was from the BSL signers on the first run and the non-signers on the second run. The Wilcoxon Signed Rank test was used to test for any differences between the total number of responses in the first and second runs for each group. For the BSL, SSL and the non-signers, no significant difference between the total number of responses recorded in the first and second run was found (BSL: W = 10, Z = -1.14, p = .26; SSL: W = 26, Z = -.15, p = .88; NS: W = 15.5, Z = -.84, p = .4). For the ASL group,

a significant difference was observed (ASL: W: 6, Z = -1.98, p = .05). All ASL participants but one made fewer responses in the second run (although in total, there were only 12 fewer button pushes in the second run).

For each group, the majority of responses occurred at the same points in the second run. Table 6.7 above presents the number of pairs recorded and the proportional value. As with previous narratives, the SSL group produced the highest number of pairs in the ASL narrative (50 more pairs than the ASL signers). The lowest number of pairs was found in the non-signers' responses.

In Table 6.8 below, the number of responses at the 34 boundaries marked in the ASL narrative is presented.

ASL Narrative	1st run	2nd run	In agreement	Total
BSL signers	97	111	71 (89%)	208 (76%)
ASL signers	115	115	94 (89%)	230 (75%)
SSL signers	158	162	126 (81%)	320 (73%)
Non-signers	94	83	62 (84%)	177 (69%)
Total	464	471	353 pairs	935

Table 6.8: Total number of responses at boundaries by all groups watching the ASL narrative

No significant differences for any group between the number of responses in the first and second runs were found when the Wilcoxon Signed Rank test was applied. (BSL: W = 11, Z = -1.71, p = .09; ASL: W = 13.5, Z = -.09, p = .93; SSL: W = 22, Z = -.57, p = .57; NS: W = 6, Z = -1.7, p = .09). In the 'in agreement' column, it can be seen that for each group at least 80% of paired responses occurred at boundaries. The highest number of paired responses was by the SSL group and the lowest by the non-signers. In the following paragraph, the distribution of responses in the ASL narrative by all groups is considered. Do they occur at strong or weak boundaries and how does each group vary?

Table 6.9 displays the distribution of responses by all groups to the ASL narrative. Of the 37 boundaries, 18 were classed as strong boundaries (27 seconds of the total running time) and 19 as weak boundaries (28.5 seconds of the total running time) and a further 38 windows which represent the remaining length of the narrative (57

seconds). The chance level for each group watching the ASL narrative is also presented.

ASL Narrative	Strong boundaries		Weak boundaries		Other	
	1st run	2nd run	1st run	2nd run	1st run	2nd run
BSL signers	76	90	21	21	34	31
BSL chance level	*40*	*40*	*30*	*30*	*70*	*70*
ASL signers	90	86	25	29	45	33
ASL chance level	*36*	*36*	*36*	*36*	*81*	*81*
SSL signers	111	107	47	55	60	59
SSL chance level	*60*	*60*	*50*	*50*	*110*	*110*
Non-signers	73	61	21	22	38	41
NS chance level	*30*	*30*	*30*	*30*	*70*	*70*

Table 6.9: Distribution of responses by all groups watching the ASL narrative

In order to determine whether results are significantly different from the corresponding chance level, a Mann-Whitney between groups test was applied. When responses at strong boundaries are compared to chance level, all groups on both runs produce responses significantly higher than chance level (BSL 1st run: $U = 5$, $Z = -3.73$, $p = .001$; BSL 2nd run: $U = 0$, $Z = -4.05$, $p = .001$; ASL 1st run: $U = 0$, $Z = -3.83$, $p = .001$; ASL 2nd run: $U = 0$, $Z = -3.83$, $p = .001$; SSL 1st run: $U = 15$, $Z = -2.9$, $p = .01$; SSL 2nd run: $U = 10$, $Z = -3.23$, $p = .002$; NS 1st run: $U = 0$, $Z = -4.05$, $p = .001$; NS 2nd run: $U = 5$, $Z = -3.75$, $p = .001$). However, when responses at weak boundaries are compared to chance-level, no significant differences are observed between groups and random pressing except for the BSL signers on the second run, the SSL signers on both runs and the non-signers on the first run (BSL 1st run: $U = 20$, $Z = -2.57$, $p = .02$; BSL 2nd run: $U = 30$, $Z = -1.71$, $p = .14$; ASL both runs: $U = 22.5$, $Z = -1.75$, $p = .11$; SSL 1st run: $U = 50$, $Z = 0$, $p = 1$; SSL 2nd run: $U = 45$, $Z = -.44$, $p = .74$; NS 1st run: $U = 15$, $Z = -2.93$, $p = .007$; NS 2nd run: $U = 35$, $Z = -1.33$, $p = .28$). Overall, all groups respond to strong boundaries more often than to weak boundaries on their first and second runs. Responses at weak boundaries are mixed with some significantly lower than chance level in some cases and some showing no difference to random pressing.

When responses elsewhere in the ASL narrative ('other') are compared to chance data, the number of responses in this category is significantly lower than that for random button-pressing (BSL 1st run: U = 5, Z = -3.73, p = .001; BSL 2nd run: U = 15, Z = -2.91, p = .01; ASL 1st run: U = 9, Z = -3.17, p = .004; ASL 2nd run: U = 4.5, Z = -3.5, p = .001; SSL 1st run: U = 10, Z = -3.24, p = .002; SSL 2nd run: U = 20, Z = -2.43, p = .02; NS 1st run: U = 5, Z = -3.75, p = .001; NS 2nd run: U = 0, Z = -4.06, p = .001).

To complete the analysis, the distribution of paired responses by all groups is considered. An overview of this distribution is presented in Figure 6.6 below.
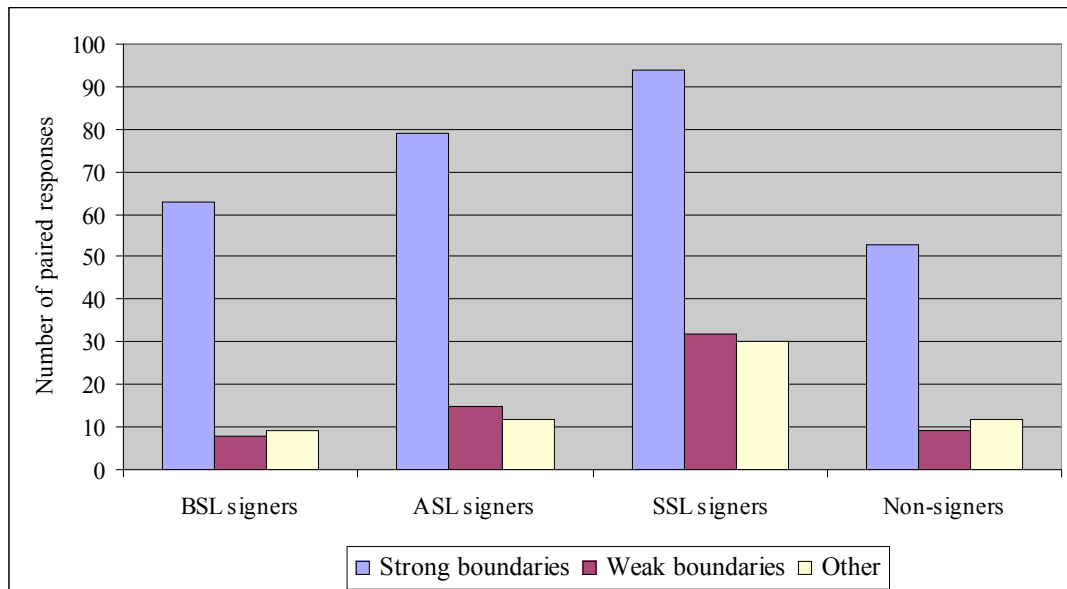
Figure 6.6: Distribution of paired responses by all groups watching the ASL narrative

In Figure 6.6 above, it can be seen all groups produce the highest number of paired responses at strong boundaries. The highest total number of pairs at strong boundaries was produced by the SSL signers (94 pairs) and the lowest number of pairs by the non-signers (53 pairs). For responses at weak boundaries, the highest number of pairs was by the SSL signers (32 pairs) and the lowest number of pairs by the BSL signers (8 pairs). For responses that occur at all other points in the narrative, the highest number of pairs was by the SSL signers (30 pairs) and the lowest number

of pairs by the BSL signers (9 pairs). A non-parametric test of variance (Kruskal-Wallis) was applied to the following data: (a) all groups' responses at strong boundaries, (b) all groups' responses at weak boundaries, (c) all groups' responses at 'other'. Whilst no significance was found for all groups' responses at weak boundaries and 'other', a significant difference was found for strong boundaries ((a) H = 9.7, 3 df, p = .02; (b) H = 6.65, 3 df, p = .08; (c) H = 6.25, 3 df, p = .1). That is, responses made at strong boundaries between groups differed significantly. When the same test was reapplied (this time excluding the non-signers), no significance was found (H = 3.65, 2 df, p = .16). The signing groups were not found to differ significantly from each other in the total number of pairs observed at strong boundaries. When the total number of responses made by the non-signers is compared to the lowest performing signing group: the BSL signers, a result of no significance is observed (Mann-Whitney: U = 42, Z = -.616, p = .58). Therefore, although responses by the non-signers can be said to differ from the signing groups as a whole, they are still similar to the BSL group.

6.7.3.1 Summary of results from the ASL narrative

When responses to U boundaries in the ASL narrative are analysed, all groups can be seen to respond in a similar way. All groups respond to strong boundaries at a level greater than that observed by random pressing and the distribution of responses (whether at strong or weak boundaries) in each group is very similar. Non-signers respond significantly less at strong boundaries than the signing groups.

6.7.4 Discussion of quantitative data

The quantitative results indicate that signers identify a higher proportion of strong boundaries than weak boundaries when watching their native language. The results also indicate that all signers are better able to identify strong boundaries than weak boundaries when watching a narrative signed in an unknown sign language. In each case, group responses were compared to random data and were found to be significantly above chance level when responses at strong boundaries were compared and were found to not differ from chance level when responses at weak boundaries were compared. This finding was replicated in a three-way analysis

among the signing groups: all groups performed similarly whether they were watching a signed language they knew or not. These results indicate that visual markers are highly informative in segmentation because they can be used in the absence of lexical and grammatical cues to segment a narrative.

As well as the signing groups, the non-signers demonstrated that they were proficient at indicating boundaries in all three signed narratives. Like the signing groups, they are more reliable in indicating strong boundaries than weak boundaries. This finding provides strong evidence to support the claims in the previous chapter. Visual markers are highly informative in segmentation: they can be used to identify boundaries by those who know another sign language but also by those who do not know a sign language at all.

The increase in the number of participants has strengthened the data and has allowed us to see clearly the distribution of responses. In addition, the inclusion of two signing groups (SSL and ASL signers) and two signed narratives (in SSL and ASL) allows the testing of the distribution of responses within multiple groups and multiple narratives. The similarity of the findings in each condition indicates that all groups respond to the segmentation task in a similar way regardless of language, and provides further evidence for the claim that visual markers in signed languages in general are highly informative since all groups perform similarly to native signers of that language. However, it is important to remember that although a significant value has been obtained in each condition, the statistical power of this experiment is low. Changes to the experiment design which increase the statistical power of this experiment are suggested in 7.3.

In addition, not only can these boundaries be generally perceived by those who do not know the language, it is clear that the perceptual strength of a boundary is recognised by those who do not know the language. For each narrative, responses by each group to weak boundaries do not differ significantly from chance pressing in contrast to responses at strong boundaries. It is therefore important to consider how these boundaries differ in visual markers in order to determine how those who are

sign-naïve are able to distinguish these boundaries from lower-level boundaries. This avenue for future research is discussed further in the following chapter.

Finally, the frequency of responses at strong boundaries demonstrates that the group watching their native language do not always record the highest number of responses. For example, in the ASL narrative, the highest number of pairs at strong boundaries is by the SSL group and not the ASL group. In this experiment, a clear difference between native signers segmenting their native language and other groups is not observed. In addition, a clear difference between the non-signers and the signing groups is not always observed. Except for the ASL narrative, non-signers respond to strong boundaries at a similar rate to the signing groups. The experiment therefore, does not show an advantage for the signing groups in terms of sign language knowledge when indicating boundaries in a signed narrative.

The null hypothesis put forward in Section 6.5 has been disproved. That is, there is a clear pattern of responses by all groups clustering at strong boundaries at a level greater than chance. Hypotheses 1b and 1c are also disproved. That is, the group watching their native language does not differ significantly from other groups (Hypothesis 1b) and the signing groups do not out-perform the non-signers (Hypothesis 1c). The hypothesis that is proved is Hypothesis 1d: that no difference is observed between groups in their ability to detect boundaries in narratives (in unrelated sign languages) at a level greater than chance. In the following section, results from this experiment are analysed by group, and data collected through a post-experiment questionnaire is presented.

6.8   Results by group

In this section, the results of the experiment will be analysed by group. In addition, questionnaire responses will be discussed.

