FINGERSPELLING IN AMERICAN SIGN LANGUAGE:

A CASE STUDY OF STYLES

AND REDUCTION

by

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ABSTRACT

Fingerspelling in American Sign Language (ASL) is a system in which 26 one-handed signs represent the letters of the English alphabet and are formed sequentially to spell out words borrowed from oral languages or letter sequences.

Patrie and Johnson have proposed a distinction in fingerspelling styles between *careful fingerspelling* and *rapid fingerspelling*, which appear to correspond to *clear speech* and *plain speech* styles. The criteria for careful fingerspelling include indexing of fingerspelled words, completely spelled words, limited coarticulation, a slow signing rate, and even rhythm, while rapid fingerspelling involves lack of indexing, increased dropping of letters, coarticulation, a faster signing rate, and the first and last letter of the words being held longer. They further propose that careful fingerspelling is used for initial uses of all fingerspelled words in running signing, with rapid fingerspelling being used for second and further mentions of fingerspelled words.

I examine the 45 fingerspelled content words in a speech given by a Deaf native signer using quantitative measures, including a Coarticulation Index that permits comparing the degree of coarticulation in different words. I find that first mentions are more hyperarticulated than second mentions but that not all first mentions are hyperarticulated to the same extent and that topicality of the words may have bearing on this. I also show that the reduction of fingerspelled words is consistent with the reduction seen in repeated words in spoken English.

To Joe, who continues to stand by me.

CONTENTS

LIST OF FIGURES

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I could not have completed this thesis without my committee, especially Marianna Di Paolo, who was unfailingly generous with her time and her experience, and who was not afraid to venture into unknown territory with me. I am grateful to friends and family who have been encouraging and enthusiastic in their support of me along the road to this degree. And finally, my thanks go to Flavia Fleischer, whose class assignment led to my research question and who generously allowed me to use video of her father for my data. This is the paper I wanted to turn in for her class.

INTRODUCTION

Many signed languages include systems for representing the written form of the majority oral language of the area, called manual alphabets or fingerspelling. British Sign Language uses a two-handed manual alphabet; Japanese Sign Language has two systems, one to represent kanji and the other to represent kana (Padden & Gunsauls 2003); signers in Taiwan and Hong Kong trace ideographs in the air (Padden 1991). American Sign Language (ASL) uses 26 one-handed signs to represent the letters of the alphabet used by English speakers (see Figure 1), and signs for numbers can be mixed with the letter signs as needed. Twenty-four of the letter signs are static handshapes with specific orientations, and the other two (representing J and Z) have movement components. Except for J and Z, no movement is specified in fingerspelling. Normal hand orientation for most of the letters is with the palm facing forward. While fingerspelling can be produced anywhere in signing space depending on the discourse needs of the signer, it is frequently formed in the “fingerspelling area,” which is in front of or to the outside of the ipsilateral shoulder (the shoulder on the same side of the body as the hand forming the letters) and moves slightly away from the center of the body as the word or phrase is spelled (Battison 1978).

This study will develop a methodology for examining fingerspelling and apply it in an examination of the fingerspelling in a public speech.

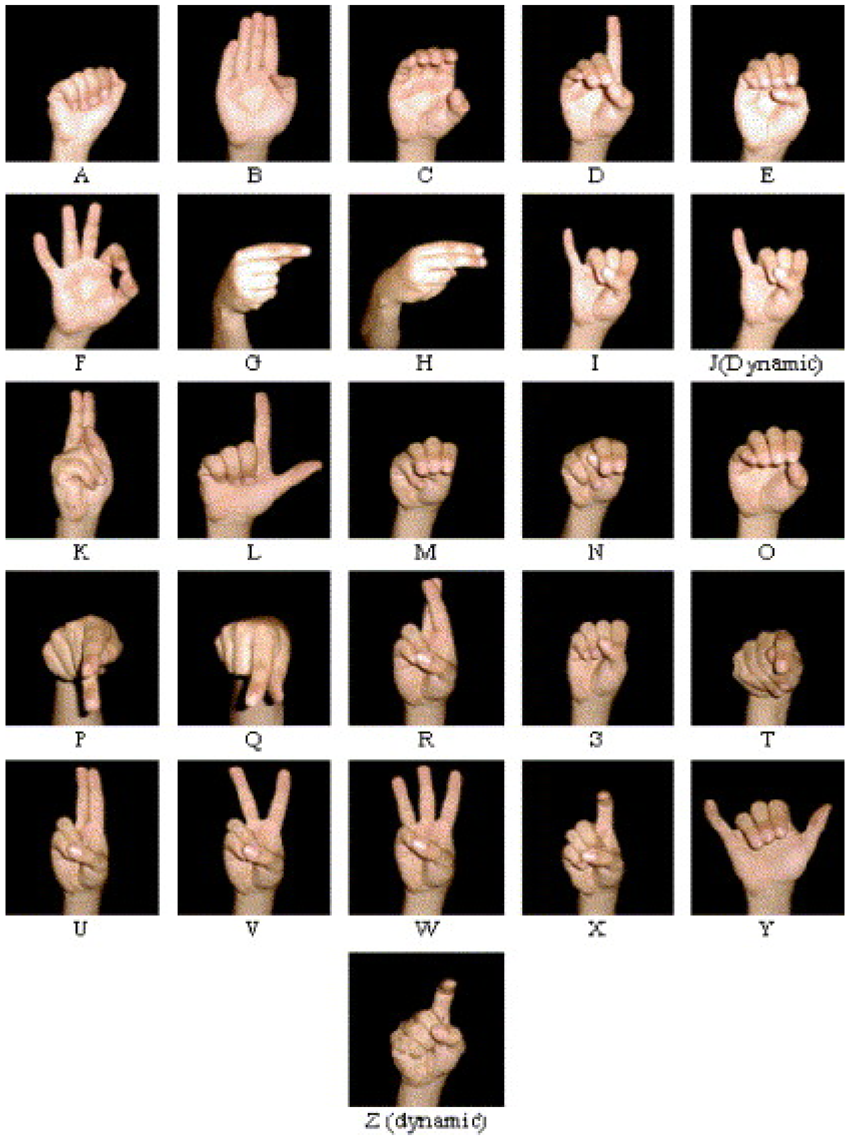

Figure 1. ASL fingerspelling handshapes (Source: Munib et al. 2007, used with permission from Elsevier).

Theories of Fingerspelling

Two theories on the nature of fingerspelling have been proposed. The first, dating from Battison's (1978) work, presumes that fingerspelling is spelling. Words are formed by stringing together sequences of letters, which retain their character as individual signs. This theory requires that an analysis of fingerspelled words consist largely of an analysis of their component letters.

An alternate theory articulated by Wilcox (1992) holds that fingerspelled words consist of patterns of articulatory movements or gestures and that "letters of words are neither produced nor recognized as isolated letters." This approach requires that words be analyzed as a whole and that individual letters be seen as aspects of that whole but not necessarily as separately analyzable entities.

This study is set within the framework of the first theory but some of the discussion will be informed by the second.

Categories of Fingerspelling

Battison (1978) described the changes involved in the transition from fingerspelling to the lexicalized forms of some fingerspelled words that become ASL signs in their own right. These changes are described in terms of nine variables, which he assesses in a binary manner (present or not): Deletion (of letters), Location (out of fingerspelling area), Handshape (changes in form), Movement (added or changed), Orientation (changes from citation form), Reduplication (of movement), Second hand (added), Morphological Involvement, and Semantic changes. These changes are shown to be present in lexicalized forms of fingerspelled words, increasing their similarity to ASL signs not based on fingerspelling.

Two more recently published papers, Davis (1989) and Thumann (2009), make use of a distinction between two categories of nonlexicalized fingerspelling. The two articles use different terminology and come to different conclusions about the status of the two categories.

In Davis's (1989) analysis of lexicalization of contact phenomena, he defines three categories: *lexicalized*, which are signs that have undergone the changes outlined by Battison (1978); *nonce fingerspelling*, which is context- and topic-specific "but eventually follows the pattern of lexicalization" (Davis 1989:97); and *full fingerspelling*, in which "each 'letter' (i.e., ASL morpheme) is clearly represented" (Davis 1989:97). Other specific characteristics of full fingerspelling are that it is confined to the fingerspelling area and palm orientation is outward (except for the letters G, H, J, P, Q, and Z, which require other orientations for normal formation).

