The Transition From Fingerspelling to English Print: Facilitating English Decoding

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Fingerspelling is an integral part of American Sign Language (ASL) and it is also an important aspect of becoming bilingual in English and ASL. Even though fingerspelling is based on English orthography, the development of fingerspelling does not parallel the development of reading in hearing children. Research reveals that deaf children may initially treat fingerspelled words as lexical items rather than a series of letters that represent English orthography and only later begin to learn to link handshapes to English graphemes. The purpose of this study is to determine whether a training method that uses fingerspelling and phonological patterns that resemble those found in lexicalized fingerspelling to teach deaf students unknown English vocabulary would increase their ability to learn the fingerspelled and orthographic version of a word. There were 21 deaf students (aged 4–14 years) who participated. Results show that students were better able to recognize and write the printed English word as well as fingerspell the word, when training incorporated fingerspelling that is more lexicalized. The discussion focuses on the degree to which fingerspelling can serve as a visual phonological bridge as an aid to decode English print.

One significant challenge for deaf children learning to read is their reduced access to the phonological system of spoken languages, which impacts their ability to develop the connections between phonology and the orthography available in most written systems. Research on hearing children's development of reading has found strong connections between children's phonological systems and awareness of phonological regularities and their ability to read (see Snow, Burns, & Griffin, 1998). Typically, reading is viewed, in large part, as reflecting English skills, and deaf children's longstanding difficulties with learning to read are considered to be a problem with English (King & Quigley, 1985; Paul, 1998). More recently, researchers have begun to investigate how American Sign Language, or ASL, can support and facilitate reading in English (see Chamberlain, Morford, & Mayberry, 2000). For example, Hoffmeister, Philip, Costello, and Grass (1997) and Strong and Prinz (1997) have adopted the Linguistic Interdependence Theory (Cummins, 1989, 1991) as a model for the bilingual education of deaf students, which proposes that when semantic and phonological features exist in different language forms, a student's first language can be used to bridge the gap. Accordingly, a bilingual student's experience with language, particularly their first language, will lead to increased competence in both languages.

However, a particular stumbling block for many researchers and educators is the fact that ASL and English do not share a phonological system that is remotely similar on many levels. Mayer and Wells (1996) have argued that in order for a first language to support a second language, there must be the development of an inner speech system, as well as some way for the inner speech system to directly relate to

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written text. They point to the fact that the differences between ASL and English, including modality as well as phonemic and morphemic rules, constitute a barrier rather than a bridge between the two languages. They hypothesize that these differences prevent the deaf child from engaging, in part, in sound-to-print mapping and one-to-one mapping of meaning to print, which they believe are essential for learning to read. It should also be noted that Mayer and Wells believe that ASL has a critical role in education, particularly in cognitive and academic domains.

There are models of reading in deaf children that attempt to define more specifically how knowledge of ASL could relate to the ability to read in a broad sense. Chamberlain and Mayberry (2000) have adopted a model, developed for hearing children, called a Simple View of Reading to examine the relationship that exists between ASL and reading development (Hoover & Gough, 1990; Tunmer & Hoover, 1992). In this model, reading comprehension is made up of just two components, linguistic comprehension and decoding. Decoding is defined as the ability to rapidly derive a representation from printed input that allows access to the appropriate entry in the mental lexicon and, thus, the retrieval of semantic information at the word level. Chamberlain and Mayberry describe some of the multiple functions that decoding can serve including (a) a prelexical link between the printed letters of a word and the child's cognitive representation for the word that facilitates retrieval of word meaning (as in figuring out orthographic patterns in order to recognize words that the child already knows in sign or speech), (b) a postlexical mental notepad to hold in mind meaning that has already been recognized in print (as in working memory), and (c) a means to pronounce or express and, hence, keep in mind an unknown word encountered in print until a meaning can be attached to the new word (as in novel word learning via reading). The simple view of reading model stresses that both semantic and phonological components are necessary and that neither is sufficient independently.