6.8.1   BSL signers watching all narratives

Figure 6.7 below presents an overview of paired responses by BSL signers during all signed narratives. Figure 6.7 is organised by narrative, with bars indicating

responses occurring at strong and weak boundaries and elsewhere in the narrative (other).
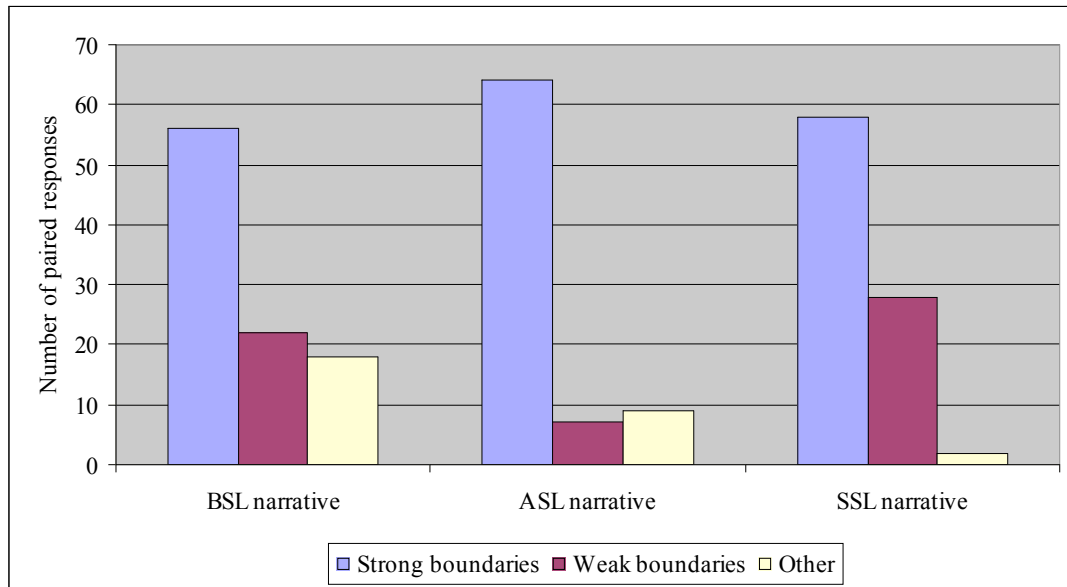
Figure 6.7: Overview of paired responses by BSL signers watching all signed narratives

The distribution of responses by the BSL signers is very similar in all three narratives, with the highest number of pairs observed at strong boundaries in all narratives. In the previous section, it was observed that the number of responses made at strong boundaries was significantly greater than chance and that responses made at weak boundaries and elsewhere did not differ from random button- pressing or were fewer than would be predicted by random button-pressing. The results for each narrative cannot be directly compared as they vary in length and the number of boundaries. However, following each condition, participants were given a questionnaire to rate each narrative on a number of issues. When asked to rate how difficult each narrative was to understand on a scale of 1-7 (where 1 is easy and 7 is difficult), the BSL signers marked the ASL narrative as the most difficult (with an average of 5.2), followed by the SSL narrative (4.2) with the BSL narrative as the easiest of the three (3.5). When asked to rate how accurate they thought they were (where 1 is not very accurate and 7 is very accurate), the BSL participants felt that they were most accurate whilst watching the BSL narrative (with an average score of 4.6) followed by the SSL narrative (3.9) and the ASL narrative (2.6). Participants

were also asked to rate how confident they felt they were about the task (where 1 is not very confident and 7 is very confident). Again, the BSL signers were most confident in their decisions for the BSL narrative (4.3), followed by the SSL narrative (3.8) and finally the ASL narrative (3.0). Participants were also asked to rate how much of the narrative they understood. Unsurprisingly, they rated the BSL narrative the highest (6.9) (where 1 is "didn't understand a lot" and 7 is "understood a lot"), followed by the SSL narrative (5.0) and the ASL narrative (3.9). On a whole, the questionnaire data indicates that the BSL participants as a group rated the BSL narrative (their native language) the highest on each issue. The questionnaire data also indicates that the BSL participants rated the ASL narrative the lowest on each issue.

As well as rating their performance and the narratives, all participants were asked to explain how they decided where to put a full-stop in all the narratives. When describing boundary marking in the BSL narrative (their native language), the explanations demonstrate that participants are clearly attending to visual markers to indicate boundaries.

(6f)   *'[I looked for] head nods…'*

         '[I was] looking for pauses…'

         '[I looked for] head movements, pauses…'

Of the visual markers listed by BSL signers, pauses were mentioned frequently. However, as well as visual markers, the BSL signers also mentioned that they attended to cues at the lexical and grammatical level to indicate boundaries.

(6g)   *'[I looked for] topic change[s] and new information in the story.'*

         '[I used a change in] character, event, role shift.'

         'When [the signer was] done describing something, e.g. the moral of the story is… then full-stop.'

'[I looked for] the start of a subject [or] the end of an event.'

When reporting on their responses to a signed language that they did not know (ASL and SSL), the BSL signers also reported using visual markers to indicate boundaries. For instance:

(6h)   *'[I used] head movements [and] pauses.'*

       '...when facial expression changes.'

       '...when he nods his head.'

       '...when [he] put down [his] hands.'

Despite not knowing ASL and SSL, the BSL signers also reported using role-shifts and other elements linked to the content of the narratives to indicate boundaries.

(6i)   *'...each part involving a different person.'*

       '[I used] pauses, change of scene in story, [and] role shift.'

       '[I looked for] pauses and [for] the end of describing things.'

Role shift is mentioned frequently by all participants when trying to explain how they identified boundaries in a language they did not know. In addition, some BSL signers reported that they identified repeated signs such as 'ANSALDO' in the ASL narrative as indicating a boundary. This sign is repeated 9 times in phrase-initial position as shown in Figure 6.8 following the quotations.

(6j)   *'When he signed the name of the person, I assumed a full-stop went before that.'*

       '...signs that were repeated (the name)'

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ANSALDO   IN   NICE

[ANSALDO IN NICE]
Ansaldo thought the dining room was nice.

Figure 6.8: ANSALDO in phrase-initial position in the ASL narrative

In summary, the BSL participants report that they use a range of visual markers when indicating boundaries in all signed narratives. Additionally, they also report that they use lexical and grammatical cues to indicate boundaries in all signed narratives regardless of whether they know the language or not.

6.8.2 SSL signers watching all narratives

In this section, results and ratings from the SSL signers are presented. Firstly, an overview of paired responses made in each narrative is presented in Figure 6.9 below. Figure 6.9 is divided into paired responses occurring at strong boundaries, weak boundaries and elsewhere in the narrative.
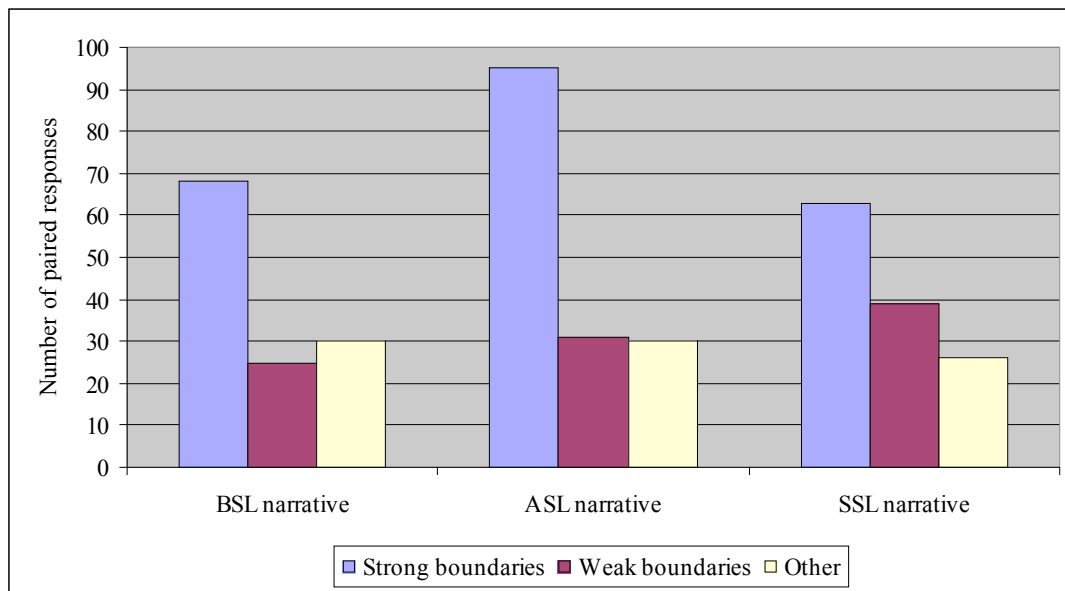

Figure 6.9: Overview of paired responses by SSL signers watching all signed narratives

The distribution of paired responses by SSL signers is similar in all signed narratives. The highest number of pairs is found at strong boundaries for all signed narratives and all were significantly above chance level. In contrast, paired responses at weak boundaries did not differ from chance, and pairs found elsewhere in the narrative (other) were all significantly below chance level.

Following the experiment, and using the same scales as the BSL signers, the SSL signers were asked to rate their performance. The SSL signers reported the ASL narrative to be the most difficult (an average score of 4.4) followed by the BSL narrative (3.8) and the SSL narrative (2.7). The SSL signers felt their judgements were most accurate with the SSL narrative (4.9) followed by the BSL and ASL narratives (3.4 for both). The SSL signers were most confident with their decisions in the SSL narrative (5.3) followed by the ASL narrative (4.3) and the BSL narrative (4.2). When asked to rate how much of the narratives they had understood, the SSL signers indicated that they had understood the SSL narrative the most (7.0) followed by the BSL narrative with a score of 6.0 and then the ASL narrative with 4.1. As a group, the SSL signers gave the SSL narrative the highest rating for each question. Results for the ASL and BSL narratives are mixed. Whilst the SSL signers report that they understood the ASL narrative the least and found it to be the most difficult, they gave similar accuracy and confidence ratings to BSL and ASL.

As with the BSL signers, the SSL signers were asked to describe how they decided where to place a full-stop in the signed narratives. When explaining the criteria they used to decide on boundaries in their native language, the SSL signers indicated that they relied on both visual markers (such as head movements, blinks, pauses) and the content of the story.

(6k)   *'...in the movement of his arms, head and trunk…'*

         '..through nods and pauses…'

         '[I used] role shifting, nods and pauses.'

'[I looked for] nods, blinks, [and I used] the narrative description.'

'[I used] pauses and the structure of the story.'

When viewing an unknown signed language, the SSL signers reported using visual markers such as head movement to help them decide where the boundaries lie. Interestingly, the most frequent visual marker mentioned for the BSL narrative was eye-gaze, for example, when the narrator directed her gaze towards the camera or changed gaze direction. The most frequent marker mentioned in their feedback about the ASL narrative was pauses and head nods.

(6l)   *'...pauses... eye contact towards the camera.'*

'... eye contact, pauses.'

'I looked at the eyes, eyebrows, pauses between the signs, direction of the head.'

'[I used] eye-gaze, nods...'

'...pauses...'

As well as these markers, the SSL signers indicated that they used a change in role to identify boundaries, even in a language that they did not understand. As with the BSL signers, one SSL signer reported using the repeated sign ANSALDO in the ASL narrative to help identify boundaries.

(6m)   *'Through nods, blinks and the shifting between the narrative and the descriptive texts.'*

'...when he changed role was a clue for me.'

'[I used] shifts, pauses and name.'

'The change of perspective...'

For the SSL signers, similar comments to the BSL signers were made at the post-experiment interview. SSL signers reported using visual markers to indicate boundaries in all narratives as well as lexical cues (e.g. ANSALDO) and role shift.

6.8.3 ASL signers watching all narratives

In this section, the results from the ASL groups are presented. As in previous sections, the distribution of paired responses in all signed narratives is presented followed by the questionnaire data. In Figure 6.10 below, the distribution of paired responses is organised by narrative and boundary type.
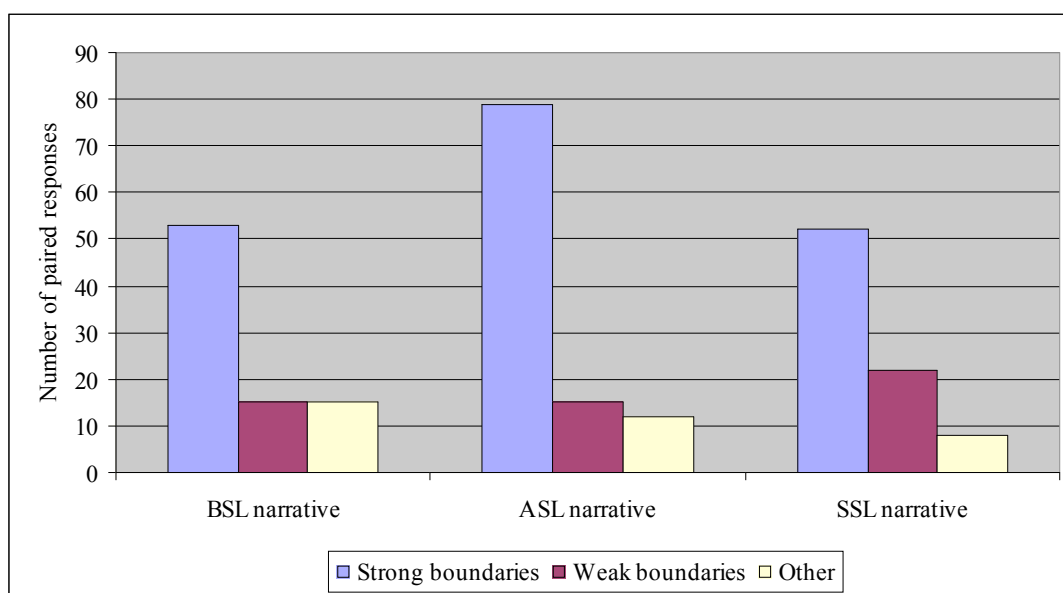
Figure 6.10: Overview of paired responses by ASL signers watching all signed narratives

Figure 6.10 above indicates that the distribution of responses by ASL signers is similar across all narratives. Paired responses by the ASL signers are placed at strong boundaries more frequently than at weak boundaries or elsewhere in the narratives (other). When asked to rate which narrative they found the most difficult, the ASL signers reported that that the BSL narrative was the most difficult (with an average score of 4.2), followed by the SSL narrative (3.6), with the ASL narrative as the easiest (2.1). They reported that they felt they were most accurate when watching their native language (6.0) followed by the SSL narrative (5.0) and then the BSL narrative (4.5). They also reported most confidence with their responses to the ASL

narrative (6.4), followed by the SSL narrative (5.4) and the BSL narrative (4.3). When asked how much of the narratives they understood, ASL signers reported understanding the ASL narrative the most (6.6), followed by the BSL narrative (5.6) and then the SSL narrative (5.1). As did the other signing groups, the ASL signers gave the highest rating for each question to their native language, however, with the average scores for all narratives in the upper half of the scale.