He focuses on the nonce fingerspelling category, saying that it consists of words that, through repeated use in a piece of discourse, shift from full fingerspelling to being treated "as an ASL lexical item, as opposed to a fingerspelled representation of an English orthographic event. For example, there is either deletion or assimilation, or both, of the number of handshape letters involved during the production of these repeated fingerspelled words" (Davis 1989:98). Additional event marking characteristics that he notes for fingerspelling are mouthing of an English gloss, even with lexicalized fingerspelled signs; indexing; eye-gaze; and support of the active arm with the passive hand. He examines the signing of ASL-to-English interpreters and finds that fingerspelling occurs along a continuum from full fingerspelling to lexicalized fingerspelling, with nonce fingerspelling as an intermediate step along the path of increasing lexicalization.

Thumann (2009) has a different perspective on the changes she documents in repeated fingerspelled words as she looks at the reduction and changes in a single word (M-O-B-I-L-E[1], the city in Alabama) repeated 23 times in a conversation between two native signers. This conversation began as an interview but became an informal conversation between the two women, who had both lived in Mobile, Alabama and had gone to the same school for the Deaf[2] as children, though they were in different generations. Thumann calls the reduced versions *rapid fingerspelling* and distinguishes this type of change from the lexicalization process outlined by Battison (1978), saying that lexicalized signs "generally have no more than two handshapes and, like any ASL sign, they are made with the same movement, location, and handshapes each time. This does not appear to be the same process that occurs with the changes from the first instance to later instances of fingerspelled words in discourse" (Thumann 2009:105). She cites Patrie and Johnson (2011) for her definitions of *careful fingerspelling* ("characterized by a sequence of signs, each representing one of the letters in the written version of the word ... the fingerspelled signs are produced fully and completely") and rapid fingerspelling ("the signs are not complete and the words are not composed of a sequence of individual signs. The signs that do exist often contain remnants of other signs in the word"). She shows the reduction in the number of frames of video for each

[1] This paper follows the standard practice of glossing fingerspelled with dashes between the letters to differentiate them from nonfingerspelled signs. Subscripts present on some glosses denote the token number of repeated words.

[2] This paper follows the practice of using *Deaf* (with an uppercase D) to refer to those who identify themselves as cultural members of the Deaf community. The word *deaf* (with a lowercase d) is used to refer to those who are audiologically deaf but who may not identify as members of the Deaf community.

repetition, from 34 for the first token to 14 for the 23rd. She uses Liddell and Johnson's notation system (from class notes; an expanded version has since been published as (Johnson & Liddell 2011a; Johnson & Liddell 2011b)) for identifying selected fingers, thumb alignment, and finger and thumb extension, allowing her to describe and discuss the coarticulation that occurs in rapid fingerspelling.

Thumann finds that the distinction between careful and rapid fingerspelling is that in careful fingerspelling there is at least one frame in which each letter was a "prototypical" sign, sometimes being held for several frames, and that the transitions between the letters were meaningless. In contrast, rapid fingerspelling had overlap and compression with each sign, conforming to Wilcox's (1992) description of fingerspelling as being gestural rather than segmental in nature. In rapid fingerspelling letters are often not held but features of multiple letters may be present simultaneously during movement. In this case the transitions between holds are not meaningless but are important because they contain the information that shows what letters are intended to be in the word.

In addition to these papers, Patrie and Johnson (2011) define careful fingerspelling, saying that "each of the English letters of the written word is represented by a single fingerspelled sign. There are cases in which a letter from the center of the word is not represented, but, for the most part, there appears to be an attempt to represent each letter of the word, and there is a perception by the receiver that each letter has been represented" (preproduction manuscript, chapter 5, pp. 1–2). This is contrasted with letter-by-letter fingerspelling, which they say would be produced in response to a request for the spelling of a word. They further give several event markers to signal careful fingerspelling: looking at the hand that will fingerspell, pointing to it with the other hand,

and mouthing an approximation of the English word. On the topic of coarticulation Patrie and Johnson state that some coarticulation will occur and describe as examples a few specific coarticulated forms of letter handshapes showing perseveration of number of fingers, and the ILY handshape that is frequently used to articulate I and L simultaneously.

Patrie and Johnson describe rapid fingerspelling as being exemplified by noninitial instances of a given fingerspelled word. It is characterized by less consistency in the forms of the words and letters, blending and combined forms, and dropped letters. The sequence of handshapes, the durations of the individual signs, and the durations of the overall words all vary greatly. The overall duration of the word is less both because of dropped letters and because the signs are made faster. This increase in the rate of letter formation is said to contribute to increased coarticulation. The rhythm of words fingerspelled rapidly is also different, with the first and last signs being held longer, perhaps longer than in carefully fingerspelled words, and the medial signs being made very quickly. They say that while it is predictable that deletions will occur, the form of the deletions is unpredictable, and there is no way to tell which of the signs will be deleted, though the first and last have lower probability of being deleted. *Nonce words* are defined here as being "signs that are clearly invented and are intended just for temporary use," such as in a lecture about a technical topic, where a particular handshape is moved back and forth in front of the shoulder to represent a fingerspelled word.

While Patrie and Johnson say that there is no way to tell which signs will be deleted, Brentari (1998) posits that letters are deleted in ways that maximize sonority in what she calls "locally lexicalized" words. She defines sonority as contrast in the handshape envelope, differentiating between flexed and unflexed handshapes. A and S, both classified as flexed, would be the same in this measure and when appearing together in a locally lexicalized or rapidly fingerspelled word, one would have a high probability of being dropped.

There are similarities among the categories of fingerspelling used by each of these authors, though the terminology differs. Davis's (1989) full fingerspelling and Thumann's (2009) and Patrie and Johnson's (2011) careful fingerspelling all refer to words that have each letter fully represented, while Davis adds specifications of location and palm orientation and Johnson adds eye gaze, indexing, and mouthing to the definition. Davis's nonce fingerspelling correlates to Thumann's and Patrie and Johnson's rapid fingerspelling. Davis says that these words follow the pattern of lexicalization but have not completed their conversion to fully lexicalized words. Thumann focuses on incomplete signs, coarticulation, and transitions, while Patrie and Johnson include less consistency in the formation of signs, coarticulation, dropped letters, signing speed, and rhythmic changes in his specifications.

In this thesis I will use the terminology of Thumann and Patrie and Johnson because I feel that they are more descriptive of the uses of the different categories of fingerspelling.

Reduction and Speech Styles

Research on spoken languages has also looked at different articulatory issues that surround repeated uses of a word. Fowler and Housum (1987) found evidence that repeated words are reduced in American English and that this reduction signals that a word often conveys old information rather than new. This phenomenon, called second mention reduction, has been studied within the framework of the H&H Theory (Lindblom 1990), which hypothesizes a continuum of articulation styles from hyper-articulation to hypo-articulation. Hyperarticulated words are produced in situations where communication is potentially compromised, such as hard-of-hearing listeners or noisy environments, while hypoarticulation is found to occur in situations where a word is highly predictable for a variety of reasons, such as lexical frequency or context.

Hyperarticulation has been used as a component in the definition of the *clear* speech style (Lindblom 1990; Aylett 2000; Uchanski 2005; Baker & Bradlow 2009; Smiljanić & Bradlow 2009) (see Figure 2). Aylett (2000) defines clear speech in terms of vowel space, with the vowel space for each vowel being well separated from the space used for other vowels. Baker and Bradlow summarize the requirements of clear speech as involving "significantly longer sound durations, … [longer] vowels in stressed syllables, … longer voice onset times (VOTs) in [unvoiced stops], … less alveolar flapping …, fewer instances of stop burst elimination, and less reduction of unstressed vowels to schwas" when compared to plain speech (Baker & Bradlow 2009:396). However, reduction is found in clear speech as well as in plain speech (Baker & Bradlow 2009). In order to elicit samples of clear speech Baker and Bradlow (2009) instructed participants to read as if speaking to someone with a hearing loss or to an English language learner.

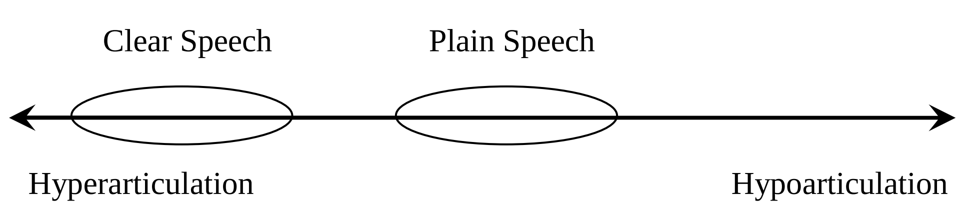

Figure 2. Clear speech and plain speech on the H&H continuum.