Hearing and Deaf Decoding Strategies

Research to date indicates that deaf and hearing students can differ in how they decode printed material. Hearing individuals frequently adopt a coding strategy for verbal materials that is primarily based on an auditory, spoken phonology (see Snow et al., 1998). Though little is known about the exact nature of how deaf students use decoding strategies derived from mental representations of signed language, there is some research that provides insight.

There is evidence that proficient deaf readers have some form of English phonological knowledge (Hanson & Fowler, 1987; see also Leybaert, 1993). However, it is unclear whether this phonological knowledge caused reading proficiency or was a result of learning to read an orthography that has regular rule-governed relationships with speech. It is also true that rather than using only a speech-based code, deaf students often adopt manual and visual coding strategies. For example, Schaper and Reitsma (1993) found that young deaf children use visual strategies to remember pseudowords. Other research has found that in order to facilitate their recall of letters or words, some deaf students may rely on fingerspelling, using the letters of the manual alphabet to rehearse individual letters or to spell out whole words (Bonvillian, 1983; Locke & Locke, 1971). Hirsh-Pasek (1987) also found that deaf children use fingerspelled handshapes in the same way that hearing children use phonemes, connecting them to written words. Ross (1992) found that beginning deaf readers use rule-governed relations between orthographic patterning and the sublexical structure of sign. Interestingly, Ross found that the words that the subjects only fingerspelled were typically words they had not recognized on a previous task, providing preliminary evidence that fingerspelling plays a specific pronunciation-expressive function for deaf students for words they do not yet know (Chamberlain & Mayberry, 2000).

Deaf adults also show us that fingerspelling may serve a critical link in word learning, providing alternative cognitive representations of a word and providing an explicit ASL–English link. Padden and Ramsey (2001) observed both Deaf and hearing teachers and found that the Deaf teachers would frequently incorporate fingerspelling in their teaching. They were much more likely than hearing teachers to link words written on the blackboard with both sign and fingerspelling, going back and forth between fingerspelled and lexical representations, a procedure they called

"chaining" (p. 62; see also Humphries & MacDougall, 2000). Chamberlain and Mayberry (2000) suggest that this "pedagogical procedure arises from the Deaf teachers' intuitions about the complex relations of sign, fingerspelling, and print that need to be developed in the minds of deaf students if they are to be skilled readers," (p. 255).

Finally, there is strong evidence that fingerspelling skills are important to reading. Sedey (1995) found that deaf adolescents' ability to learn new fingerspelled words quickly (i.e., fast mapping) was highly correlated with their reading vocabulary, meaning that the better a student's receptive fingerspelling skills, the larger their knowledge of English words. Similarly, Padden and Ramsey (1998) found that deaf children's ability to write an English word after they had seen the fingerspelled word in a sentence was correlated with reading comprehension skills, as measured by the Stanford Achievement Test.

These data indicate that deaf students use fingerspelling in a variety of ways as an aid to decode printed text and its importance in learning is evidenced by how Deaf teachers incorporate fingerspelling. Fingerspelling may provide a form of a cognitive representation that is more readily linked with English print.

Fingerspelling in Adult ASL

Fingerspelling has a unique role within the signing system of ASL. Simply defined, it consists of single handshapes to represent each letter of the English alphabet, what we term neutral fingerspelling in this paper. However, fingerspelling is used in ways other than neutral fingerspelling. The lexicon in ASL includes many fingerspelled words that have become more sign-like, termed *loan signs* (Battison, 1978) or lexicalized fingerspelling. These loan signs do not look like fingerspelled words in that they have undergone a structural change, mostly in phonological movement, so that they look more like signs, with movement patterns that create a larger prosodic envelope. That is, phonological movement does not just occur on a letter-by-letter basis, but rather the entire sequence of letters has a sign-like movement pattern. The resulting fingerspelled production looks like a complex phonological production, in contrast to the relatively simple monosyllabic signs that are common in ASL (see Brentari, 1998). There are linguistic rules that govern such phonological restructuring (Battison, 1978), and it is entirely appropriate to think of lexicalized fingerspelling as having its own subset of phonological rules that are independent of its neutral representation of English orthography. Lexicalized fingerspelled words are pervasive in ASL, and they often convey unique meanings in ASL (Brentari & Padden, 2001; Padden, 1991). In many cases, the changes are so major that the fingerspelled loan signs are seen as regular ASL signs, and many times signers do not realize that they were originally fingerspelled words borrowed from English (Baker-Shenk & Cokely, 1980).