When asked to explain how they decided where to place a full-stop in the ASL narrative, the ASL signers reported attending to both visual markers and lexical and grammatical cues.

(6n)   *'..the signer paused a lot ... and being able to completely understand ASL really helped me decide where to put a period.'*

'...pauses between sentences [and] change of scene or role.'

'...whenever the signer broke eye-contact and moved his head, otherwise I followed the content of the story as well as role shifts.'

'[I used] pauses and head nods.'

When responding to a language that they did not know, the ASL signers again reported using both visual markers and cues from within the story to determine where the boundaries were located.

(6o)   *'[I watched] the eye-gaze of the signer, when she made eye-contact with the (audience) whilst pausing and in combination with a head nod.'*

'[I followed] any pauses or change in position.'

'[I used] repetition, eye blinks, pauses, role shift, head nod.'

'When I see head movements, clasping or spreading out of hands, and when it seems appropriate.'

'[I]tried to make sense of the signing.'

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'The signer moved his shoulders downwards (at ease) and his facial expression [became] neutral, followed the content of the story and role-switching and the sense of the story's pattern.'

'Whenever the storyteller pause[d] in his signing or when he switches the person who is talking.'

'[When there was a] change of scene, [or a] change of person speaking.'

Responses by all groups to the post-experiment questionnaire were very similar. All groups rated their native language the highest in each instance (such as being the most confident in responses made to their native language). They also reported that they used visual markers and lexical and grammatical cues to identify boundaries in their native language and indicated that they also perceived these types of cues when watching a narrative signed in a language that they do not know.

6.8.4 Non-signers watching all narratives

In this section, the non-signers' responses are reviewed. In Figure 6.11, the distribution of paired responses in all signed narratives is presented, arranged by narrative and type of boundary.
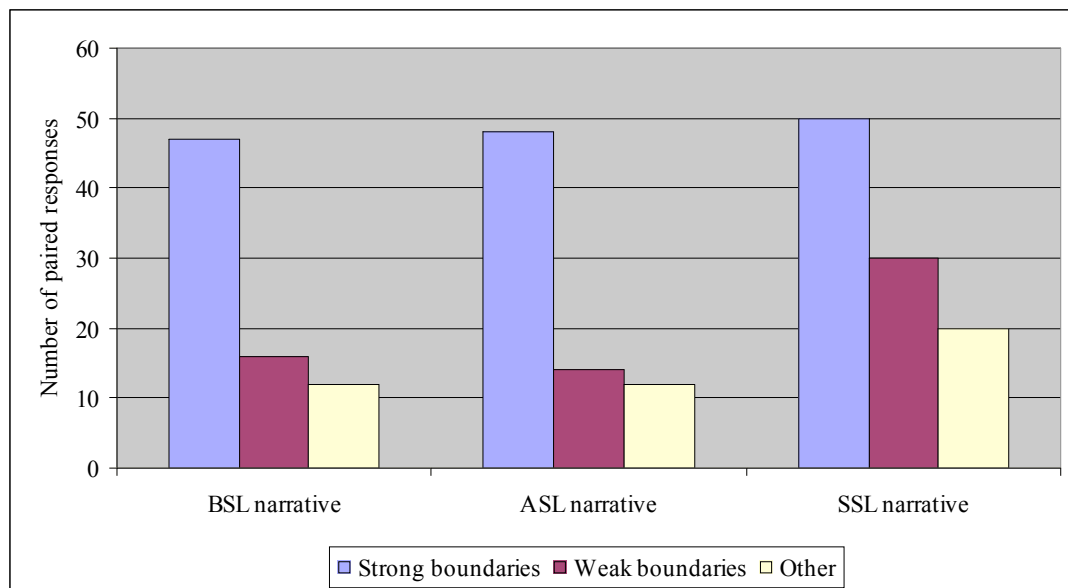
Figure 6.11: Overview of paired responses by non-signers watching all signed narratives

In Figure 6.11 above, the distribution of paired responses by the non-signers is consistent across all narratives. The highest number of pairs is observed at strong boundaries in each case, (over 40 pairs for strong boundaries) followed by weak boundaries and 'others' (with 30 pairs or less for each language). When asked to rate each narrative for difficulty, the non-signers reported that they felt the ASL narrative to be the most difficult (average score of 5.5), followed by the SSL narrative (4.8) and then the BSL narrative (4.1). When asked to rate accuracy, the non-signers reported that they believed they were least accurate in the ASL narrative (1.6) followed by the SSL narrative (2.3) and then the BSL narrative (2.4). The non-signers also reported that they were more confident for the BSL and SSL narratives (an average of 2.5) than for the ASL narrative (1.5). Although the non-signers reported the ASL narrative to be the most difficult, the differences reported were small. In general, the non-signers report lower scores than the signers in all the signed narratives. Finally, the non-signers were asked to indicate how much of the narrative they had understood. They reported understanding the BSL narrative the most (3.2) followed by the SSL narrative (1.9) and finally the ASL narrative (1.2).

The non-signers were also asked to explain how they decided where to place a full-stop. Their responses indicated that they used a variety of visual markers to determine where boundaries were positioned.

(6p)   *'By seeing where the person paused for a bit longer and drew out their movements or longer.'*

'[I looked for] a pause in the flow of signing or a change in expression.'

'[I pressed the button] when the person paused in their hand gestures or if they looked straight ahead rather than around…'

'I used the changes in facial expression in the man, when it changed I put in a full-stop.'

'More the facial expression of the woman; when she seemed to have a relatively expressionless face, I put a full-stop.'

Non-signers frequently reported looking for a change in facial expression or position or for 'a break' in signing where no signing occurred. In addition, they also reported using changes in character or topics to determine boundary position despite not understanding the narrative fully.

(6q)   *'[I used] pauses in the signing, inferred changes in the topic, facial expressions, switched from characters/actions.'*

'[I used] actions, eye contact, switches in perceived characters, plot lines in the story.'

'[I used] pauses in signing, change of character in story, change of facial emotion.'

Interestingly, when watching the BSL narrative, some of the non-signers indicated that they attempted to lip-read the narrator to determine what was being said and when to press the button.

(6r)   *'[I used] pause[s], change of expression and lip reading.'*

'[The] actions of [the] 'dog', imagining the story which was largely possible due to lip reading of words such as bone and water.

In addition, one non signer mentioned attempting to lip-read the SSL narrative but found it difficult to do so.

(6s)   *'I tried to use pauses in signs and mouthing of words but this was very difficult this time.'*

When asked to rate their performance, the non-signers reported being least confident in their decisions overall (when compared to other groups). However, their comments indicate that they attend to different types of cues to indicate where the

boundaries lie in a signed narrative. These cues include visual markers (such as lengthening, a change in facial expression and pauses) and cues such as role-shift and a change in topic. What is different from the other groups is the claim that they attempted to lip-read the narrators to indicate boundaries. These similarities and differences between groups are discussed in greater detail in the following section.

6.8.5 Discussion

This discussion brings together the findings from the questionnaire data and the comparison of the distribution of responses by group before ending with a chapter summary.

The questionnaire data provide a clear indication that all participants are aware of visual markers that may be associated with boundaries. Importantly, the questionnaire data indicates that participants are looking for similar cues in all narratives regardless of whether they know the language or not. In each case, they mention markers such as pauses, head nods, blinks, and changes in facial expression, all of which have been shown to coincide with boundaries in signing. As well as an awareness of visual markers, the signing participants, when watching their native language, also indicate that they are looking for linguistic information. The signing groups also report that they used a change in role or a change in the topic of the story to decide on boundaries. These comments, alongside the use of visual markers, suggest that signers consciously make use of both visual markers and cues from lexical and grammatical information to determine boundary placement. When watching an unknown signed narrative, it is surprising to see that signers mention that they used a change in role or topic to determine boundary placement despite not having access to the linguistic content. Therefore, participants appear not to be viewing visual markers superficially but are attempting to associate meanings such as role shifts with body leans for example. When one considers the similarities in the type of markers associated with role shifts in narrative storytelling (such as a change in head and torso position) across signed languages and between signed and spoken languages (Earis 2008), it is not surprising that this association is easily made. However, this raises some concerns. To what extent can it be claimed that the

signers have no access to the content of the narrative when viewing a signed language that they do not know? Both the BSL and SSL signers reported using the character's name (ANSALDO) which occurred in phrase-initial position several times, to identify a boundary. It of course may be possible that although participants have recognised accurately that the repeated sign represents a character in the story, they are subconsciously responding to visual markers that are co-articulated with ANSALDO (such as a backwards head tilt) linked to topic marking and therefore the beginning of a new phrase, rather than to the name.

As well as the visual markers investigated in the current thesis, the participants report further markers that have not been analysed for frequency in this thesis but which may make a significant contribution to boundary detection. For example, eye-gaze is frequently mentioned as a determining factor in boundary placement when viewing an unknown sign language. This is not surprising since a change in eye-gaze often accompanies a change in role. The direction of gaze can also change from the periphery to the camera lens (since the narrators were instructed to retell the narratives facing the camera). Since eye-gaze is used as a tool in turn-taking (Argyle & Cook, 1976), a direct gaze at the camera may be used by the narrator as a surrogate for a conversational partner to cue boundary points, in turn assisting participants to detect boundaries.

None of the signing participants mentioned the use of mouthing as a cue for boundary detection, instead focusing on other visual markers. In contrast, the non-signers reported using information on the mouth when watching the BSL narrative. Since the BSL narrative uses British English mouthing, British non-signers are in a position to understand part of the story by lip-reading where there is sufficient information to be obtained in this way. However they cannot successfully use this strategy for the Swedish narrative, which has Swedish mouthing, although this was attempted by one participant. It is possible that non-signers are not attempting to understand the content of what is being said but are watching for periods of no lip movement contrasting with periods of lip movement. This may be a marker to boundary placement in face to face communication.

A condition using a video of a spoken narrative without the audio channel was included in the segmentation experiment reported in Chapter 5. Although a full analysis has not been undertaken for this thesis, preliminary analysis of responses by non-signers and native signers of BSL showed that participants identified boundaries as occurring when lip movement was absent (i.e. in gaps between sentences). It is interesting to note that the comment about the use of information on the mouth was not made for the ASL narrative, although ASL can also use English mouthings. It should be noted, however, that the non-signing group were users of British English and may have found mouthing in ASL more difficult to lip-read than mouthing in BSL. It should also be noted that ASL has been reported to use less mouthing in narratives than in conversation (Nadolske & Rosenstock, 2007). The extent to which the mouth can vary in function (i.e. between mouthings, mouth gestures and echo phonology) may have an effect on how a signed stream is perceived as a whole. When asked to rate difficulty, the non-signers do rate the ASL narrative as being the most difficult narrative to segment. Whether this finding is down to the use of mouthings in ASL (and the extent to which it may be different from mouthings in the BSL and SSL narrative) is not clear but this possibility cannot be dismissed.

Related to the question of accessibility of BSL mouthings, to what extent do BSL boundary features resemble gestural features accompanying British face-to-face spoken interaction? Since all the non-signers included in the experiment were British, any similarities between visual markers in BSL and visual markers found in face-to-face interaction in British English may have made the BSL narrative easier for the non-signers to segment. ASL may in general use features that are similar to American English and this may be less familiar to some British participants. Although an understanding of how narrative features in a signed language and the spoken language used in the same country is beyond the scope of this thesis, any possible influence of shared visual cues found in populations in British culture (English speakers and BSL signers) is a matter of interest as well as any general cues found in populations where English is the common spoken language. Alternatively, BSL and SSL may share some northern European gestural features in narratives than

ASL which would have an effect on how narratives are perceived by participants of different language backgrounds. These questions have been left to future research.