In spoken languages, reduction involves several aspects of articulation, including vowel quality, reduction to schwa, schwa deletion, and duration of vowels and of words, and can be based on many factors, including the frequency of occurrence of a word in the language, contextual probability, speech style, and content vs. function words (Bybee 2001; Baker & Bradlow 2009).

Patrie and Johnson's (2011) characterization of careful fingerspelling being used the first time a word is fingerspelled and rapid fingerspelling being used for repetitions of the word leads to the question of what constitutes the first use of a word. In discussing “new” vs. “old” or “given” information, Chafe (1974) hypothesized that given material is attenuated (through weaker stress, “attenuated specification,” pronominalization, etc.) and that the givenness applies not only to the specific words used but to their conceptual representations, including part/whole and generic/specific relationships. By extension, the topic of a piece of discourse would be assumed to be “present … in the addressee’s consciousness” (Chafe 1974:121) and therefore given. In testing this, however, Fowler and Housum (1987:493) found that “words judged most important to the topic … were shortened less than less important words” between the first and second occurrence. Subsequent research (Gregory et al. 1999; Bybee 2001; Baker & Bradlow 2007; Baker & Bradlow 2009) has looked at the reduction between the first and second occurrences of lexical items as they occurred in the speech samples being analyzed without taking into account the topic of the passage being read or whether close synonyms were present.

Research Questions and Hypotheses

Thumann's (2009) and Patrie and Johnson's (2011) definition of careful fingerspelling seems to correlate with the definition of clear speech in the types of hyperarticulation specified, as shown in Table 1. Indexing does not match any element in the clear speech definition; it could potentially be implemented in spoken language through raised pitch or volume, but these features are not specified in the definitions I found. Hyperarticulation and less reduction to schwa are means of ensuring that each element is clearly represented, as is ensuring that letters are not dropped in fingerspelling. Canonical letter formation in fingerspelling is much like well-defined vowel spaces in speech. Longer vowels and VOTs in spoken language are similar to a slow signing rate. Rhythm is not included in the definitions of clear speech that I found. While these definitions seem to indicate similar types of language use, the requirement on one hand of use for a particular audience (clear speech) and on the other of routine use for first mentions (careful fingerspelling) bears investigation.

This study examines the question of whether initial uses of fingerspelling in running discourse meet the criteria of careful fingerspelling and also looks at the reduction of second mentions to see if their formation is categorically distinct from that of first mentions.

Table 1. Comparison of careful fingerspelling and clear speech definitions

Careful Fingerspelling	Clear Speech
• Indexing	
• Each letter represented	• Hyperarticulation
	• Less reduction to schwa
• Limited coarticulation; canonical letter formation	• Well-defined vowel spaces
• Slow signing rate	• Longer vowels & VOTs
• Even rhythm	
• Used for first mention	• Elicited by asking people to speak as if to an HOH or ESL listener

I hypothesize that all of the fingerspelled words in running discourse meet the criteria of rapid fingerspelling, which correlates with the spoken language speech style of plain speech. Specific variables I will measure that have been specified in definitions of careful vs. rapid fingerspelling are Indexing (by eye gaze, pointing, or support), Dropped Letters, Coarticulation, Signing Rate (frames/word), and Rhythm (ratio of first and last letter length to average letter length).

With regard to the repeated words, I hypothesize that they exhibit the expected reduction of second mentions. The same variables given for first mentions will be measured for repeated mentions. If first mentions are shown to fall in the category of rapid fingerspelling I would not expect Indexing or Rhythm to be changed for second mentions. I expect an increase in Dropped Letters and Coarticulation and a decrease in Signing Rate in reduced second-mention words.

METHODOLOGY

Data Set

My data set consists of the fingerspelled content words extracted from the digitized videotaped 7 minute, 30 second recording of a speech given in ASL by a Deaf native signer in 1989. At the time the recording was made the signer was 44 years old, a highly educated man working as a professor in southern California. He was born to Deaf parents in New York and graduated from the New York School for the Deaf and Gallaudet University before earning his doctorate from a mainstream university.

This speech was given at a conference for educators of the deaf, so the audience would have consisted of educated native or fluent signers familiar with the topic of the speech, which was deaf education. As a speech, the language use in this sample is more formal than that in many genres of ASL and falls under the general characterization put forth by Baker and Cokely that the signs would be made larger and more slowly than in other contexts and lexical choices would tend toward the more formal variants (1980:94). As his audience was fluent in ASL he would not have needed to account for language fluency issues in his signing, and their fellow membership in the speech community of deaf educators means that the vocabulary of that community would be expected and unremarkable in its use.

To investigate my research questions of whether initial uses of fingerspelled words are correctly classified as careful fingerspelling and whether second mention reductions correspond to the reductions found in second mentions in spoken languages, I extracted still frames showing the fingerspelled words and their contexts from the QuickTime recording. The speech contained 45 fingerspelled content words. Although Baker and Bradlow (2009) found that in English, function words reduced in the same way that content words did, I did not include function words in my analysis because ASL fingerspelled function words frequently have characteristics that indicate grammaticalization, such as consistent movement paths and hand orientations that distinguish them from other fingerspelled words and fall within the phonological rules for nonfingerspelled ASL signs (Battison 1978). While content words can and do become grammaticalized, none of the words in this data set displays characteristics of grammaticalization. These 45 content words included 33 unique words, eight of which were repeated during the course of the speech (two of these words were used three times and one four times).

Variables

Specific characteristics that have been proposed to distinguish careful fingerspelling (first mentions) from rapid fingerspelling (second mentions) are:

- signaling by eye gaze or indexing in careful fingerspelling but not in rapid fingerspelling (Patrie & Johnson 2011)
- completeness of the word (no or few dropped letters in careful, many dropped letters in rapid) (Davis 1989; Thumann 2009; Patrie & Johnson 2011)
- coarticulation (limited in careful fingerspelling, prevalent in rapid fingerspelling) (Thumann 2009; Patrie & Johnson 2011)

- canonical formation of the letters (citation handshape, palm orientation, and location of signing in careful fingerspelling) (Thumann 2009; Patrie & Johnson 2011)
- signing rate (a word is formed more slowly in careful fingerspelling than in rapid) (Patrie & Johnson 2011)
- rhythm (letters are held for approximately equal amounts of time in careful signing; rapid signing is characterized by a rapid burst of letters with the final letter held longer) (Patrie & Johnson 2011)

Indexing

To evaluate indexing, I noted when the word was indexed by gaze or pointing or was supported by the nonsigning hand (see Figure 3). Because of the two-dimensional nature of the video it was not always possible to be sure if the signer was looking at his hand or not, especially when he was in profile. I marked the word as indexed by gaze if the signer's head or eyes changed direction visibly toward the fingerspelling hand, but if his hand was in front of his eyes and I could not see any movement I marked it as unsure.

Figure 3. Indexing by gaze (l, from E-P-I-D-E-M-I-C), by pointing (c, from A-L-I-C-E$_2$), and by support (r, from I-S-O-L-A-T-E-D$_2$).

<u>Dropped Letters</u>

I noted which letters were formed in each word and calculated the percentage of dropped letters, as well as the percentage of words that had dropped letters. I counted all letters that were visible as being present, even if they were not fully formed or if their formation overlapped with the formation of another letter. In Figure 4a the thumb crosses under the descending index finger before moving out to form the Y. This T was counted as present even though the index finger never covered the thumb, as it would in a canonic production. Figure 4b shows the closest the thumb gets to the T position between its extension for L and Y. While it does move out of the extended position it occupied when forming both the preceding L and the following Y, there is nothing in this handshape that would indicate a T is being formed; this T was counted as dropped.

<u>Coarticulation</u>

Thumann (2009) coded for coarticulation using charts that compared actual production of the letters to an idealized citation form. However, upon examination it was not clear that all of the differences were attributable to coarticulation due to phonological

a.  b. 

Figure 4. T in Q-U-A-L-I-T-Y-E-D$_1$(a) and Q-U-A-L-I-T-Y-E-D$_2$ (b).

processes, as undershoot or other production variables may also cause changes in handshape. Additionally, her characterization of the charts as visually demonstrating an increase in coarticulation does not lend itself to numerical comparisons.

Rather than focus on these fine phonetic implementations of production variability, I chose to look instead at the phonological processes involved. In an effort to quantify the degree of coarticulation in each word so that I could compare them I devised a measure I call the Coarticulation Index that takes into account the phonological processes present in a word as well as the number of letters affected by each process.