Acquisition of Fingerspelling by Native-Signing Children

Research indicates that young deaf children acquire fingerspelled words as lexical items without formal instruction in natural interactions. Children have fingerspelled words as part of their earliest lexicon and ample evidence exists that fingerspelling can appear very early in a signing child's life, as young as 13 months old (Akamatsu, 1982; Anderson & Reilly, 2002; Erting, Thumann-Prezioso, & Sonnenstrahl-Benedict, 2000; Kelly, 1995; Maxwell, 1988; Padden, 1991; Padden & LeMaster, 1985). Deaf adults frequently use fingerspelled words with children as part of the language, not as a means to borrow from English (Akamatsu, 1982; Humphries & MacDougall, 2000; Kelly, 1995). Yet, even when parents explicitly attempt to associate fingerspelling and print, children do not begin to connect the two until about 3 years of age (Kelly, 1995).

In terms of perception, it seems that children first attend to the sign-like qualities of fingerspelling. When fingerspelling skills first emerge, children attend to the overall movement, or prosodic envelope, of fingerspelled words rather than to specific handshapes (Akamatsu, 1982; Padden & LeMaster, 1985). In her research, Akamatsu (1982) noted an interesting paradox in her participants fingerspelling: some of the children's fingerspelled words were unintelligible despite clear handshapes, whereas others were intelligible despite unclear handshapes. Akamatsu proposed that

the children were analyzing the fingerspelling as a complex sign rather than as a concatenation of manually represented letters. She found that fingerspelled words that showed limited distinctions among handshapes (and seemingly incorrect) in fact mirrored the overall prosodic movement patterns of adults. That is, the children produced the fingerspelled words in terms of a larger movement pattern rather than series of clear handshapes. By focusing on the movement envelope, the children managed to produce fingerspelled utterances that were intelligible to the adults even though they had not acquired details about the specific handshapes used to represent letters.

Padden (2006) describes the development of fingerspelling as learning to fingerspell twice. The first fingerspelling skill, lexicalized fingerspelling, emerges naturally as signing children begin to recognize the movement shapes of the fingerspelled words as a lexical item. In time, the children develop an understanding of how fingerspelling functions in ASL. It is not until the child begins to learn to read and write that the second fingerspelling skill emerges, the ability to use neutral fingerspelling. This second skill requires understanding that words have internal linguistic patterns made up of handshapes that correspond to English alphabetic letters.

Parallels to this development can also be found in children learning spoken language. Many models of early speech production propose that children do not initially treat words or even phrases as a series of connected phonemes (Ferguson & Farwell, 1975; Jusczyk, 1997; Menyuk & Menn, 1979; Peters, 1983). From a perceptual perspective, there are many other important cues to help children learn how to perceive and produce spoken words, including prosody, suprasegmentals, and its gross acoustic shape (Jusczyk, 1997). That is, initially many words are probably not organized in phonemic segments. For many children, they learn words in a seemingly holistic manner and only later analyze the phonological word into its component phonemes (Jusczyk, 1997; Peters, 1983). Although researchers who have studied the development of fingerspelling have not drawn direct parallels with that of spoken phonologies, there are strong similarities in that children initially treat fingerspelling as complex phonological words, including prosodic contours that make them look quite lexical, and with development, children discover the word internal segments.