The consistency of responses to strong boundaries can be seen for all groups watching all three signed narratives. This consistency is interesting in light of feedback on accuracy, difficulty, confidence and understanding. For example, despite low average scores for each of these, the non-signers' responses have a similar distribution to those of the signing group for each narrative, with their responses largely placed at strong boundaries. The non-signers often underestimate their performance in each task, particularly in comparison to the signing groups. A similar finding is reported in Brentari (2007), where non-signers returned lower confidence scores overall when compared to ASL signers in a boundary detection task despite being able to successfully detect boundaries. In addition, the signing groups always give the highest confidence ratings to their native language in each instance despite having similar scores for accuracy for the narratives in an unknown signed language. This may be because they recognise that they are able to make full use of all the cues in the narrative, not just visual markers but the other lexical and grammatical cues that they can access in their native language. An attempt to mark boundaries in an unknown signed language using visual markers alone may be regarded as more difficult if they typically prefer to make use of all cues involved (or have a greater reliance on lexical and grammatical cues than visual markers). In short, boundary marking strategies between narratives might differ depending on whether individuals know the signed language in question or not.

Although all participants have shown themselves to be consciously aware of different types of cues associated with boundaries in signed narratives, it remains difficult to say with certainty which cues had the most effect on their decisions about boundaries. The questionnaire data have illustrated that several factors contribute to boundary detection under different conditions. In the following chapter, areas for future research are proposed as these results are discussed in relation to other findings in this thesis.

6.9   Summary

This chapter has further confirmed that visual markers are highly informative for boundary position, and are accessible to those who do not know a signed language. In addition, signers watching an unknown sign language are able to detect boundaries at a reliable rate. Although all groups were able to detect strong boundaries at a level above chance, the non-signers were the least confident in their performance when compared to signers watching an unknown sign language. In addition, all groups show an awareness of different types of markers that function as boundary markers regardless of whether they know a language or not.

Chapter 7: Discussion and summary of the thesis

In this chapter, the findings from the thesis' two main areas: the production of visual markers at IP boundaries and the perception of prosodic boundaries by different groups will be brought together. This discussion also aims to locate these findings in the context of current literature on sign language and audio-visual prosody. Following this discussion, the strengths and limitations of the thesis will be outlined. Finally, the chapter ends with suggestions for future avenues of research in the visual prosody of signed languages.

7.1   The production of visual markers in BSL narratives

In Chapter 3, an analysis of IP boundaries in eight BSL narratives showed that the edges of IPs are marked by a number of non-manual and manual features described as visual markers. The inventory of non-manual features found to coincide with these boundaries comprised head nods, single head movements, repeated head movements, torso leans and movements, brow movements, and blinks. Manual features comprised holds, handshape spread and pauses. Furthermore, it was shown that these visual markers varied in the extent to which they occurred at IP boundaries and that none of the markers occurred at the majority of boundaries as linguistic markers. Of the 418 boundaries analysed in the narrative data, the three most frequent markers (when only linguistic markers are considered) recorded at IP boundaries were single head movements (46%), holds (30%), eyebrow movement (22%) and head nods (21%). The three least occurring markers were the torso (7%), pauses (7%) and handshape spread (2%).

The results from the frequency analysis show that visual markers that have been strongly associated with IP boundaries in sign language literature occur at less than half of the boundaries analysed. For example, it has been suggested that a change in head position marks IP boundaries (Nespor & Sandler, 1999; Sandler, 2005; Sandler & Lillo-Martin, 2006; Sze, 2004) and similar claims (that an overall change in facial expression marks an IP boundary) have been made for brow movements (Nespor & Sandler, 1999; Sandler & Lillo-Martin, 2006). That is, where brow movements

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which are associated with specific constituents occur (e.g. topics) their domain is the IP. In the BSL data, single head movements are present at 46% of the boundary data whilst a change in brow position is present at 22%. It has also been suggested that blinks are a reliable indicator of IP boundaries in ASL (Baker & Padden, 1978; Brentari & Crossley, 2002; Wilbur, 1994, 1999, 2009) and in BSL (Stone, 2009) although their reliability has been debated in HKSL (Sze, 2004). However, boundary marking blinks are only observed at 10% of the boundaries identified in the BSL narratives. Other low frequency markers in the narrative data studied here that have been strongly associated with IP boundaries in the sign language literature include head nods (Wilbur, 2009), pauses (Sandler, 2005; Wilbur, 2009), and holds (Wilbur, 2009). Other markers that are not frequent in the data are markers that have not been explicitly linked to IP boundaries, for example, repeated head movements (8%). Non-dominant handshape spread, when analysed as a phonologically empty unit, has been identified as marking smaller prosodic constituents (the phonological phrase) in ISL and ASL (Brentari & Crossley, 2002; Nespor & Sandler, 1999; Sandler, 2006; Sandler & Lillo-Martin, 2006) and occurs less frequently than other markers in the narrative data (2% overall).[27] Overall, results from the narrative data suggest that determining a reliable and consistent marker of IP boundaries in BSL narratives by frequency alone will be impossible.

A general analysis of these visual markers shows that some frequently occur as an important narrative device. These include single head movements that mark role or enact an action of a character in the story and brow movements that convey a character's emotional state. Blinks can occur as part of a physical need to blink or as a response to the hands moving need the face and are not always boundary marking. Handshape spread is not always a phonologically empty unit but can originate from a classifier functioning as an important reference point in the story. These markers may also occur with IP boundaries but are not restricted to occurring at these boundaries. For example, it was noted that the head, torso, brow and non-dominant hand when performing a narrative function could spread beyond an IP boundary. In

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[27] Brentari and Crossley (2002) also observe that the non-dominant handshape spread coincides with phonological phrase boundaries. However, these boundaries were also identified as IP boundaries.

contrast, linguistic use of the same markers tended not to persist beyond an IP boundary. This was explained in Chapter 3, where the head and the torso were shown to be held in position over a boundary to represent a character's role within the discourse. In addition, the brows were held in position over an IP boundary when conveying the attitude of a character as was handshape spread originating from classifier constructions and functioning as an important part of a signed sequence (such as marking role or a reference point within the discourse). It was noted that whilst these markers were held in position, boundaries could be identified using other markers such as pauses, holds and head nods. Since these markers do not return to a neutral position after the boundary, this may present a challenge for segmentation of a sign language based on markers (at a superficial level) alone.

Interestingly, it was observed that markers which involved repeated movement (such as the head and torso) did not spread beyond an IP boundary and that repeated movements analysed as a narrative element were not precisely aligned with the time windows assigned to boundaries. Some explanations were suggested. Firstly, because the onset and offset of these visual markers are aligned with a lexical sign and therefore will not spread across a boundary. In addition, repeated movements that enact an action of a character in the story are gestural and therefore will not necessarily be time-aligned with prosodic boundaries. Finally, only visual markers that are static are able to spread across a boundary. In Nicodemus (2009), it was noted that markers that involved repeated movement were less frequently observed at boundaries when compared to markers that were held. Nicodemus concludes that markers that are held are more effective at indicating boundaries when compared to markers involving repeated movements. If this is the case, it is not surprising that markers involving repeated movements do not spread across a boundary in the data here as boundaries are often punctuated with periods of held positions.

The findings in this thesis highlight the need to understand how visual markers interact with prosodic boundaries in difference contexts. For example, the results presented here might be specifically characteristic of narrative signing and therefore cannot be generalised to other signing contexts (e.g. conversational signing). It has

been shown that narrative signing involves a greater use of role-shift in Auslan (de Beuzeville et al., in press) and this may in turn lead to a greater use of the head and torso to signal role. In addition, since a change in eye-gaze (as well as head and torso position) can signal role (cf. Earis 2008) and blink rate is demonstrated to vary in different situational contexts of signing (such as monologue vs dialogue (see Sze 2004)) an increase in Type III blinks at boundaries may also be typical of narrative signing. The increase in these markers as narrative devices may have an impact on the frequency of the same markers as cues to prosodic boundaries. Therefore, the low frequency of markers strongly associated with IP boundaries in other signed languages (such as the head and the eyebrow) might be typical of signed narratives. In an analysis of rhythmic side-to-side movements of the torso, Boyes-Braem (1999) observes that this type of movement is not observed in specific types of discourse such as pantomimic-like-passages. Therefore, signed narratives, where a high occurrence of constructed action sequences and pantomimic gestures might be expected, may impact on the frequency to which a specific marker is observed at boundaries. However, it was demonstrated that some markers, when performing a narrative function, can overlap with linguistic use of the same markers. For example, the head might tilt in one direction to mark role but can indicate a boundary with a slight upwards movement or a head nod (nested head movements, see Stone, 2009) or linguistic use of the eyebrows might combine with affective uses. The observations made here highlight a growing need to understand how visual markers align with prosodic boundaries in a variety of signed discourse since it is very possible that a difference in the distribution of visual markers and their frequency at boundaries might be observed.

The low frequency of linguistic visual markers present problems when one attempts to define how an IP is typically marked using the results of the analysis conducted here. Although the data suggest that markers typically associated with IP boundaries points (such as the head and eyebrows) do occur, they are not frequent enough to be considered a consistent marker. Further analysis of manual rhythm is required to properly characterise how an IP boundary is marked. This analysis would need to

refer to repetitions and the size of a sign in phrase final position (whether it is larger than signs in non-final position).

In addition, some visual markers may be marking a higher boundary at the discourse level and above the level of the IP. For example, a change in head and torso position may correspond more closely with role boundaries (Earis, 2008). Handshape spread cannot always be analysed as an empty phonological unit which spreads to a prosodic boundary but can represent a classifier functioning as a point of reference and may therefore correspond to a boundary at a higher level. This is discussed in the following section where participants' responses were found to frequently coincide with discourse boundaries.

One of the aims of this thesis has been to determine whether visual markers can be used at a superficial level to identify boundaries. An analysis of visual markers at boundaries in BSL narrative resulted in several observations which pose problems for straightforward association of specific markers with segmentation. There is no single marker that is present at all of the 418 boundaries analysed here. The most frequent marker at boundaries is single head movements (46%). In addition, single head movements also occur at other boundary points but perform a narrative function. In turn, these head movements cannot be expected to occur within an IP but can span more than one phrase when marking role. At a superficial level, the difference between the use of the head in each context may not be clear and therefore an approach that attempts to segment a signed narrative without reference to context may be misleading. In addition, blinks occurring at IP boundaries are not always linked to the function of boundary marking. When the number of boundaries featuring a blink (regardless of function) is counted, blinks can be found at 56% of the boundary data. These include physiological blinks (Type I), blinks linked to head and gaze changes (Type III) and voluntary blinks (Type IV). Again, the difference between these blink types at a superficial level may not be clear. In addition, voluntary blinks are said to have a lexical function in marking assertion or stress and therefore are not restricted to the end of a phrase (Stone, 2009; Sze, 2004; Wilbur, 1994, 1999, 2009). The claim that blinks are not restricted to the end of an IP

boundary can be extended to Type I and III blinks where blinks are either physically motivated (e.g. connected to the articulation of a sign such as the hands moving closely to the face) or temporally linked to head and gaze changes independent of boundaries (Stone, 2009; Sze, 2004). Although it is suggested that the timing of these blinks can vary (voluntary blinks are longer than other blink types (Sze, 2004; Wilbur, 1994, 1999) and Type I blinks are shorter than Type III (Sze, 2004)) they remain formationally similar. That is, all blinks have an opening and closing phase and the difference between blinks in form may not be obvious.

The present study has shown that BSL makes use of a large inventory of visual markers when marking prosodic boundaries in narratives. However, determining reliable and consistent markers of IP boundaries is not simple. The fact that some markers are not exclusively linguistic and in turn cannot be expected to align with boundaries presents a problem for automatic segmentation. This may also present a challenge for the linguist when attempting to parse a signed narrative with reference to these markers at a superficial level. These issues lead us to the remaining chapters of the thesis, which focus on the perception of boundaries and discuss in detail the reliability of visual markers for online segmentation of signed narratives.

7.2   The perception of boundaries in narratives by different groups

To determine whether these boundaries can be reliably perceived, a series of segmentation experiments by groups with different levels of language experience was conducted. Firstly, native BSL signers were asked to watch a video of a signed narrative and to press a button when they saw a boundary. The findings from the experiments reported in Chapter 5 and 6 provide strong evidence that responses by BSL signers watching a BSL narrative are aligned with boundaries that have been independently identified by linguistic analysis. In each experiment, the majority of their responses occurred at these boundaries at a level above that of chance pressing. This finding agrees with perceptual studies in ASL where it has been shown that native signers agree on where the boundaries lie in a signed stream (Brentari et al., 2007; Nicodemus, 2009). However, this does not provide full evidence for visual markers as being reliable or crucial tools for sign language segmentation since native

signers can also make use of cues deriving from lexical and grammatical information in the text.