Coarticulation in signed languages is very similar to coarticulation in spoken languages and occurs through the same type of phonological processes, such as metathesis and assimilation (Reich 1975; Liddell & Johnson 1989). In fingerspelling, coarticulatory effects have been found to extend an average of 1.5 letters (0.5 seconds), both forward and backward (Jerde, Soechting & Flanders 2003) in the course of a word.

Specific coarticulatory effects that have been described in the literature are:

- assimilation of the number of fingers used to articulate letters, as in the word H-E, where H has two specified fingers and E, which has four specified fingers canonically, is frequently formed with two fingers (Wilcox 1992) (see Figure 5).
- assimilation of movement, by which the letter A in M-A-Z-E, which is not specified for movement, participates in the movement of the Z (Wilcox 1992).
- the “twist” (supination of the wrist) present in G and H can carry over into adjacent letters (Reich 1975) (see Figure 5).

Figure 5. O in H-O-R-N, showing coarticulatory effects from H on orientation and number of fingers.

- metathesis has been noted but no pattern identified, and it is described as "one feature in a general degradation of the message, which also includes adding and dropping letters and hitting the wrong letters" (Reich 1975:353) (see Figure 6).
- both assimilation and dissimilation of handshapes have been found, and in fact can occur simultaneously on different joints of the fingers (Jerde, Soechting & Flanders 2003)

Since multiple coarticulatory processes can affect the formation of a single letter (Jerde, Soechting & Flanders 2003) and a single coarticulatory process (e.g., perseveration of I) can persist across multiple letters (see Figures 5 and 6 for examples), I

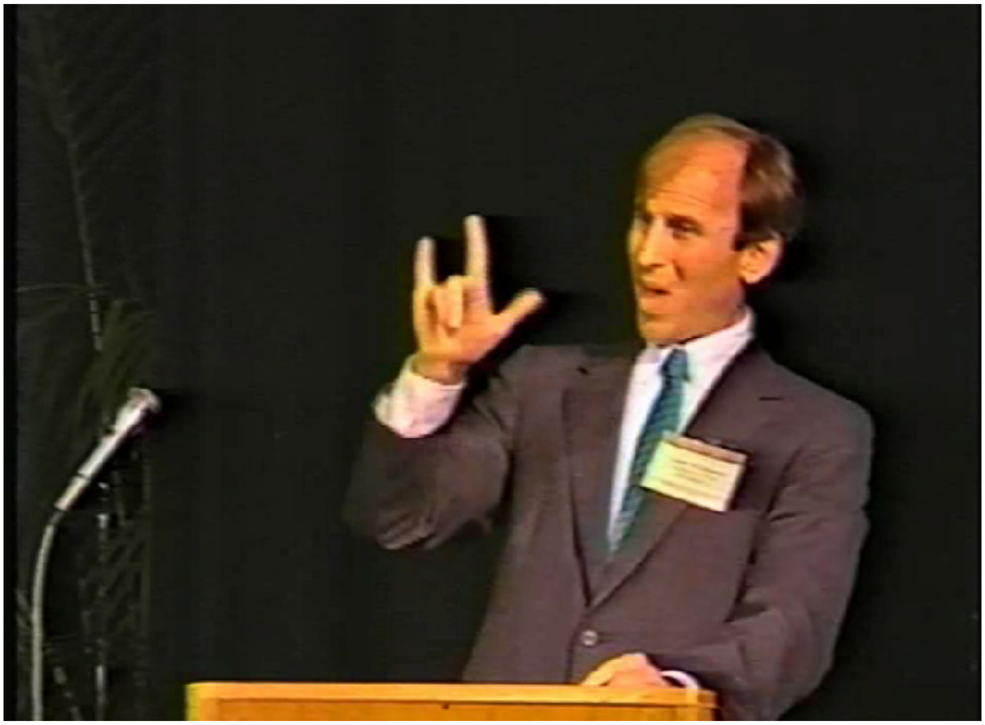

Figure 6. The classic coarticulatory ILY handshape, from Q-U-A-L-I-T-Y-E-D_3, showing perseveration of the metathesized I while forming L.

evaluated the processes present in the frame showing the most fully formed or most canonical formation of each letter. The Coarticulation Index was calculated for each word by counting the number of coarticulatory phonological processes (perseveration; assimilation and dissimilation of handshape, movement, and supination; and metathesis) on each letter, totaling the number or processes in the word, and dividing by the number of letters formed. This allows processes that extend across multiple letters to be weighted more heavily than those that are more fleeting.

<u>Signing Rate</u>

The first step in figuring the signing rate is to determine the number of video frames required to form the word. I discuss here two methods of determining the beginning and end of a word.

<u>Postural segments.</u> In an effort to isolate meaningful phonetic material from the surrounding transitional movements of the hands, Johnson and Liddell (2011c) developed a framework for identifying postural segments that define a sign. They consider the four parameters of signs—hand configuration, placement, facing, and nonmanual gestures—in determining the beginning and end of signs and each of the postural segments that serve to identify the sign. In applying this framework to fingerspelling, we see that hand configuration is the letter handshape; placement is the location in space where the word is formed; facing is the orientation of the hand, sometimes called palm orientation; and nonmanual gestures include an approximate mouthing of the English word being spelled (if present; this feature is not obligatory) as well as other movements of the head and body. In this system the sign is said to start at the point when all four parameters are in place and end at the point at the end of the word when the four parameters are no longer in place.

Figure 7 shows some key frames preceding the formation of I-W-O-J-I-M-A. In Figure 7a the nonmanual mouthing is being made and the I handshape begins to form with the extension of the pinky finger. Figure 7b, four frames later, shows the facing in place. Figure 7c, two frames later, shows the I handshape fully formed, with the thumb in place. Figure 7d, the next frame, shows the final parameter, placement, having been achieved. The frame shown in Figure 7d would be counted as the first frame of the word using Johnson and Liddell's Postural Segment framework.

The placement of the fingerspelled words in this data set varied, and in some cases moved across the signer's body as the word was spelled, for a variety of discourse-

a.  b. 

c.  d. 

Figure 7. Some key frames leading up to I-W-O-J-I-M-A

related reasons. However, each production of a word had internal consistency that made it possible to assign an appropriate placement.

While some words ended with one hand or the other moving to form the next sign, nonmanual gestures associated with the fingerspelled words were often useful in determining the ends of words. In some cases the end of the mouth gesture marked the end of the word; in others eyeblinks, which are explicitly mentioned by Johnson and Liddell (2011c) as marking the end of a word, were used. An additional marker which has been found to serve as a prosodic phrasal marker, and thus as a marker of the end of a word, was movement of the head or body (Nicodemus 2007).

A few issues arose in attempting to implement this framework. The first issue is that several tokens did not achieve stability in the placement parameter until the second or third letter of the word was being formed, while a few others had an eyeblink before the last letter was fully formed. While it is important to be able to determine where the meaningful phonetic information for a word begins and ends, it is more important that all the information be included in the word being analyzed. In a fingerspelled word the most salient information is contained in the handshapes. If some of these are dropped from the analysis the word that would be analyzed would not be the word that was fingerspelled.

Another issue I found with this method of analysis is the cutting off of the held ends of words. The definition I tested specifies that the first and last letters of some words will be held. It may be that held letters at the beginnings of words are an artifact of the process of bringing all the parameters of a sign into the proper relationship, as described above with the beginning of I-W-O-J-I-M-A. Alternatively, the lengthened holding of the handshape may be a crucial feature of the beginnings of words, similar to the prevoicing of stops in spoken English. However, lengthening at the end of a word follows a pattern found in English and many other languages of lengthening words at the end of intonational phrases and for emphasis. Nicodemus (2007) found that the most agreement on the placement of intonational phrase boundaries occurred at locations where signs were held. Reasons for cutting these held signs off should be evaluated carefully and cautiously.

The flip side of this issue is the difficulty of coding the ends of some words. While many words ended without a hold, in others the last letter was held for a considerable period of time. Some words with these held last letters were cut off by nonmanual markers of various sorts—eyeblinks in particular—and others were not. This leads to inconsistent treatment of words with held last letters as some of them are coded with little or no hold while others have the entire held letter included in the analysis.

Seven tokens (C-A-S-E, C-I-V-I-L-I-Z-A-T-I-O-N, I-N-T-E-L-L-I-G-E-N-C-E, L-A, L-A-U-N-I-F-I-E-D, P-L-9-4-1-4-2_1, and R-A-D-I-O) did not include all the letters formed—that is, they did not achieve their placement until after the first letter had ended or were cut off at the end by an eyeblink or other nonmanual marker before the last letter was formed—and they were dropped from this portion of the analysis of this variable and for the rhythm variable, which also relies on the determination of the start and finish of a word.