Although linguistic investigation of fingerspelling assumes that it is a part of the phonological system, there has been little investigation of how these properties might facilitate a connection between English orthography and fingerspelling phonology. The purpose of this study was to explore the effects of fingerspelling on learning new English words. Broadly speaking, we wanted to know whether fingerspelling facilitated learning of English words when compared with just associating ASL signs with English print. We propose that fingerspelling, and in particular, lexicalized fingerspelling, can serve as a cognitive representation bridge between lexical words and concepts and their orthographic representation, as shown in Figure 1. There is no phonological link between a sign and its representation in orthography as there is in spoken language. Fingerspelling and lexicalized fingerspelling may create an intermediate cognitive representation.

A preliminary study compared word learning when children were presented with new words, either with fingerspelling or only with an ASL sign. The study (Haptonstall-Nykaza, 2004) included 14 deaf children learning ASL at a bilingual school. Children were taught new English words in two conditions, using neutral fingerspelling or print. However, as the researcher worked with the deaf children, they occasionally adapted the neutral fingerspelling by adding movement envelopes that made the fingerspelling look more like the related sign phonology or some other aspect of meaning. During the course of the training, other movement patterns emerged, such as using the natural up-and-down movement when fingerspelling the word *paint* and connecting it with the lexical sign PAINT. The results of that study showed a significant effect for training with fingerspelling versus a no fingerspelling condition, $F(1, 13) = 11.64$, $p = .005$, effect size = .63. However, as a result of the childrens' corruptions, the time spent on the two conditions differed, with more time spent in the fingerspelling condition, making the results difficult to interpret. Clearly, the children had their own intuitions about learning fingerspelling in that they formally and systematically included phonological movement patterns that resemble lexicalized fingerspelling.

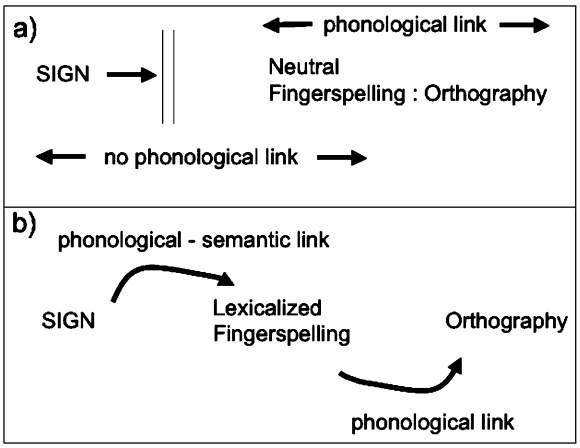

Figure 1 The relationship between signs, fingerspelling, and English orthography for neutral fingerspelling (a) and lexicalized fingerspelling (b).

This study was designed to explore how well children could learn fingerspelled words and words in print by capitalizing on making the fingerspelling more sign-like by adding prosodic contours that we know from development, theory, and adult use, may provide important phonological cues to help children retain and recall linkages between fingerspelling, signs, and print. That is, can fingerspelling provide a phonological bridge between ASL phonology, semantic meaning, and English orthography? This study was designed to teach children new English words in two different training conditions, using different sets of words. One condition used ASL signs and English print to teach unknown English words. Another condition used principles of lexicalized fingerspelling to enhance neutral fingerspelling to teach unknown English words. Rather than using words that are represented using lexicalized fingerspelling in ASL, such as #BANK, #BACK, and #RICE, which some children would already know, we taught unknown words, altering the fingerspelling to look more sign-like. It was hypothesized that lexicalized fingerspelling would help create a link between the semantic and phonetic components in a sign with the orthographic representation in fingerspelling that would facilitate learning the printed English word. Because of the difficulty of creating matched experimental groups, this study utilized a within-subject design with each participant trained in each of the two conditions.