The inclusion of a second group consisting of non-signers showed that even those who do not know a signed language are able to identify boundaries in a signed BSL narrative. Since the non-signers are unable to use lexical and grammatical cues to segment a narrative, their ability to detect boundaries in a signed BSL narrative suggested that visual markers are highly informative of boundary position. This conclusion is further supported by the experiments reported in Chapter 6 where non-signers were able to successfully identify boundaries in a second BSL narrative. Furthermore, this was also found for additional conditions: non-signers watching a signed ASL and SSL narrative (reported in Chapter 6). The findings suggest that visual markers to boundaries are perceived in a reliable way by both signers and non-signers when watching a signed narrative. A further finding is that all groups systematically respond to certain boundaries over others. Participants were instructed to press a button when they saw a sentence boundary, and the number of responses at specific boundaries was calculated. Therefore, variation amongst groups in the number of responses at sentence boundaries was expected. It was hypothesised that the non-signers would be unable to discriminate between boundaries that coincided with a sentence boundary (strong boundaries) and those that did not (weak boundaries). However, this was not the case. Instead, non-signers were able to able to identify strong boundaries successfully and they scored at below chance level on weak boundaries (as did the signers).

The similarities between the two groups are surprising when one considers what is available to each group when segmenting a signed narrative. Since the native signers are segmenting their native language, they not only have access to visual markers but also to the lexical and grammatical content of the narrative. In contrast, the non-signers do not have access to lexical and grammatical cues. Despite this, a similar distribution of responses (indicating preference for strong over weak boundaries) between the native signers and the non-signers is observed.

An analysis of boundaries that were marked frequently in Chapter 5 attempted to determine what level of constituent was identified by participants. It was noted that boundaries that attracted a higher number of responses corresponded with a discourse boundary. These boundaries represented points in the narrative that occurred before a new theme was introduced to the story or when a previously mentioned referent was foregrounded. In general, responses were not found to coincide with lower level boundaries (such as boundaries at the level of the IP). This pattern was observed for both the BSL and SSL narrative. In Chapter 6, this observation was tested further by examining responses at U boundaries in general which were then grouped into 'strong' or 'weak' boundaries. Strong boundaries represented U boundaries that coincided with a discourse boundary (termed a narrative unit in this thesis). In general, participants' responses were found to occur at strong boundaries at a level greater than would be expected by random pressing. Furthermore, responses at weak boundaries did not differ from what would be expected by chance.

A qualitative analysis of the boundaries that produced a high number of paired responses compared to those with no paired responses, shows that some differences could be observed. Strong boundaries were characterised by changes in head and torso position and other infrequent markers such as strong pauses and holds. Boundaries which received no paired responses from participants were characterised by spreading of non-manual and manual features (e.g. a torso lean to the right to mark role being held in position over an IP boundary, or non-dominant handshape representing a classifier spreading over a boundary). The layering of different types of markers (and their intensity) at boundaries may have an effect on their perceptual strength which is reflected in the judgments made by participants of different backgrounds. In an ASL study of visual markers to boundaries identified by ASL participants, Nicodemus (2009) observed that markers using larger articulators such as the hands (in hand clasps) and body leans had a high relative frequency.[28] It was suggested that this finding may be explained by perceptual features. That is, larger

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[28] Prosodic markers were grouped into four categories: hands; head and neck; eyes, nose and mouth; and body, and frequency was compared within groups.

articulators are more successful at indicating boundary position (driven by the perceptual needs of the viewer) and smaller markers (such as the face) may play a supporting role. As the results in this data suggest larger articulators correspond with the boundaries identified by participants, Nicodemus's findings can be tentatively applied here. Further research on the differences between visual markers and how they are layered at strong and weak boundaries is suggested in the following section.

In Chapters 5 and 6, additional conditions were introduced to the segmentation experiment so that further evidence for the conclusions made here could be obtained. In Chapter 5, native BSL signers and non-signers were instructed to identify the boundaries in a narrative presented in an unknown signed language (SSL). Results showed that both groups identified boundaries successfully and that no clear differences between the groups could be observed. The results also confirmed that visual markers are reliable indicators of boundaries since neither the non-signers nor the BSL signers were able to access cues at the lexical and grammatical level in SSL. In the experiment discussed in Chapter 6, the addition of two new signing groups (native signers of ASL and SSL) and an extra signed narrative (ASL) provided further evidence. For each narrative, all groups were able to identify boundaries successfully and no clear differences between the native signers of the language being viewed and the other three groups were observed. Again, a linguistic analysis in each narrative showed that participants' responses coincide with boundaries at a discourse level (such as when a new character is introduced to the story).

Interestingly, the results from Chapter 5 and 6 show that there are no clear differences between signers and non-signers when both groups view an unknown sign language. Although signers have native experience of a language expressed in the visual-gestural modalities, no differences between them and non-signers in the location or accuracy of responses during the segmentation tasks are observed. As far as the results of the experiment are concerned, knowing another sign language does not facilitate the identification of boundaries in an unknown sign language. This result is similar to findings in a perceptual study in ASL (Brentari et al., 2007). In

this study, ASL signers and non-signers were successful at identifying the presence of an IP boundary in a set of ASL sentences. However, the groups differed in their confidence levels, with the non-signers reporting overall lower confidence scores than the ASL signers. Similar results were obtained from feedback collected through a post-experiment questionnaire described in Chapter 6. That is, non-signers generally reported lower confidence scores (although it is not possible to say whether the difference is significant) than the signing groups when asked to indicate how accurate they felt their decisions were and how well they thought they had done. Despite the non-signers having been shown to be adept at identifying boundaries in signed narratives, they underestimated their performance in each condition. The findings here can also be compared to another study looking at perception of boundaries in an unknown spoken language (Carlson et al., 2005). This study demonstrated that speakers could identify the presence and strength of a boundary in an unknown spoken language on prosodic cues alone. The current study demonstrates that similar findings can be obtained for viewing an unknown language in a different modality (the visual-gestural modality).

As well as being asked to rate their performance, participants were also asked to describe how they had decided where the boundaries were in each narrative. When commenting on segmenting their native language, signers of BSL, ASL, and SSL stated that they used visual markers such as pauses, a change in facial expression, head nods and holds along with lexical and grammatical cues such as role shift and a change in topic. When segmenting a narrative that they did not know, signers reported that they made use of the same visual markers and, perhaps surprisingly, mentioned cues such as role shift and changes in topic as assisting their decision, despite having no access to the meaning of what was being signed. Non-signers also indicated that they used visual markers as well as cues such as a 'shift in character and actions' in the story despite reporting that they understood very little of what was being signed.

The feedback from the questionnaire raises the question of how subjects are able to make use of visual markers at a superficial level when segmenting an unknown sign

language. The visual features used to identify role (such as movements of the head and the torso) are similar in the three sign languages and this might make the task of assigning meaning to these utterances easier for the signers. Non-signers, however, must be using their experience of gestural cues in face-to-face communication to mark boundaries. Very similar devices (the use of the head to represent a character's point of view) are found in spoken language face-to-face communication (McClave, 2000) and in spoken language narratives (Earis 2008). Therefore, both signers and non-signers are able to draw on common features in signed and spoken language communication.

The issue of whether the non-signers are using knowledge of gestural cues in face-to-face communication to interpret visual markers in general can be applied to visual markers occurring at boundaries. Studies of audio-visual prosody have reported that visual markers produced whilst speaking are aligned with prosodic features of speech (Bolinger, 1986; Cavé et al., 1996; Dohen et al., 2005; Flecha-Garcia, 2006; Guaïtella et al., 2009; Hadar et al., 1984; Munhall et al., 2004). There is also evidence that these visual features are attended to when perceiving audio-visual speech (Bernstein et al., 1998; Dohen et al., 2004); and that errors in perception or delayed responses can occur when they are mismatched with the speech stream (House et al., 2001; McGurk & MacDonald, 1976; Swerts & Krahmer, 2005) but that overall perception is improved when vision and sound are aligned (Swerts et al., 2003). These observations, underlining the importance of visual markers in face-to-face communication, have been extended to include the detection of boundaries (Barkhuysen, Krahmer, & Swerts, 2005, 2006; Barkhuysen et al., 2008). Together, these studies suggest that non-signers are not gesturally naïve but are sensitive to visual markers produced whilst speaking and therefore might apply this experience to sign language segmentation tasks. As mentioned in the previous paragraph, the extent to which visual features of signed and spoken narratives perceived audio-visually are similar may enable the non-signers to perceive these markers more readily. There has been limited study of the extent to which these markers are similar in spoken and signed narratives (although see Earis (2008) for a comparative

analysis of role and point of view and their visual markers in BSL and spoken English narratives) but several studies have pointed out similarities in visual markers produced whilst signing to those found in speech (e.g. Antzakas, 2007; Janzen, 1999).

Another possibility is that non-signers may use their knowledge of how spoken language is parsed into its constituents in the speech stream to guide their decisions when viewing signing. In Vaissiere's (1983) typological study, it was shown that unrelated spoken languages exhibit similarities in the function and form of prosodic cues. Our findings suggest that there is a modality-independent match between elements in spoken and signed languages. For example, signed narratives use phrase-final lengthening to mark phrases. Therefore, non-signers watching a signed narrative may recognise an abstract category of 'hold' as one possible method of lengthening and apply knowledge of how spoken language is structured prosodically (phrase-final lengthening) to their analysis of signed languages.

Returning to the post-experiment questionnaire, feedback collected from all groups indicates that other visual markers – lip-reading and eye-gaze - are attended to that are not included in the frequency analysis in Chapter 3. Only the non-signers reported that they attempted to lip-read what was being said in order to access the content of the signed narrative and to decide where the boundaries were positioned. In Chapter 5, a further experimental condition involving a silent recording of an Aesop Fable in spoken English was mentioned. In this condition, native signers of BSL and hearing non-signers were asked to press a button when they saw a sentence boundary. Preliminary analysis of participants' responses suggests that responses by both signers and non-signers are strongly aligned with the movement of the lips. In other words, participants appeared to be attending to periods of lip movement contrasted with periods of no lip movement to detect boundaries. As well as lip reading, a further cue mentioned by all participants was eye gaze. Both the non-signers and the signers reported that boundaries were identified where the narrator made eye contact with the camera or changed gaze direction. The use of eye gaze to

cue turns at boundaries has been reported (Argyle & Cook, 1976) and these may therefore serve as a marker of boundaries in narrative monologues.

In addition to manual and non-manual markers, it is also apparent that signers make use of lexical cues to identify boundaries. For example, in the ASL narrative, the character's name, 'ANSALDO', is frequently articulated in phrase-initial position and this repetition is noticed by the BSL and SSL signers as a possible indicator of boundary position. Therefore, signers do not only attend to manual and non-manual cues for boundary position but will respond to other cues within the signed stream. However, it is worth noting that ANSALDO is also co-articulated with visual markers associated with boundaries and topic marking (i.e. a head nod, a change in head position, raised brows and pauses). Therefore, it is not clear whether signers are responding to the lexical sign as an indicator of boundaries or to the visual markers that are simultaneously and sequentially layered with the sign. The presence of distinctive lexical cues, together with lip-reading and eye-gaze may indicate that further evidence is available to participants to identify boundaries beyond the visual markers analysed in Chapter 3.

Since a number of possibilities exist to aid each group in segmentation tasks, it cannot be assumed that all groups use similar markers (or a similar combination of markers) to identify boundaries. In Brentari et al.'s (2007) study, it was shown that although ASL signers and non-signers identified boundaries correctly, they differed in strategies used to locate boundaries. ASL signers attended to specific markers whilst non-signers attended to a broad range of markers and this was in turn attributed to differences in language experience. Brentari et al.'s study highlights the possibility that differences may still exist between groups which cannot be seen clearly here. Groups or individuals may use different strategies, or be sensitive to different markers, when locating boundaries but with similar results. Questions about what sign language segmentation involves and how tactics may differ according to language experience are suggested for future research (see Section 7.4).

7.3   Strengths and limitations

In this section, the strengths and limitations of the thesis are discussed. Since the field of sign language prosody has not been thoroughly researched, it is hoped that the limitations described here will provide guidance for further studies in production and perception of prosody in signed languages.

This thesis is the first to look at the production and perception of visual markers at prosodic boundaries in BSL. A further strength is the use of narratives signed by everyday users of the language. In each case, in the production and perception sections, the narrators are experienced storytellers who use sign language (whether BSL, SSL or ASL) as their preferred language. In addition, the three groups of signers who participated in the segmentation tasks were all native (or near native) users of the language. There have been no previous studies looking at boundary perception in these languages as a group. Therefore, the thesis is uniquely positioned to answer questions about the perception of boundaries in sign language by users of three unrelated sign languages.

A further strength of this thesis is that it reports online segmentation of a signed narrative. Therefore the data collected are as close as possible to understanding real time segmentation by native users of a sign language. This thesis is also unique in that it examines perception of visual prosody in an unknown signed language by native sign language users. The inclusion of ASL and SSL signers in the study reported in Chapter 6 enables the conclusions drawn to be supported by comparing group performances across several narratives. In addition, responses from the non-signing group can be directly compared to native users of that language and users of other sign languages. Overall, the similarities observed between groups are highly informative and provide strong backing to the claims made in this chapter.