<u>Handshapes.</u> An alternate method of determining the beginning and ending of words is to simply measure the length of the word from the beginning of the first letter's handshape to the end of the last letter's handshape. Though it is not specified in the other papers I looked at that evaluate the length of fingerspelled words (Davis 1989; Thumann 2009), it seems likely that this one parameter is used to determine the length of the words in those studies.

Issues that arise with using handshapes alone to determine the length of a word include inconsistent amounts of time for the hand to move into position. Sometimes the previous sign ends very close to the location of the fingerspelled word and the first letter is very short, other times a longer distance must be traversed, or for some other reason the hand takes longer to move into position. Similar issues also arise with regard to held letters at the end of words with this method of determining word length as with Postural Segment method: how do we differentiate between a held word and a pause with the articulators still in place? As is common in signed languages due to the spatial nature of the language and the ability of the two hands to articulate separately, with some words the fingerspelling hand remained in position while the other hand formed another sign. In these cases I counted the movement of the other hand into position as the end of the fingerspelled word.

I evaluated the variables that required a word length measure using both methods of measurement, and I discuss the results in the Discussion section below. It is expected that the values found using the Handshape method will be larger than those found using the Postural Segment method because no word would be found to be shorter using the Handshape method and many words would be found to be longer using this method.

To evaluate the Signing Rate variable, I divided the number of frames in the word by the number of target letters in the English word (combining doubled letters, as they were not signed separately). I used this number rather than the number of letters actually produced to provide consistency across multiple productions of words.

Two of the words omitted from this measure for the Postural Segment method were among the repeated words. Following Baker and Bradlow (2009), for the six remaining repeated words I calculated the ratio of the length of the first use to the length of the second use.

Rhythm

I looked at the number of frames each letter was held for. In many cases a letter was never held, but if it was identifiable in passing (see the section on Dropped Letters, above, for discussion of identifiability) I counted one frame for this measure. If a letter was not identifiably formed I omitted it from the calculations. Since the definition being evaluated specifies that the first and last letters are held longer than the middle letters, two-letter words were not evaluated. For each word that was three or more letters long I compared the number of frames the first and last letters were held to the average number of frames for the middle letters.

As with the Signing Rate variable, I calculated values for Rhythm using both the Postural Segment and the Handshapes method of determining the beginning and end of words. For a discussion of the issues raised by these two methods, see the Signing Rate section above. In my evaluation using the Postural Segment method, I only counted frames that fell between the first and last frame for the word. For all letters, I counted the number of frames the handshape was held at its fullest extension (which varied from word to word; some words were made up of clearly formed, fully extended letter handshapes, while others were made up of poorly-defined letters with curled fingers) in the expected orientation, with the caveats listed in the last paragraph.

What is a word? Many of the “words” in this data set are actually two-word phrases (e.g., H-U-M-A-N-B-E-I-N-G-S), abbreviations (e.g., S-P-E-D, for Special Education), or initialisms (e.g., L-A-U-S-D, for Los Angeles Unified School District). In determining whether to count two-word phrases as separate words or as single words, I considered Bybee’s (2006) discussion of constructions. Since her analysis of constructions relies on the frequency of collocations and no analysis has been made of the collocational frequency of fingerspelled words in ASL, I have no basis for determining which word pairs might form stronger constructions than others. However, the fact remains that these constructions can be expected to occur. Additionally, it becomes difficult to determine how to split phrases such as S-P-E-D, since neither S-P nor E-D is recognizable as a word on its own. Consequently, I decided to leave each sequence that was signed without interruption as a word. The only variable that is likely to be impacted by this decision is Rhythm, and I will discuss the issues that arise in that section.

DATA

Indexing

As shown in Table 2, 13 of the 45 fingerspelled words (29%) were indexed in some manner while they were being fingerspelled. By far the most common form of indexing was gaze (N=11), which accounted for all the indexing of first uses of fingerspelled words. Three of the eight second mentions (38%) were indexed, one by

Table 2. Summary of data.

	Overall (N=45)	First Mentions (N=33)	Second Mentions (N=8)	Third Mentions (N=3)	Fourth Mention (N=1)
Indexing					
Yes	29%(N=13)	30%(N=10)	38% (N=3)	0% (N=0)	0% (N=0)
Unsure	13% (N=6)	15% (N=5)	13% (N=1)	0% (N=0)	0% (N=0)
Dropped Letters					
% of words	44%(N=20)	38%(N=13)	50% (N=4)	67% (N=2)	100%(N=1)
% of letters	10%	8%	12%	16%	33%
Coarticulation Index (N=44)	0.41	0.39	0.48	0.39	0.57
Signing Rate (frames/letter)					
Postural Seg.	3.7 (N=38)	4.1 (N=27)	2.6 (N=7)	2.5 (N=3)	1.8 (N=1)
Handshape	4.7 (N=45)	5.2 (N=33)	3.3 (N=8)	3.2 (N=3)	1.8 (N=1)
Rhythm (ratio to middle letters)					
Postural Seg.	(N=37)	(N=23)	(N=6)	(N=3)	(N=1)
first letter	0.90	0.93	1.00	0.49	1.00
last letter	1.30	1.48	0.95	0.60	1.00
Handshape	(N=40)	(N=29)	(N=7)	(N=3)	(N=1)
first letter	1.78	1.84	2.00	1.05	1.00
last letter	1.87	2.09	1.38	1.22	1.00

gaze, one by index, and one by support. Table 3 shows the direct comparison between the first and second mentions of the eight repeated words.

Dropped Letters

As shown in Table 2, 44% of the fingerspelled words had one or more dropped letters. First mentions dropped an average of 8% of the letters in those words. Second mentions dropped an average of 12%. Third mentions dropped an average of 16%, and the fourth mention dropped 33% of its letters.

In the eight repeated words summarized in Table 3, 12% of the first mentions and 50% of the second mentions dropped letters. 2% of the letters were dropped in the first mentions, 12% in the second mentions.

Table 3. Comparison of criteria for careful/rapid fingerspelling in eight repeated words.

	First mentions	Second mentions
Indexing	3	3
Dropped Letters (% of words)	12% (N=1)	50% (N=4)
Dropped Letters (% of letters)	2% (N=1)	12% (N=6)
Coarticulation Index (N=7)	0.37	0.48
Signing Rate (frames/letter) (N=6)		
Postural Segment	4.3	2.6
Handshape	4.7	3.3
Rhythm (ratio to middle letters) (N=7)		
Postural Segment		
First letters	0.93	1.00
Last letters	2.14	0.95
Handshape		
First letter	1.91	2.00
Last letter	2.44	1.38

Coarticulation

The Coarticulation Index ranged from 0.00 (in five words) to 1.00 (in one word). There is no theoretical upper limit to this index, so this range is not particularly meaningful in and of itself. The overall average index was 0.41, as shown in Table 2. For first mentions the index was 0.39, for second mentions it was 0.48, and for the three third mentions it was 0.39, and the fourth mention had a coarticulation index of 0.57. In the repeated words summarized in Table 3, the average index was 0.37 on the first mention and 0.48 on the second mention. Only seven repeated words were analyzed on this measure because one token was too blurry to tell what the fingers' positions were.

Signing Rate

Signing Rate, as explained above, was calculated for both the Postural Segment method and the Handshape method of determining word length. Both sets of numbers are reported in summary in Table 2 and for the repeated words in Table 3.

Using the Postural Segment method, the signing rate varied widely, from 1.3 to 9.5 frames per target letter. Using a conversion factor based on the speed of the video (30 frames/second), this equals approximately 42 to 317 msec/target letter. The mean (3.7), median (3.3), and mode (3.2), however, point to a more moderate overall signing rate. As a group, the first mentioned words were produced at a rate of 3.8 frames per target letter, second mentions were produced at a rate of 2.7, third mentions were produced at a rate of 2.4, and the fourth mention was produced at a rate of 1.8 frames per target letter.

Using the Handshape method of determining the length of words, the range was as expected even larger, from 1.8 to 18.5 frames/target letter. This translates to a range of 59 to 617 msec/target letter. The average signing rate using this method is 4.7

frames/target letter overall, 5.2 for first mentions, 3.3 for second mentions, 3.2 for third mentions, and 1.8 for the fourth mention.

Of the six repeated words analyzed for this measure using the Postural Segment method, one had more frames in the first use than the second, one had the same number of frames in the second use as in the first use, and the other four were shorter in the second use. Overall, the signing rate dropped from 4.3 frames/target letter on the first mention to 2.6 frames/target letter on the second mention. The ratio of the number of frames in the first use to the number of frames in the second use was 1.5, which ranged from 0.9 to 3.4 for individual words.