Method

Participants

There were 21 profoundly deaf participants, ranging from 4 to 14 years of age, all prelingually deafened. Nine children had Deaf parents (DOD) and 12 had hearing parents (DOH), as shown in Table 1, which also shows parental hearing status, gender, grade level, and reading level for each child. All attended an ASL immersion school where they received a bilingual education in ASL and written English. The students had significant exposure to fluent ASL: about one third of the students had deaf families; all teachers and aides were fluent in ASL; and about one half of the staff were deaf. The deaf teachers reported that many of the deaf children with hearing families were quite nativized in their signing; that is, much of their signing looked like they had grown up in deaf families. The students' reading level was taken from school records, which included a teacher-determined level based on formal assessment (Developmental Reading Assessment, Beaver, 1997) and informal assessment. This resulted in seven levels.

A separate list of words was created for each of the two conditions (List A and B). Within each condition, lists were created to represent each of the seven reading levels, resulting in 14 lists of words (Appendix). Each list contained from five to eight words for each training method, for a total of 10–16 new words per subject. In both conditions, the words were taken from a leveled vocabulary list. The participants were pretested, and the words that were recognized by any of the participants were eliminated from the lists. Words were selected from the unrecognized words based on the need to balance the A and B lists in terms of word length, word frequency (using the MRC Psycholinguistic Database, Wilson, 1988), orthographic similarity, and phonological similarity of ASL fingerspelled handshapes. In addition, the words were distributed between the lists to balance the degree to which each sign could be matched with its fingerspelled equivalent by either a semantic or prosodic contour link, that is, whether the typical fingerspelling of the word provided any clue to its meaning. Pictures were obtained for each word from books of teaching materials.

Table 1 Age, parent hearing status, and reading level for each participant

Subject number	Age	Gender	Parent hearing status	Reading level
2	5	F	DOD	1
6	5	M	DOD	2
5	6	M	DOD	2
9	6	M	DOD	4
8	7	M	DOD	3
10	7	F	DOD	4
11	7	M	DOD	4
12	7	F	DOD	4
21	11	F	DOD	7
4	4	F	DOH	1
3	5	F	DOH	1
1	6	M	DOH	1
7	7	M	DOH	3
15	11	F	DOH	5
18	11	M	DOH	6
13	12	M	DOH	5
14	12	M	DOH	5
19	13	M	DOH	6
20	13	M	DOH	7
16	14	F	DOH	5
17	14	M	DOH	5

F, female; M, male.

Lexicalized fingerspelling versions were developed for words in the Fingerspelling conditions. In some cases, a movement pattern was "borrowed" from a semantically similar sign or, with words where this was not possible, a semantically empty movement pattern was added. For example, the lexicalized fingerspelling of CLOWN incorporated a fluid motion whereby C-L began at the right of the researchers face, the O was signed as CLOWN, and the W-N continued to the left of the researchers face. Similarly, the word "doll" was fingerspelled originating with the fingerspelled D, curling into the sign for DOLL, and ending with a fluid O-L-L.

Measures to Assess Learning

Participants' learning was assessed using three tests, administered immediately following training and 1 day later to better assess carryover. All trained words were tested in each of the three tests. Each item or plate in the Receptive Print test consisted of four printed words and a picture of the target word. One printed word matched the picture, one resembled the target word phonologically–orthographically, one was semantically related to the target word, and one was chosen to resemble the fingerspelled handshapes of the target word. The Written English test asked the child to write the English word, looking at a picture. The Fingerspelling test required children to fingerspell the word, looking at a picture.

Accuracy in all three tests was measured by the proportion of target words correctly recognized or correctly expressed. Each correctly identified word was given five points. Both the fingerspelled and written words were evaluated according to a scoring rubric where each letter of each word was given the value of one point. One point was taken off for each missing letter. One point was also deducted for added letters. In the cases where letters were transposed, the subject was given one point for the two letters. For example, the word sincere spelled S-I-N-E-C-R-E would be given six points.

Training Methods

All training and testing was conducted by the first author who is a hearing native ASL signer and is currently a reading specialist at a state residential program for deaf children.