A particular strength of this study is that responses by all groups were compared to responses that would be seen by random button-pressing. The calculations that determined the level of responses at boundaries was based on the actual conditions of the experiment. That is, the length of the narratives determined the number of

response windows (columns in the Excel spreadsheet) and the number of responses which were distributed randomly within each row (each representing a single participant) was the average number of responses for each group. The numbers obtained from the random conditions reflect the differences between narratives and response totals for each group, and permits greater confidence in the reliability of the responses reported here. Furthermore, participants were required to segment both narratives twice. This confirmed that the majority of responses made by each participant in the first run coincided with a response in the second run, confirming that these responses did not occur at random but were motivated responses to a stimulus.

This study is also the first to use ELAN software for experimental purposes. The use of tiers to represent participant responses time-aligned to a video allowed the analysis of those responses in relation to specific points in the signed narrative. ELAN is being increasingly used for transcription and analysis in sign language linguistics and these experiments have demonstrated how ELAN can be further adapted to answer a broad range of questions in sign language experimental research.

Finally, the results from the experiment clearly indicate the importance of visual cues in sign language segmentation and in comprehension of a signed narrative. A major strength of the study is that it attempts to create a bridge between the literature on audio-visual prosody and on sign language prosody. The conclusions in this thesis have the potential to support further research, particularly in spoken language face to face communication and for research on signing avatars where the inclusion of visual markers may improve perceived naturalness and ease of segmentation.

The findings of this study can provide further directions for research in sign language prosody. However, there are a number of limitations which are described below together with suggestions as to how they may be overcome in future studies. In choosing to examine online segmentation of a pre-existing short narrative, some sacrifices are made. Firstly, no specific claims can be made about boundary marking

strategies (e.g. which visual markers subjects use to identify boundaries). The length of a narrative and the number of boundaries, as well as the number of visual markers that combine simultaneously and sequentially at those boundaries present complexities in analysis. In other words, the simultaneous and sequential layering of several markers makes it difficult to identify which markers are the primary motivators of a given response. Furthermore, the number of boundaries that received a high number of responses was too small to enable the identification of which visual marker(s) was used to identify boundaries. This also means that it is difficult to see whether groups (e.g. native signers versus non-signers) differ in the type of marker they look for when identifying boundaries. These shortcomings could be overcome by increasing the length of the narratives (and potentially the number of boundaries). For example, in Nicodemus' study (2009), the length of the stimulus video was approximately 22 minutes, in contrast to the narratives in this study which are each approximately 2 minutes in length).

A further limitation of this study is the use of questionnaires to directly ask participants how they identified boundaries in each signed narrative. Although the feedback from the questionnaire data is informative, it can only tell us which markers participants are aware of but not which markers participants are using to identify boundaries. However, the feedback from the questionnaire data also clearly demonstrates that subjects, including non-signers are not gesturally naïve but are attempting to interpret the occurrence of visual markers when watching an unknown sign language. This offers a further perspective on the data analysed here that could not be obtained from statistical analysis.

Some limitations in the research design were overcome during the course of this research. In Chapter 5, it was reported that the number of participants (6) in each group was too small to obtain significant responses. This was rectified in Chapter 6 by increasing the number of participants in each group to 10. Furthermore, the absence of a group of native signers of SSL in the first study was noted. Whilst BSL signers and non-signers responded in a similar way whilst watching an SSL narrative, it was impossible to know if they responded in a similar way to how SSL

signers would respond. This shortcoming was overcome by the inclusion of an SSL group and an additional group of ASL signers in the second experiment, providing a unique perspective on sign language segmentation by participants from different (and unrelated) sign language backgrounds.

An important limitation lies within the statistical analysis reported here. That is, the sample size for the experiments is very small and as a result, the statistical power (the ability for the statistical tests used here to correctly reject the null hypothesis) is low. Although a significant value is returned frequently when responses by groups are compared to random pressing, there is a need to carry out the test again with a larger sample size in order to achieve the required power level (where power is at least 0.8). When a-priori power analysis is carried out to determine the required sample size to achieve an appropriate level of power, a sample size of at least 34 participants is required if a p value of <.05 is desired and a sample size of at least 50 for a p value of <.01. As the study has shown that there is no difference between the first and second try, these responses could be summed together to form one group. Therefore, a sample size of between 17 to 25 participants to a group would give the test the appropriate level of statistical power. An easier alternative would be to increase the number of narratives for each language. This way, the group size could remain at 10 (as in Chapter 5) and each participant would be asked to watch five narratives each presented in the same language (e.g. BSL). Responses could then be summed together as one group of 50 participants watching BSL narratives.

One limitation of the study lies in the instructions given to participants. Participants were asked to identify the end of a sentence or where they would put a full-stop and responses at prosodic boundaries were analysed. Depending on a signer's rate and style of signing, a single prosodic constituent could include more than one sentence. One issue that has not been investigated here is whether the signers when watching their native language respond to sentence boundaries if defined by syntactic criteria (whether they are aligned with prosodic boundaries or not) while non-signers only respond to prosodic boundaries. However, this line of research was not considered since what constitutes a sentence in sign language is not clear (e.g. Crasborn, 2007).

This question is particularly complex when looking at sign language narratives where other elements (such as constructed action and classifier constructions) can add to the complexity of decision-making. It was decided that the conditions of the experiments (real time segmentation of a two minute narrative) would not enable a sufficient investigation of this issue to take place. Instead, some avenues of research aimed at answering this question are suggested in the following section, although it should be remembered that the majority of responses made by all participants were associated with the boundaries identified in this thesis.

In spoken languages, it has been shown that the division of a speech stream into IPs is subject to variability in rate or style of speech (e.g. Cruttenden, 1995; Nespor & Vogel, 1986). In addition, idiolectal differences between speakers and how they use prosodic cues to mark boundaries have been reported (Cutler and Isard (1980) (cited in Warren, 1996)). The possibility that signers may exhibit variation in boundary marking and structuring of a signed stream into prosodic constituents is high although it has not been explored in detail here. The analysis of the production of visual markers in IP boundaries only included two signers. Although some variation in the frequency of markers at boundaries was observed, future studies should focus on the production of these markers in a larger group of signers.

This also highlights a further limitation concerning the narrative data used for the perceptual experiments. In each experiment, only one narrator is used to represent each of the languages under scrutiny. Any differences between boundary perception in the narratives may not be attributable to the language but rather to the degree to which a signer's style has contributed to the prosodic organisation of the text. Therefore, idiolectal differences between each narrator and other signers must be considered. It is also important to note that the signed narratives were not matched for difficulty. Since the narratives each involve a different signer telling a different story in a different language, it is hard to determine whether these narratives present the same level of difficulty to participants. If visual markers are not robust across signers, this could present a challenge for individuals when marking boundaries. Therefore similarities in the distribution of responses must be viewed as restricted to

the narratives included here and not generalised to all sign language narratives. To overcome this limitation, it is suggested that future studies include more than one narrative for each language, each retold by a different signer.

The claims made in this thesis on the production and perception of visual markers to indicate boundaries is restricted to signed narratives and cannot be extended to other types of signed discourse (such as conversational signing). Visual markers can be expected to vary in frequency and distribution according to discourse type (e.g. Sze, 2004) and therefore different results may be expected from a frequency analysis of markers in other discourse types. These differences may affect the level of agreement between groups when segmenting different types of signed discourse. Whilst a similar distribution of responses whilst watching a signed narrative is found among the groups in this study, it is possible that there may be different patterns when viewing other discourse types.

For all its limitations, the course of this thesis has been worthwhile. This study is the first serious attempt to look at the production and perception of visual markers in BSL and has been a learning experience. In considering the study limitations, ideas and questions for future research projects have developed and are explored in the following section. It is hoped that the lessons learned in this thesis will inform and encourage future projects in the field of sign language prosody.

7.4   Ideas for future research

The work reported in this thesis has shown that visual markers are aligned with IP boundaries and that prosodic boundaries at the discourse level are reliably perceived by different groups. However, much research remains to be done. These areas of potential interest, yet to be explored, apply to both the production and perception of visual markers at boundaries in sign language. In this section, ideas for future research are suggested. These ideas have developed over the course of the thesis and focus not solely on theoretical areas of interest but on methodological issues also (such as how the current research design could be modified to answer these questions). Research conducted with the aim of exploring the ideas put forward here

will enable a better understanding of the production and perception of visual markers at boundaries in signed languages and of sign language prosody as a whole.

An obvious area for future research is to extend these findings to other types of signed discourse. It was mentioned in the previous section that one area in which the study is limited is that the findings are restricted to signed narratives. Therefore, it should be a priority to look at the perception and production of boundaries in other types of signing such as conversational signing. The production of visual markers may be different from those reported in narrative signing and, in turn, variation in the type and frequency of visual markers at boundaries may present a new challenge for signers and non-signers when asked to identify boundaries. A similar research design to the one presented in this thesis could easily be applied to other types of signing. It is also of crucial importance that the findings discussed here be tested with a larger sample. Since idiosyncratic variation in type and frequency of markers at boundaries is expected, it is a potential area of interest to know the degree to which individual variation is found. Another area for further research which will be very informative is the relative frequency of visual markers at IP boundaries. In a study into German Sign Language, it was noted that a set of markers (such as blinks, change in gaze, lengthening) were not exclusive to boundaries (Hansen & Hessman, 2007). The current investigation of visual markers at boundaries was restricted to specific time windows and therefore did not consider whether these visual markers occur elsewhere in the phrase. How often do these markers occur elsewhere in the phrase when compared to their frequency at boundaries? And to these markers occur when expected? For example, does brow raise always occur with constituents (such as topics and conditional clauses) with which they are associated? In addition, handshape spread (when prosodic) is dependent on whether an IP contains a two-handed sign. Therefore, its low frequency in the study reported in this thesis may be due to a low occurrence of two-handed signs. Its reliability as a boundary marker might then be judged according to whether it stops spreading at a boundary and not by its frequency at IP boundaries overall. Studies that aim to clarify this will bring us closer to determining the reliability of a given marker.

As well as studies examining markers independently, further studies looking at how visual markers are layered at boundaries will be of great interest. Although the current study has described the co-occurrence of some markers at boundaries, a detailed study of how visual markers combine simultaneously and sequentially at boundaries remains to be undertaken. Such a study would address whether some markers systematically occur with other markers. In addition, for sequentially arranged markers, it will be interesting to observe whether there is a systematic order to markers at boundaries. For instance, it was observed that head nods at boundaries were delayed when a hold on the final sign in a phrase occurred. In such cases, the head nod occurred after the completion of the hold. Studies aimed at addressing these issues will show whether the temporal organisation of visual markers at boundaries is highly constrained. Additionally, it will be interesting to see which combinations are most common. In Nicodemus' study (2009) the frequency of markers occurring sequentially, simultaneously or overlapping with the most frequent marker (hand clasps) was calculated. Surprisingly, nearly a third of her boundary data showed markers to occur sequentially with hand clasps (and not simultaneously as anticipated). Similar questions should be applied to future studies on boundaries in narratives and other types of signed discourse.

Instead of focusing on the physical presence of a given visual marker at boundaries, it would also be of interest to learn how these markers vary in degree or intensity of movement and how these may be (or may not be) related to the strength of a boundary. The use of motion capture technology in sign language research may assist in providing a detailed analysis of this aspect of prosody. Another area of interest is in the temporal organisation of signs in a sequence (as shown in Boyes-Braem, 1999) and the presence of a rhythmic structure which may also provide further cues to boundaries. It has been shown that the relative length of durational markers such as holds and pauses at boundaries in ASL may vary depending on the syntactic constituency (Grosjean & Lane, 1977). In addition, the size of signs are larger in phrase-final position (Nespor & Sandler, 1999) and this should be examined in future studies.

In addition, a detailed analysis of boundaries above the level of the IP needs to be conducted in future. This would focus on U boundaries and the frequency of visual markers observed at these boundaries as well as the discourse boundaries identified by participants in the perceptual experiments. These areas highlight further issues that may have an effect on the perception of boundaries in sign language by different groups.

The claim that the low frequency of linguistic markers to boundaries in the BSL narratives might be linked to discourse type needs to be investigated further. For example, does the increase of these markers as narrative devices lead to a decrease in their usage as linguistic markers? In some cases, these uses were shown to overlap. For example, the head could be held in one position to signal role and an IP boundary may be marked by a short upward thrust of the head which does not affect its overall position. However, it was not investigated whether specific constructions which require non-manual markings had these features. For example, how often in the narratives are topics that are not marked with a raised brow (as would be expected) observed? In these cases, the brow might be used primarily for marking character or conveying the emotional state rather than marking a topic which might be signalled using other means (e.g. a short pause).

Future studies should not be restricted to examining the production of markers at boundaries but should focus on which markers are more successful at indicating boundary points and whether they might differ according to group (signers and non-signers). In Nicodemus' study (2009) it was noted that the most frequent markers at boundaries identified by ASL signers were those involving larger articulators. The experiments reported in Chapter 5 and 6 could be replicated using longer narratives which would increase the number of boundaries identified by participants. A frequency analysis applied to this experimental data could show which markers are the most frequent at boundaries identified by native signers and compared to boundaries identified by non-signers to look for possible differences in the type of visual markers attended to. A larger data set would also permit analysis of any differences in terms of visual markers between boundaries with varying levels of

agreement, compared to boundaries with no responses. This has been reported on a small scale in the qualitative analysis reported in Chapter 5 but a larger study is required. Alternatively, an approach similar to Brentari (2007) where participants are shown a short signed sequence of fixed length (as opposed to a full narrative) and asked to indicate whether a boundary is present would be very informative. This would enable a statistical analysis of responses against the type of markers present at each boundary. In the ASL study, this analysis led to the conclusion that ASL signers and non-signers differed in the markers they used to decide whether a boundary was present.