Using the Handshape method of measuring word length for these same six words, one was longer on second mention than on first and the other five were shorter. The overall signing rate dropped from 4.7 frames/target letter on first mention to 3.3 frames/target letter on second mention. The ratio of the length of first use to second use ranged from 1.0 to 4.1, with an average of 2.0.

Rhythm

The rhythm measurements were also calculated using both the Postural Segment and the Handshape methods of determining word length. These values are summarized in Table 2, and the comparison of the first and second uses of repeated words is shown in Table 3.

Using the Postural Segment method of determining word length, the overall ratio of first letters to the average middle letter is 0.90, and of last letters to average middle letters is 1.30. For first or only mentions of words, the ratio for first letters is 0.93 and last letters is 1.48. For second mentions the ratio for first letters is 1.00 and for last letters is

0.95. Third mentions produced the first letter at a rate 0.49 times the average middle letter and the last letter at 0.60 times. The fourth mention was produced very evenly, with each letter visible for a single frame, giving a ratio of 1.00 for both first and last letters.

Using the Handshape method of determining word length, the overall ratio of first letters to the average middle letter was 1.78 and of last letters was 1.87. For first mentions first letters were 1.84 times the length of middle letters while last letters were 2.09 times the length of middle letters. Second mentions had a ratio of 2.00 for first letters and 1.38 for last letters, while third mentions had a ratio of 1.05 for first letters and 1.22 for last letters and the fourth mention had ratios of 1.00 for both first and last letters.

DISCUSSION

In this section I will discuss each variable, then I will discuss two phrases, I-W-O-J-I-M-A and Q-U-A-L-I-T-Y-E-D-U-C-A-T-I-O-N, in the context of the variables and definitions I examine in this study.

Indexing

The indexing rate was very similar between first and second mentions (30% of first mentions and 38% of second mentions, 45% and 50% if unsure tokens are included). For the eight repeated words the exact same number (N=3) of words were indexed (N=4 for second mentions when unsure tokens are counted). Interestingly, the first mentions that were indexed were all indexed by gaze, while all of the methods were used to index second mentions. If anything, the more definitive indexing methods were used to mark second mentions than first mentions, supporting my hypothesis that first mentions would not be indexed more than second mentions. This finding does not necessarily point to one style or the other, though a rate approaching 50% seems to make indexing pretty common.

Another interesting finding is that all four of the second mentions that were indexed were also indexed on the first mention. While Table 3 shows only three of the first mentions in that group having been indexed, one of the second mentions that were indexed was Q-U-A-L-I-T-Y-E-D_2. While Q-U-A-L-I-T-Y-E-D_1 was not indexed, the fully spelled out form Q-U-A-L-I-T-Y-E-D-U-C-A-T-I-O-N which preceded it was.

My feeling is that indexing of fingerspelled words has more to do with indexing in general than it does with fingerspelling. Liddell (2003) discusses a feature of ASL he calls a pointer buoy, expressed as a finger pointing at a sign or a spatial element of the discourse. The function of this pointer buoy is to highlight an important element in the discourse, and it seems to me that this is exactly what is happening with indexing of these words. This explanation would also fit with the finding that only words that were indexed on first mention will be indexed on second mention, though the form of indexing may change and even become stronger with the second mention of the word.

Dropped Letters

Both the percentage of words that dropped letters and the percentage of letters that were dropped increased with increased numbers of repeats, supporting my hypothesis that reduction would include increasing rates of dropped letters.

Among the first or only mentioned words, 38% of the words (N=13) exhibited at least one dropped letter. About half (N=7) of these words dropped a single letter while the rest (N=6) dropped two, with a maximum of 25% of the letters in a single word dropped. On second or further mention, words dropped up to three letters each, up to 33% of the letters in a word.

Patrie and Johnson's (2011) discussion of dropped letters and coarticulation describes the cognitive differences of accessing a lexical item for the first time in a piece of discourse vs. accessing an already active 'template'. This difference in retrieval requirements is used as justification for their statement that there is a categorical difference between the type of fingerspelling that must be used on first mention of a word and that which can be used on future mentions. However, as both the rate of words dropping letters and the rate of dropped letters increases smoothly, there is no indication that first mention words as a group are categorically different in this regard from repeated words. It seems that the difference between first and second mention words in terms of dropped letters may be more one of degree than of type, as the pattern that appears in my sample is a progression of increasingly dropped letters.

An examination of the dropped letters sheds little light on the validity of Brentari's (1998) sonority theory, as most of the dropped letters were surrounded on one side by a flexed letter and on the other by an unflexed letter, giving neither support nor lack of support to the theory. However, five of the 26 dropped letters were surrounded by letters with the same sonority value as the dropped letter, and five were surrounded by letters with a different sonority value than the dropped letter. According to Brentari's theory these last five should have been more resistant to being dropped. While they were dropped, they were all dropped from second, third, or fourth mentions rather than from first mentions.

Coarticulation

There were five fingerspelled words that did not show signs of coarticulation in their formation, i.e., they had a Coarticulation Index of 0. They were, with one exception, two to four letters in length and were formed more slowly or held longer than most of the other words (4.0, 5.4, 5.5, 6.5, and 9.5 frames/letter using the Postural Segment method of determining word length; 6.0, 8.3, 9.0, 12.0, and 18.5 using Handshape). Slower formation and longer hold times favor decreased coarticulation because there is more time for the handshape to reach its target position, and since I was evaluating a single frame for each letter it would be these more precisely formed handshapes that would exhibit no coarticulatory effects. These five words, formed more slowly than average and with more discretely formed letters, would seem to be candidates for classification as careful fingerspelling, or at least to be farther toward the hyperarticulation end of the H&H continuum than the other words in my sample.

While most of the fingerspelled words in this sample exhibited coarticulation, it is clear that overall, the coarticulatory effects increased with increased repetitions of a word. The index shown for third mentions is lower than that for second, in part due to the small number of tokens (three). Of those three words, two exhibited the same degree of coarticulation in their third use as in their second use, and one increased. In only one case (Q-U-A-L-I-T-Y-E-D_2) did a repeated word show less coarticulation on a repeat than on the previous use of that word, though sometimes a repeated word did show the same degree of coarticulation as it did in its previous use.

Increasing levels of coarticulation with increasing repetitions support my hypothesis that coarticulation will increase with repetition as a component of reduction.

Signing Rate

As predicted, the value of the signing rate variable decreased with repetition of words under both methods of determining the length of the words, indicating a faster formation of the words. Since the length of many words was shorter using the Postural Segment method of determining word length, the signing rate for that method is predictably faster. The values for Signing Rate show a greater drop between first and second mentions (first mentions are about 1.6 times the signing rate as second mentions using either method) than between second and third mentions. The ratios of first to second mention word duration are higher than those found by Baker and Bradlow (2009), which were around 1.1. This difference could be due to a variety of issues, including the fact that Baker and Bradlow eliminated tokens that occurred at the end of intonational phrases and were thus likely to be lengthened, and I did not. Other researchers I have found have not looked at reduction beyond the second use of a word, so it is not known whether a leveling of the reduction of signing rate is to be expected on repeated mentions.

Rhythm

The rhythm variable is the one for which the different methods of determining the length of the word made a real difference. Patrie and Johnson (2011) state that the first and last letter of a rapidly fingerspelled word are held longer than the middle letters.

The values calculated using the Postural Segment method for determining the beginning and end of words lead to the conclusion that final letters are held longer on first mention and that last letters after first mention and first letters are held on average for the same or less time than middle letters. Most of these shorter values were very close to 1.0, meaning that the first and last letters were held for close to the same length of time as the middle letters. However, the third mentions have values of close to half the length of the middle letters. This pattern is the opposite of the prediction made in the definition of careful versus rapid fingerspelling, which is that (careful) first mentions will have an even rhythm and (rapid) second mentions will be produced with the first and last letters held longer and the intermediate letters rushed through. However, this data set included words that were likely held due to being at the end of clauses or intonational phrases. If ASL follows the pattern of many languages of new information being placed at the end of a clause this would make the last letters of first mentions more likely to be held.

A different pattern emerges using the Handshape method of determining word length. Predictably, most of the ratios are larger. None of the summary values using this method is less than 1.0, meaning that none of the groups of data had shorter first or last letters than middle letters. The largest values, at approximately twice the length of middle letters, were the first and last letters of first mentions and the first letters of second mentions. The smallest values, at approximately the same length as the middle letters, were first letters of third mentions and first and last letters of the fourth mention. Again, increasing mentions appear to lead to increased evenness of the production of letters rather than increased unevenness.

It seems that the Postural Segment methodology is unsatisfactory in the analysis of fingerspelling because it sometimes artificially truncates the word at one or both ends. On the other hand, the Handshape methodology leaves open the question of how to determine the end of a held sign. Neither seems to give a clear picture of the length of the fingerspelled words in all situations.

Topicality

While Fowler and Housum (1987) found that topical words were reduced less between their first and second uses than nontopical words, a finding that led them to conclude that topicality did not increase the reduction of a word as they had hypothesized, I consider here the possibility that instead the difference may have been that highly topical words are more reduced in their initial use than nontopical words. A few words in the data set stand out as being nontopical, and I will discuss I-W-O-J-I-M-A in this context. At the other end of the spectrum is Q-U-A-L-I-T-Y-E-D-U-C-A-T-I-O-N, the most topical word and also the word with the most repetitions.

I-W-O-J-I-M-A

I-W-O-J-I-M-A is a two-word Japanese place name that is used in English very similarly to the way this signer used it in ASL, to refer to an iconic moment of flag raising by a team. This fingerspelling sequence is one of only five words that did not display coarticulation, and its length distinguishes it among that group. It was relatively hyperarticulated, perhaps because it is so unpredictable. In the context of this speech—a conference on deaf education—the signer lauds the efforts of the many present who had been involved in educational reform as shown in (1).

(1) SAME, WELL, KNOW I-W-O J-I-M-A THERE. THERE CHINA, AMERICAN SOLDIERS GATHER, GRASP-FLAGPOLE, RAISE-FLAG.

Like, well, you know, Iwo Jima, in China, where American soldiers came together to raise the flag.

The signer offers reinforcement for the word by further specifying the location and describing the scene he had in mind. This level of reinforcement for the word is consistent with its hyperarticulation in ensuring that the audience has the opportunity to make the cognitive leap from deaf education to World War II flag raising.

Although the two words Iwo and Jima are virtually never used separately in English or ASL, this signer held the O for eight frames before blinking, both the hold and the blink marking the division between the two words.

I-W-O-J-I-M-A, along with the four shorter words mentioned in the Coarticulation section above, is perhaps the most likely candidate to be classified as careful fingerspelling. The letters are all formed and are held at least two frames each.

While the first and last letters of the combined phrase are not held, the last letter of Iwo is held, and the overall signing rate is slower than average under either method of determining word length (5.4 frames/letter compared to the overall rate 3.4 frames/letter using the Postural Segment method, 6.0 vs. 5.1 frames/letter using the Handshape method). Without numeric cutoffs in the definition it is hard to tell, but this phrase seems to meet the criteria for careful fingerspelling.

Q-U-A-L-I-T-Y-E-D-U-C-A-T-I-O-N

Q-U-A-L-I-T-Y-E-D is the most frequent fingerspelled word in this speech, and it is itself a reduction from Q-U-A-L-I-T-Y-E-D-U-C-A-T-I-O-N, spelled out nearly fully on first mention. Though I counted Q-U-A-L-I-T-Y-E-D as a separate word in my analysis above, it bears discussing in the context of its reduction from Q-U-A-L-I-T-Y-E-D-U-C-A-T-I-O-N. Table 4 shows a summary of the values for each repetition of Q-U-A-L-I-T-Y-E-D-U-C-A-T-I-O-N / Q-U-A-L-I-T-Y-E-D.

Table 4. The progression of Q-U-A-L-I-T-Y-E-D-U-C-A-T-I-O-N

	Indexing	Dropped Letters	Coarticulation Index	Signing Rate PS / HS	Rhythm First PS / HS	Last PS / HS
Full Spell-out	Gaze	6% (N=1)	0.60	4.2 / 4.9	1.39 / 1.73	0.46 / 1.30
1	None	0% (N=0)	0.67	3.4 / 3.6	1.08 / 1.08	1.08 / 1.08
2	Gaze	11% (N=1)	0.33	3.4 / 3.7	0.46 / 1.38	0.92 / 0.92
3	None	22% (N=2)	0.57	2.3 / 2.6	0.62 / 1.88	0.62 / 2.50
4	None	33% (N=3)	0.57	1.8 / 1.8	1.00 / 1.00	1.00 / 1.00

The initial use of Q-U-A-L-I-T-Y-E-D-U-C-A-T-I-O-N was indexed, as was the second token of the reduced form, Q-U-A-L-I-T-Y-E-D. Since every other case in which second-mention words were indexed involved a word that was indexed on first mention also, but the first reduced token of Q-U-A-L-I-T-Y-E-D was not indexed, this finding supports the idea that the reduced form was not the first mention of the word but rather the second mention.

One obvious reduction that can be seen is the dropping of letters from the full spell-out (minus the O) of E-D-U-C-A-T-I-O-N on first mention to the abbreviated E-D on second mention (though Table 4 shows 0 dropped letters for Q-U-A-L-I-T-Y-E-D_1, the change in the form of the word should be noted), further dropping the T in Q-U-A-L-I-T-Y on the third mention, the T-Y on fourth mention, and finally looking something like Q-U-I-T-E-D on the fifth mention. As we see, the Q-U combination was never dropped, and neither were E-D at the end of the sequence. However, the other letters (except for I, which has a strong tendency to spread its influence to surrounding letters) were all dropped during at least one token. It is likely that fewer letters would be found to be dropped using a methodology that took into account dynamic aspects of letter formation rather than just a single frame for each letter.

Coarticulation did not increase for this word over the course of the repetitions, as shown in Table 4. This variable shows a high level of coarticulation in even the early tokens, as nine coarticulatory processes are seen in this 15-letter phrase. Some other first mentions with high levels of coarticulation may also be predictable from context, and thus less hyperarticulated. Q-U-A-L-I-T-Y-E-D-U-C-A-T-I-O-N is the most topical word and it is introduced with (2), pointing up its topicality. This would make hyperarticulation less necessary, even on the first mention of the word.

(2) WHAT PRO-1 THINK PRO-1-PL ALL KNOW. VERTICAL-5-LIST DET[all choices] PRO-1 MUST REALLY PAY-ATTENTION DET[list] EACH DET[each choice]. Q-U-A-L-I-T-Y E-D-U-C-A-T-I-O-N DET[quality education].
Here's something I think we all know. We must really pay attention to something for each of these choices: Quality education.

The value for the signing rate decreased through the repetitions, showing faster production of the word as it was repeated, as shown in Table 3. Both these methods show reduction, and the numbers are similar enough that one doesn't seem to be preferred over the other in this case.

Both Coarticulation and Signing Rate show irregularities in the pattern of reduction with Q-U-A-L-I-T-Y-E-D_2. This token is indexed, though Q-U-A-L-I-T-Y-E-D_1 is not. It seems likely that this token was emphasized in the discourse for some reason.

The rhythm values varied across the repetitions. If we count the whole sequence as one word the values are as shown Table 4. Numbers less than 1.0 indicate that the first and last letters were actually present for fewer frames than the middle letters were, on some tokens using the Postural Segment method, the opposite of what would be expected under Patrie and Johnson's (2011) definition. Using the Handshape method yields results that show less patterning than with the Postural Segment method. However, it does appear with this method that most of the first and last letters are held longer than the letters in the middle of the word, and that the first use of the word does not deviate from this pattern.

If we look at dropped letters from the standpoint of fingerspelled words being patterns of articulatory movement we see that after several repetitions this word consists of a core form of Q-U-I-E-D, keeping the edges and center letter of the word intact while the intervening letters (and the rest of E-D-U-C-A-T-I-O-N) are more expendable. In the context of speaking to educators the reduction of ‘education’ to ‘ed’ is to be expected as a standard abbreviated form. Repetitions of a patterned movement are likely to increase in speed, as we see here.

Overall, we can see that Q-U-A-L-I-T-Y-E-D-U-C-A-T-I-O-N shows reduction from the first to the last token on two measures, dropped letters and signing rate, and that this reduction increases with each repetition. Two other measures, indexing and rhythm, show a less distinct pattern, which is consistent with their behavior in the data as a whole. Coarticulation, which shows a pattern of reduction in the data as a whole, does not follow that pattern with this word, likely due to the high level of coarticulation already present in the first instance of the phrase. Figure 8 shows possible placement of I-W-O-J-I-M-A and Q-U-A-L-I-T-Y-E-D-U-C-A-T-I-O-N based on the data in this study.