An intriguing area for future research involves working with manipulated data where participants are invited to make judgements on boundary position without access to the full range of markers. One possibility would be to crop the video narrative so that only the hands are visible to participants. Participants would then have to rely on markers visible on the hands, such as holds on signs in phrase final position). Such reduction in information may reveal differences between different groups. Alternatively, the approach used by some studies of spoken languages has been to examine whether boundaries can be reliably perceived in the absence of pause features (e.g. Carlson et al., 2005) and this could be applied to studies of sign language boundary perception. This could involve stopping the video on the final frame in which a sign is articulated and asking participants to judge whether a boundary followed the sequence of signs or not. This line of investigation could be taken further by focusing on specific markers in the absence of pause features, for example, if phrase-final lengthening adds to the perceptual strength of a boundary. From the narrative data, a set of BSL utterances could be created where the last sign in each sequence is of a different length and could be the final sign in the sentence. Participants would then be asked to judge whether or not a major boundary immediately follows. An analysis of responses would then determine whether signers (and non-signers) are sensitive to the length of the final sign in a sequence. Any findings from such studies will further our understanding of how individual markers contribute to the perceptual strength of a boundary and how effective they

are at signalling boundaries whether independently or in combination with other markers.

Future studies should also investigate exactly what sign language segmentation involves and to what extent the visual markers examined here are important to this process. Research in spoken languages has suggested that prosody has an important role to play in this process (Cutler et al., 1997; Frazier et al., 2006) although, in the context of other cues from syntax, it is relegated to a supporting role in the grouping of words into constituents (Cutler et al., 1997:161). Whilst it can be said that visual markers, in general, reliably indicate boundaries in signed languages on their own (in the absence of cues from the grammar), no specific claims can be made here about what sign language segmentation by a native signer involves. We may ask how important visual markers are in grouping signs into constituents in the context of other cues from syntax. Do they have a supporting role (such as enhancing the perceptual strength of a boundary) or are they simply redundant in context of other cues from the grammar? As well as examining the status of visual markers in the context of syntax, future theoretical studies of interest might focus on how individual markers compare with each other. In Eisenstein & Davies (2005), it is reported that whilst manual gestures correlate significantly with sentence boundaries in speech, they are redundant as cues in the context of language and pause features. However, the authors argue that gestural cues can be a useful tool for segmenting speech when speech is unclear. It is possible that individual markers in sign language may vary in how important they are at identifying boundaries (e.g. an overlapping of larger articulators with blinks for instance). These theoretical questions have been left to future research.

The current thesis has shown that signed and spoken languages use similar elements (such as head movement to represent a character's voice) to mark boundaries and that these elements are perceived by signers and non-signers in a similar way. Therefore, the status of these markers is a matter of interest. These elements may be gestural in both signed and face-to-face communication. Alternatively these elements may be gestural in face-to-face spoken communication but may have been

linguisticised in sign languages (similar claims have been made for negation in Greek Sign Language (Antzakas, 2007)). Even if the latter is true, it may not apply equally to all visual markers in signed languages, since some markers may be more linguisticised than others. An in-depth comparative analysis looking at these cues in both signed and face-to-face spoken communication will shed light further on these alternatives.

Although it has been suggested that work on other types of signed discourse should be undertaken, issues remain with sign language narratives that would be interesting for future research. For instance, in narrative signing signers frequently make use of sequences of constructed action and classifier constructions to convey elements of the story. The use of these elements in relation to prosodic structure has been discussed in the literature. For example, Aronoff et al. (2003) report that classifier constructions 'can continue without rearticulation across several IPs' in ASL. Classifiers and their influence on boundary perception are another area of interest for future research. In addition, the simultaneous use of visual markers in sequences of constructed action and classifier constructions and how these functions overlap with prosodic elements in signing is also of interest.

7.5 Summary

In conclusion, the field of sign language prosody has not been explored to a great extent and as a consequence we are far from a complete understanding of how this area of linguistics, predominantly explored to date within the aural-oral modality, applies to a visual language. A new interest in the field of sign language prosody is timely. An investigation into prosody should seek to answer how this system is organised and how it interfaces with other levels of the grammar. An understanding of how prosody is structured in a different medium has the potential to inform current thinking of language production and perception as a whole.

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APPENDIX 1

Experiment 1

'The Hare and the Tortoise' (BSL narrative)

1. [HARE TORTOISE]
    The hare and the tortoise.

2. [NEVER-MIND IX EXPLAIN]
    Don't worry, I'll tell you the story.

3. [TORTOISE TORTOISE TORTOISE-CRAWL-ALONG]
    The tortoise was crawling along.

4. [HARE HARE-BOUNCE-ALONG IX LAUGH SLOW POSS IX RUN
    FAST]
    *The hare bounded up beside the tortoise and laughed at him because the
    tortoise was so slow whilst he was so fast.*

5. [TORTOISE WAIT-A-MINUTE IX CAN BUT TAKE-IT-EASY IX]
    'Hang on a minute' said the tortoise, 'I can go faster but I'm taking it easy'.

6. [TWO-OF-US RACE TWO-OF-US OKAY]
    'Say, let's have a race okay?'

7. [HARE LAUGH TWO-OF-US RACE TRUE LAUGH OKAY]
    *The hare laughed out loud. 'Are you serious?' (he asked). 'Okay then, let's
    have a race.'*

8. [BUT LET-KNOW OVER-THERE LINE FINISH IX WHO WHICH
    ARRIVE FIRST PROOF OKAY]
    'Over there is the finish line. Whoever gets there first is the winner okay?'

9. [PALM-UP PLEASE-YOURSELF]
    'Okay, if you please!' (said the tortoise).

10. [OKAY READY BOTH-SIDE-TO-SIDE]
    'Ready?'

11. [HARE-RACE-AHEAD]
    The hare raced ahead.

12. [TORTOISE TAKE-TIME]
    The tortoise crawled along at a slow pace.

13. [HARE HARE-RUN-FAST-EVERYWHERE]
    The hare ran really fast.

14. [HOT AWFUL HOT SUN HARE-SLOW-DOWN]
    The weather was so hot and the hare started to get tired.

15. [FAR ALRIGHT LIE-DOWN BREATHE HARE-BREATHES]
    (The tortoise) was far behind so he lay down to catch his breath.

16. [LOOK NOTHING LIE-DOWN]
    He saw nothing so lay down to rest

17. [TORTOISE-CRAWLS-ALONG]
    The tortoise was still going slow.

18. [HARE-LIE-DOWN PALM-UP FALL-ASLEEP LITTLE-BIT ASLEEP
     DEEP SLEEP]
    The hare thought he would sleep for a little bit and then fell into a deep sleep.

19. [TORTOISE-CRAWL-ALONG IX TORTOISE-CRAWL-ALONG
     ARRIVE]
    *The tortoise was crawling along at a slow pace and saw the hare asleep by
    the side of the track. Crawling along he neared the finish line.*

20. [HARE WAKE THINK SEE NOTHING FAR LITTLE-BIT NEVER-
     MIND]
    *The hare woke up thinking it had been asleep for a short while and looking
    back behind him couldn't see the tortoise anywhere.*

21. [HARE-SURPRISED SEE IX TORTOISE ARRIVE FINISH PANIC
     HARE-RUN-FAST ARRIVE]
    *But looking ahead, the hare was stunned to see that the tortoise was actually
    close to the finish line. In a panic, he raced ahead and reached the finish line.*

22. [TORTOISE PASS FIRST]
    But the tortoise passed the finish line first.

23. [HARE HARE-EMBARRASSED EMBARRASSED HARE-
     EMBARRASSED]
    The hare was really embarrassed.

24. [TORTOISE SAY PALM-UP]
    The tortoise said to the hare 'there you go'.

25. [MEAN QUICK WAIT]
    This means, don't go too quickly…

26. [AS-YOU-GO TAKE-EASY ACHIEVE PALM-UP]
   ... take your time and you'll achieve your goal.

Two Friends and the Bear (SSL Narrative)

1. [TITLE]
    Title…

2. [TWO FRIEND AND BEAR]
    …two friends and the bear.

3. [TWO FRIEND BOTH]
    The two friends…

4. [HIKE COUNTRY WAY HIKE PERSON WALK HIKE]
    …were walking along a country road…

5. [CATCH-SIGHT-OF IX BEAR BEAR-WALK BEAR-APPROACH]
    …when suddenly they saw a bear coming towards them.

6. [IX FRIEND IX FLEE FRIEND-CLIMB-TREE TREE CLIMB-TREE
     HOLD-ONTO-TREE IX]
    One of the men ran to the nearest tree and quickly scrambled up it.

7. [IX PALM-UP HOW PALM-UP HAVE-NOT OPPORTUNITY PALM-UP]
    The other saw that he had no chance...

8. [REMEMBER AGREE HEAR]
    …but then he remembered…

9. [BEAR NEVER ATTACK SOMEONE DEAD]
    …that bears won't attack a dead body.

10. [PERSON-LAY PLAY DEAD PERSON-LAY SLEEP BREATHE SILENT
     BREATHE]
    The man lay down playing dead and held his breath.

11. [HEART HEART-BEAT WISH SILENT IX HEART-BEAT HAND-LAY]
    He wished his heart wouldn't beat so loud.

12. [BEAR WALK-UP SNIFF HEAD SNIFF EAR SNIFF STAND-STILL
     SNIFF BACKPACK PUSH-WITH-NOSE MAN-LAY-STILL NOSE-
     STILL NEVER-MIND WALK-AWAY GO-AWAY]
    *The bear came up and sniffed him all over: his face, one of his ear, and his
    backpack as well, pushing at it with his snout and then left him on his own.*

13. [MAN LIE-DOWN AWAKE-SLOWLY THERE-IS-NOT BEAR
     RELIEVED]
   The man opened his eyes slowly, looked around, and saw to his relief the bear had gone.

14. [GO-UP LOOK-AT MAN HOLD-ON-TO-TREE]
   He stood up and looked at his friend in the tree…

15. [PALM-UP BEAR GO-AWAY PALM-UP COME]
   'You can come out now – the bear has gone away.' (he said)

16. [IX MAN-CLIMB-DOWN OUT-OF-BREATH]
   The friend came down from the tree

17. [IX SEE BEAR NOSE-SNIFF POSS EAR]
   'I saw the bear sniffing close to your ear.

18. [SEEM IX TELL SOMETHING SECRET TO-YOU EAR PALM-UP]*
   He must have told you a secret?' (asked the friend)

19. [NO NOT SPECIAL]
   'No, it was nothing really' (replied the friend).

20. [PALM-UP YES-YES ONE IX SAY]
   'Well, he did say one thing…

21. [IX WILL-NOT FIND FRIEND PERSON FLEE NOT HELP IX HAPPEN
     CAUTION GO-AWAY WILL-NOT]
   …he told me that I shouldn't choose friends who desert me when danger approaches.'

APPENDIX 2

Experiment 2

'The Dog and the Bone' (BSL narrative)

1. [[[BONE IX]IP[DOG IX WHAT]IP]U]NU
The bone and the dog.

2. [[[DOG IX]IP [DOG-WALKING]IP]U]NU
The dog was walking along…

3. [[[BUTCHER IX SHOP IX]IP [SAW]IP]U [[BEAUTIFUL BONE WANT IX]IP]U]NU
He saw something in the butcher shop. It was a beautiful bone and he wanted it.

4. [[[DOG-SNEAK-UP]IP [TAKE-BONE]IP [RUN-AWAY]IP]U]NU
The dog snuck up, snatched the bone, and ran away.

5. [[[VILLAGE FAR]IP [DOG-RUN-AWAY]IP]U [[AT-SPEED]IP [DOG-RUN-AWAY]IP]U
He ran far from the village as quickly as he could.

6. [[HILL]IP [DOG-RUN-AWAY]IP]U]NU
He ran up a hill.

7. [[[SEE WHAT]IP [BRIDGE]IP [WATER THIS-AREA]IP]U[[DOG-SLOW-DOWN]IP [BREATHE]IP]U [[BONE-IN-MOUTH]IP [FIRM]IP [BONE-IN-MOUTH]IP [RELAX]IP]U[[DOG-WANDERS]IP [DOG-SEE-SOMETHING]IP]U]NU
He saw the bridge and the water under the bridge. The dog slowed down to catch his breath and with the bone held firmly in his mouth, he began to relax. He caught sight of something.

8. [[[WATER THIS-AREA]IP [DOG-LOOK-IN-WATER]IP]U [[OTHER DOG IX]IP]U [[BONE BONE-IN-MOUTH]IP [DOG-STARE-AT-OTHER-DOG]IP]U [[BOTH-STARE-AT-EACH-OTHER]IP]U]NU
The dog looked into the water and saw another dog. With the bone held in his mouth, he looked at him. They both stared at each other.

9. [[[DOG LOOK]IP [LOOK]IP]U]NU
The dog stared at him and the dog in the water stared back.