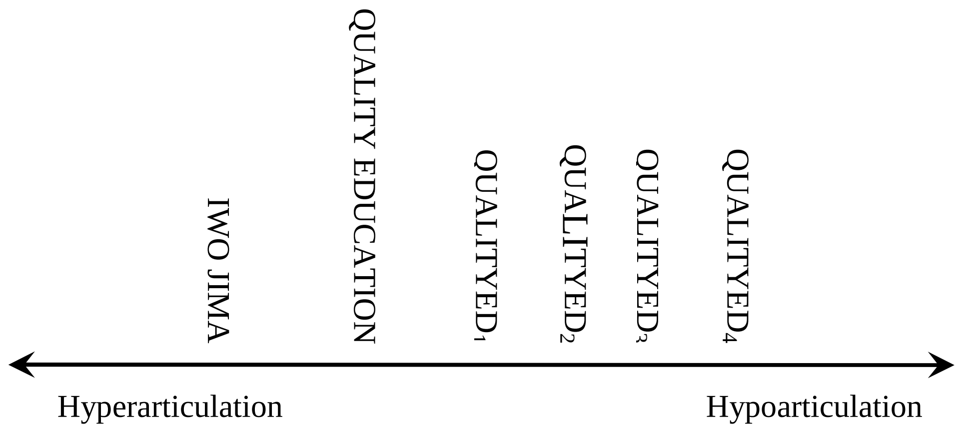

Figure 8. I-W-O-J-I-M-A and Q-U-A-L-I-T-Y-E-D-U-C-A-T-I-O-N on the H&H continuum.

CONCLUSIONS

In this study I looked at two questions. The first was whether careful fingerspelling, analogous to clear speech in its definition, was in fact present in running signing. The second was whether the reduction in repeated fingerspelled words was analogous to that present in spoken English. I will address these questions separately below.

Careful vs. Rapid Fingerspelling

The definition for careful fingerspelling given by Patrie and Johnson (2011) involves general statements but no numerical measures by which to judge a word's status relative to it. I have attempted to measure each of these variables in order to provide a benchmark of sorts to determine whether words fit into the careful or rapid fingerspelling category.

The definition for careful fingerspelling includes indexing of these words being prevalent, and while 45% of the first mentioned words were indexed, a slightly higher percentage of second mentions were also indexed. Dropped letters are predicted to be rare in careful fingerspelling and prevalent in rapid fingerspelling, yet the increase of dropped letters seems to progress steadily, growing with increasing repetitions. Coarticulatory effects found in the first use of words were also not out of line with the progression seen of increasing coarticulation with increasing repetition. The ratio of the length of first and last letters to the length of middle letters was at or close to the maximum on the first mentions compared to subsequent uses, rather than being closer to 1.00. As discussed above, the signing rate shows a large drop between first and second mentions, and the reason for this is unclear. Taken together with the other variables, however, it is not clear that this difference is sufficient to call first mentions a different category of fingerspelling.

With the exception of the Indexing and Rhythm variables, the first mentions have values in line with the definition given by Patrie and Johnson (2011), but the differences between first and second mentions do not seems to be categorical. The differences seen seem to be differences of degree more than of kind. While some first mentions, such as I-W-O-J-I-M-A, could be called Careful Fingerspelling and would be placed to the hyperarticulation end of the H&H continuum as seen in Figure 9, others such as Q-U-A-L-I-T-Y-E-D-U-C-A-T-I-O-N seem to be appropriately placed farther from that end, and the boundary between them is not clear. Second and subsequent mentions seem to be arrayed farther toward the hypoarticulation end of the continuum.

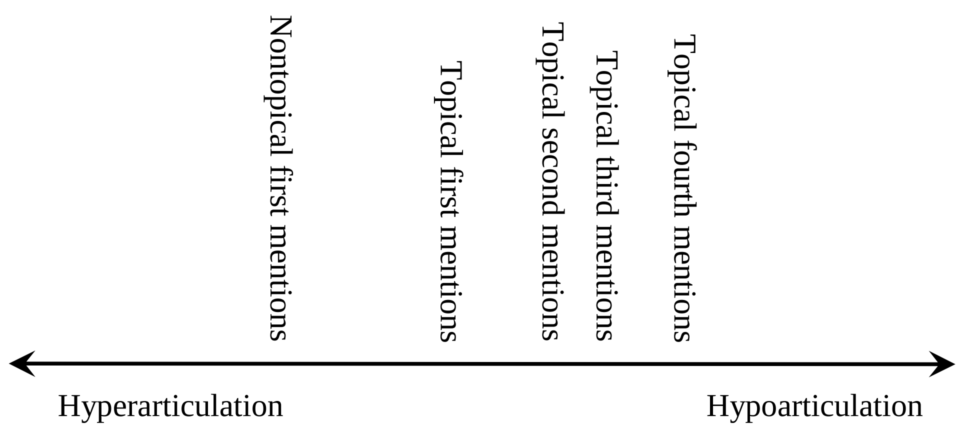

Figure 9. Different categories of fingerspelling on the H&H continuum.

Reduction

To determine the reduction of second mentions I looked only at the first and second tokens of repeated words, as summarized in Table 3. As predicted, the rate of indexing was exactly the same between first and second mentions. I expect that further investigation may show that the indexing of fingerspelling is much like the indexing of other signs in ASL. The rhythm of first mentions was less even than that of second mentions, which may reflect the placement of the words in intonational phrases more than being related to the difference between first and second mention. These two variable do not seem to be related to reduction.

As predicted, both the number of words exhibiting dropped letters and the percentage of letters dropped increased from first to second mentions, as did the level of coarticulation. The value for signing rate decreased, indicating faster production of the words, as predicted. It seems clear from this that fingerspelled words undergo the same reductive processes that have been described in spoken languages.

Future Research

This small study of fingerspelling styles has opened up many ideas for future possible explorations of the study of fingerspelling and sign language in general. I will outline some of these ideas below.

Genre Effects

This study looked at a signing sample from one genre, a speech. Now that numerical indexes for indexing, completeness, coarticulation, signing rate, and rhythm have been devised, comparison across a broader spectrum of the language is now possible. In order to determine the range of articulation effort that can be expected in fingerspelling, future studies need to examine different genres of signing, in different registers. It would be expected that less formal registers would involve increased rates of dropped letters and coarticulation and perhaps faster signing, placing them farther toward the hypoarticulation end of the H&H continuum.

Different Theoretical Approaches To Reduction

This study used a binary approach to determining the completeness of a word, registering each letter as either present or not present based on inspection of a single frame. This methodology led to some letters for which there was dynamic but not static evidence of their presence not being counted, as seen in Figure 4, where the thumb moved toward the position to form a T but did not achieve a posture that allowed me to see evidence of a T in the still frame. Using a different theoretical approach such as undershoot (Lindblom 1963) to describe the formation of the letters might allow these letters to be accounted for. Another theoretical approach to letter formation and coarticulation that could prove fruitful in understanding reduction in fingerspelling is Keating's (1990) window theory, which would give context to the paths the fingers travel in the formation of fingerspelled words.

These theories are also more compatible with Wilcox's (1992) gestural theory of fingerspelling than those I used in this study and would allow a fuller investigation of the idea of repeated patterns of movement and the role they play in the articulation of fingerspelled words.

Boundary Issues

The question of when a word begins and ends is important in the phonological analysis of a language. And while Johnson and Liddell's (2011c) Postural Segmental framework addresses the issue, it does not lead to satisfactory analysis in all situations. Determining the end of a held sign proves to be particularly difficult, partly due to the question of how to determine the end of a held sign that occurs at the end of an intonational phrase. Further work on the nature of intonational phrase boundaries in signed languages is needed. Additionally, a usable definition of word length needs to include all the information in the word and not cut off fingerspelled letters at the beginning or end of a word.

Sonority

I mentioned Brentari's (1998) sonority index, which predicts that consecutive letters that are more unlike in their formation are less likely to be dropped than are letters that are more alike. The preliminary data here are intriguing in that the letters predicted to be more resistant to dropping were not dropped in first mention words, though they were sometimes dropped in second and subsequent mentions. Other aspects of the theory could not be tested because most of the letters that were dropped were situated between a like and an unlike letter, meaning that dropping of the letter in that position would have been permitted no matter the value assigned to it.. A closer look at this theory with a larger data set would allow it to be tested to see if it accurately predicts which letters are more likely to be dropped in fingerspelled words.

Indexing

A final area of investigation I hope to see pursued is the investigation of eye gaze as a form of pointer buoy or explicit indexing. While ASL eye gaze has been studied, it has almost always been in the context of marking syntactic verb agreement. I think it is likely that a study focusing on methods of indexing would find that eye gaze and support may be similar to pointing in their linguistic functions and that they should be classed together.

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