10. [[[IX BONE IX]IP [TRUE BEAUTIFUL]IP]U [[BONE THICK]IP [MEAT IX]IP]U [[WANT IX]IP [IX TRUE]IP [DROOL BONE-IN-MOUTH]IP]U]NU

The other bone was really beautiful. It was thick and meaty. He really wanted it.

11. [[[IDEA HAVE AREA IX HIDE IX]IP]U [[POSS BONE]IP [CAN IX DIG-
    HOLE]IP [PUT LEAVE]IP]U [[IX COME-BACK EAT IX FIRST IX]IP]U
    [[LATER IX BACK EAT IX]IP [DOG-STARE-AT-WATER]IP]U]NU
    *He had an idea to hide his bone somewhere. He would bury his bone and
    leave it somewhere. Then he would come back and eat the other bone. Later,
    he would return to eat his bone. He stared at the water.*

12. [[[DOG DOG-IN-WATER-STARE-BACK]IP [IX BARK]IP]U [[DOG
    SAME BARK IX]IP [DOG-STARE]IP]U]NU
    *The dog in the water stared back and he barked at him. The dog did the same
    thing and barked back. The dog stared at him.*

13. [[[SEE TEETH SHARP]IP [DOG-STARE-AT-WATER]IP]U]NU
    ...could see his sharp teeth as he stared back.

14. [[[BONE-FALL-OUT-MOUTH]IP [WANT FIGHT IX]IP [DOG-LUNGE-
    AT-WATER]IP]U]NU
    The bone fell out of his mouth as he lunged to attack the dog.

15. [[[WHAT BONE DISAPPEAR]IP]U [[SAME DOG VANISH]IP
    [WHAT]IP]U]NU
    The bone disappeared as the dog in the water vanished.

16. [[[WATER BECOME-STILL]IP]U]NU
    The water rippled and became still.

17. [[[IX DOG-STARE-AT-WATER]IP[THINK SELF]IP [IX TRUE HUNGRY
    IX]IP]U [[THINK WHAT SEE]IP]U [[DOG IX]IP [THOUGHT OTHER
    DOG]IP [REALLY WHAT SELF IX]IP]U[[LOOK VANISH DISAPPOINT
    PALM-UP]IP]U]NU
    *The dog stared at the water puzzled. He realised he was looking at himself.
    He was really hungry he thought he saw another dog in the water but it was
    his reflection. Now the bone was gone and he felt disappointed.*

18. [[[IX MORAL IX TRUE SHOW WHAT]IP]U [[ANYTHING IX HAVE]IP
    [SHOULD IX SATISFIED HAPPY]IP]U [[WANT MORE GREEDY
    NO]IP]U]NU
    *The moral of the story goes to show you should be happy with what you have
    and not be greedy and want more*

'Two Friends and the Bear' (SSL narrative)

1. [[[TITLE]IP [TWO FRIEND AND BEAR]IP]U]NU
   The title of this story is 'Two Friends and the Bear'.

2. [[[TWO FRIEND BOTH]IP [HIKE COUNTRY WAY HIKE]IP [PERSON-
   WALK HIKE]IP]U [[CATCH-SIGHT-OF IX]IP [BEAR BEAR-WALK
   BEAR-APPROACH]IP]U]U
   *Two friends were walking along a country road when suddenly they saw a
   bear coming towards them.*

3. [[[IX FRIEND IX]IP [FLEE FRIEND-CLIMB-TREE TREE CLIMB-TREE
   HOLD-ONTO-TREE IX]IP]U]NU
   One of the men ran to the nearest tree and quickly scrambled up it.

4. [[[IX PALM-UP HOW PALM-UP HAVE-NOT OPPORTUNITY PALM-
   UP]IP]U [[REMEMBER AGREE HEAR]IP]U [[BEAR NEVER ATTACK
   SOMEONE DEAD]IP]U]NU
   *The other saw that he had no chance but then he remembered that bears
   won't attack a dead body.*

5. [[[PERSON-LAY PLAY DEAD PERSON-LAY]IP]U [[SLEEP BREATHE
   SILENT BREATHE]IP]U [[HEART HEART-BEAT]IP [WISH SILENT IX
   HEART-BEAT HAND-LAY]IP]U]NU
   *The man lay down playing dead and held his breath. He wished his heart
   wouldn't beat so loud.*

6. [[[BEAR WALK-UP SNIFF]IP [[HEAD SNIFF]IP [EAR SNIFF STAND-
   STILL]IP]U [[NOSE-SNIFF]IP [BACKPACK]IP [PUSH-WITH-NOSE
   MAN-LAY-STILL NOSE-SNIFF]IP]U [[NEVER-MIND WALK-AWAY
   GO-AWAY]IP]U]NU
   *The bear came up and sniffed him all over: his face, one of his ear, and his
   backpack as well, pushing at it with his snout and then left him on his own.*

7. [[[MAN LIE-DOWN AWAKE-SLOWLY]IP]U [[THERE-IS-NOT BEAR
   RELIEVED]IP]U [[GO-UP LOOK-AT MAN HOLD-ONTO-TREE]IP]U
   [[PALM-UP BEAR GO-AWAY PALM-UP COME]IP]U]NU
   *The man opened his eyes slowly, looked around, and saw to his relief the
   bear had gone. He stood up and looked at his friend in the tree. 'You can
   come out now – the bear has gone away.' (he said)*

8. [[[IX MAN-CLIMB-DOWN OUT-OF-BREATH]IP]U [[IX SEE BEAR
   NOSE-SNIFF EAR]IP]U [[SEEM IX TELL SOMETHING SECRET TO-
   YOU EAR PALM-UP]IP]U]NU
   *The friend came down from the tree and said 'I saw the bear sniffing close to
   your ear. He must have told you a secret?'*

9. [[[NO NOT SPECIAL]IP]U [[PALM-UP YES-YES ONE IX SAY]IP]U [[IX WILL-NOT FIND]IP [FRIEND PERSON FLEE]IP]U [[NOT HELP IX HAPPEN CAUTION GO-AWAY WILL-NOT]IP]U]NU
'No, it was nothing really' (replied the friend). 'Well, he did say one thing, he told me that I shouldn't choose friends who desert me when danger approaches.'

'Ansaldo and the Cats' (ASL narrative)

1. [[[IX ISLAND]ɪᴘ [HAVE KING]ɪᴘ]ᴜ]ɴᴜ
   This island has a king

2. [[[KING IX]ɪᴘ]ᴜ [[WELCOME IX ANSALDO]ɪᴘ]ᴜ [[FOR DINNER
   FANCY DINNER]ɪᴘ]ᴜ]ɴᴜ
   This king. He welcomed Ansaldo (to his house) for a fancy dinner party.

3. [[[ANSALDO]ɪᴘ [OKAY FINE GO-AHEAD JOIN]ɪᴘ]ᴜ]ɴᴜ
   Ansaldo said he'd love to join.

4. [[[IN POSS HOME] ɪᴘ]ᴜ [[WOW FANCY HALL H-A-L-L HALL]ɪᴘ
   [WITH MIRROR MIRROR-ALONG-WALL]ɪᴘ]ᴜ]ɴᴜ
   They went into his home. There was an amazing hall decorated with mirrors.

5. [[[MIRROR FRAME]ɪᴘ [ALL-AROUND-FRAME G-O-L-D ALL-
   AROUND ON-WALL-CEILING]ɪᴘ [BEAUTIFUL]ɪᴘ]ᴜ]ɴᴜ
   The mirror was framed in gold and hung along the walls and ceiling.

6. [[[IX IN DINING ROOM] ɪᴘ]ᴜ] [[IX HAVE TABLE LONG]ɪᴘ]ᴜ [[FOOD
   ALL-ALONG-TABLE]ɪᴘ]ᴜ [[DIFFERENT FOOD ALL-ALONG-
   TABLE]ɪᴘ]ᴜ]ɴᴜ
   *They went into the dining room. There was a long table with many different
   kinds of food set upon it.*

7. [[[ANSALDO IN NICE]ɪᴘ]ᴜ]ɴᴜ
   As Ansaldo entered, he said the dining room was nice.

8. [[[PEOPLE-STAND WITH G-U-E-S-T]ɪᴘ [PEOPLE MOVE-TOWARDS-
   TABLE]ɪᴘ]ᴜ]ɴᴜ
   All the King's guests lined up around the table.

9. [[[ANSALDO]ɪᴘ [PEOPLE-SIT-DOWN SIT TABLE SIT-DOWN]ɪᴘ]ᴜ]ɴᴜ
   Ansaldo and the guests sat down at the table.

10. [[[ANSALDO ASK WHATS-UP]ɪᴘ]ᴜ [[WHY YOUNG MEN]ɪᴘ]ᴜ
    [[MANY-MEN-STANDING-BEHIND]ɪᴘ [PEOPLE EAT]ɪᴘ]ᴜ [[MANY-
    MEN-STANDING-BEHIND]ɪᴘ [YOUNG LINED-UP-BEHIND]ɪᴘ]ᴜ
    [[WITH CYLINDER-SHAPED-OBJECT] [WOOD FAT CYLINDER-
    SHAPED-OBJECT]ɪᴘ]ᴜ [[ANSALDO ASK]ɪᴘ]ᴜ]ɴᴜ
    *Ansaldo asked why the young men were lined up behind all the guests who
    were eating and why they were equipped with a long fat wooden object.*

11. [[[WHAT-WRONG FOUND RAT RUN-ABOUT]IP]U]NU
    They found that they had a rat problem.

12. [[[DO-WHAT]IP [IX YOUNG MAN DO-WHAT STAMP-OUT]IP]U [[RAT
    RUN-ABOUT STAMP-OUT]IP]U]NU
    *The young men would chase after the rats and try and kill them using their
    sticks.*

13. [[[[IX ANSALDO PAST FAMILY HISTORY] IP]U [[PROBLEM
    SITUATION ARISE+ DO-WHAT SOLVE+++]IP]U]NU
    *Ansaldo's family had a history of helping out and devising a solution when a
    problem arose.*

14. [[[ANSALDO THINK DO-WHAT SOLVE THAT SITUATION]IP]U
    [[DECIDE GO SHIP]IP]U [WHY IX ANSALDO HAVE TWO P-E-R-S-I-A-
    N CAT IX]IP]U]NU
    *Ansaldo thought about what he could do to solve that situation. He decided
    to return to the ship where he had two Persian cats.*

15. [[[BEFORE ANSALDO GO-AWAY ON SHIP]IP]U [[ALWAYS BRING
    ONE OR TWO CAT]IP]U]NU
    *Before Ansaldo left on the ship, he always brought one or two cats with him
    on the journey.*

16. [[[ANSALDO BRING TWO CAT TO KING POSS HOME]IP]U [[SET-
    FREE CAT]IP [RUN-AROUND CHASE RAT] IP]U]NU
    *Ansaldo brought the cats to the King's home. He set the cats free and they
    ran about chasing the rats.*

17. [[RAT FLED]IP [FLED]IP]U]NU
    The rats fled as fast as they could.

18. [[[KING WOW THANK-YOU ANSALDO]IP]U [[KIND-OF IX SAVE
    POSS ISLAND] IP]U [[LIKE FEEL LIKE M-I-R-A-C-L-E]IP [KIND-OF
    WOW THANK-YOU]IP]U]NU
    *The king was amazed and thanked Ansaldo for saving his island and said
    that it was like a miracle and thanked Ansaldo again.*

19. [[[ANSALDO]IP [TOUCH DECIDE GIVE TWO CAT]IP]U]NU
    Ansaldo was touched and decided to give the king his two cats.

APPENDIX 3

Questionnaire

Participant Number:

Please Circle: SSL   BSL   ASL

1. Did you find the task difficult? Was it more difficult compared to others?

2. How accurate do you think you were?

(not very accurate)   1   2   3   4   5   6   7 (very accurate)

3. How confident are you in your performance?

(not very confident)   1   2   3   4   5   6   7 (very confident)

4. How did you decide where to put a period? What did you use?

5. How much of the story did you understand?

   (not a lot)   1   2   3   4   5   6   7 (not a lot)

APPENDIX 4

Glossing conventions

Signs are represented in upper case using English words as shown below.

    i.   TORTOISE PASS FIRST

Where a single word is not sufficient to describe a sign, more than one word is used (separated by a hyphen).

    ii.   LET-YOU-KNOW FINISH OVER-THERE

An intonational phrase is indicated by parentheses and the following key (IP) as are phonological utterances (U) and narrative units (NU).

    iii.   [TORTOISE PASS FIRST] IP

The scope of non-manual features is represented by a running line above the text.

                                                   r
    iv.   [TWO-OF-US RACE TWO-OF-US OKAY]

                                                   ht
    v.   [AS-YOU-GO TAKE-EASY ACHIEVE PALM-UP]

(The non-manual feature that is indicated above the gloss can be identified using the table on the next page.)

Abbreviations used in this thesis and their meanings are provided in the table below.

Symbol	Meaning
IX	Index
hn	head nod
ht	head tilt
hr	head rotation
hb	head back
hm	head movement
r	raised brow
f	furrowed brow
p	physiological blink
b	boundary blink
c	head/gaze change blink
v	voluntary blink
h	hesitation blink
tl	torso lean
tm	torso movement
h	hold
sp	handshape spread
+	sign is repeated