Participants were trained in groups of two under two conditions, or training methods: (a) Sign condition (Sign), where the English word and ASL sign were matched, and (b) Fingerspelling condition (Fingerspelling), where the lexicalized fingerspelling, the sign, and the English word were matched. The training for both conditions began by presenting the subjects with a picture of the target item and its equivalent ASL sign. In the Sign condition, the trainer then presented the written word and matched it to its sign. All the students signed the word. Then the students were instructed to use magnetic letters to spell out each word. Next, the students wrote the words in English. Finally, they signed each word they had spelled. In the Fingerspelling condition, after presenting the picture and sign, the students imitated the sign. The trainer then produced a lexicalized fingerspelled version that included a sign-like movement pattern. The children attempted to imitate the lexicalized fingerspelling. Following this, the subjects

engaged in matching exercises where each English printed word was matched with a printed version using a fingerspelling font. Finally, the subject was instructed to fingerspell each word making sure that attention was given to each letter. It is important to note that both conditions required the student to produce the word in three different ways and that there were no differences in terms of length of exposure.

Testing Procedures

Two weeks before each training period, participants were pretested to ensure that the lists of words were unfamiliar. Training for each condition occurred on the same day, but conditions were counterbalanced, and each condition took approximately 20 min. Students were tested individually on two occasions, immediately following training and again later the next day (Immediate vs. Delayed).

Results

Figure 2 shows the means and standard deviations for each of the testing conditions for each type of test for the DOD and DOH students, collapsed across time of testing. The scores were higher for the Fingerspelling condition for all tests. When comparing the scores in the Fingerspelling and Sign conditions, children scored 10% higher in their recognition of the printed word, 20% higher in their ability to write the word, and 28% higher in their ability to fingerspell a word in the Fingerspelling condition. Although the children were able to learn the words in the Sign condition, they learned them better in the Fingerspelling condition. In addition, a Pearson correlation (two-tailed) was calculated that showed that the two conditions were highly correlated, $r = .941$, $p = .000$).

To examine differences related to the training conditions, a $2 \times 3 \times 2$ repeated measures analysis of variance (ANOVA) was conducted. The first factor (training method) consisted of two levels, Fingerspelling versus Sign training. The second factor (test type) consisted of three levels, Receptive Print, Written English, and Fingerspelling. The third factor was Time of Testing (Test 1 = Immediate, Test 2 = Delayed). The ANOVA revealed a significant main effect for training condition, $F(1, 19) = 50.35$, $p < .0001$, effect size = .726, confirming that the Fingerspelling condition resulted in better performance than the Sign condition. There was also a significant effect for test type, $F(2, 19) = 21.484$, $p < .0001$, effect size = .705. Planned post hoc testing revealed that each test type was significantly different from the other ($p < .05$). The Receptive Print test scores were significantly better than the Written English or Fingerspelling scores, and the Fingerspelling scores were significantly higher than the Written English scores. There was no significant main effect for Time of Testing, $F(1, 19) = 1.922$, $p = .182$. There was a significant interaction, Training Condition $\times$ Test Type, $F(2, 19) = 9.473$, $p = .006$, effect size = .321. As shown in Figure 2, the scores for the Receptive Print task were significantly better than the scores for writing a word and fingerspelling a word in the Sign condition. That is, in the Sign condition, the students could recognize the printed word better than they could write it or fingerspell it, and both writing and fingerspelling were higher in the Fingerspelling condition. No other interactions were significant ($p < .05$).

The data were also analyzed to determine whether performance differed for the DOD and DOH students. A between-subjects multivariate analysis of variance was calculated using the total score for each condition as a dependent variable and parent group (DOD and DOH) as an independent variable. Because the mean age of the two groups were quite different (DOD = 6.8 years, $SD = 1.8$; DOH = 10.2 years, $SD = 3.6$), age was entered as a covariate. The results show that DOD students performed significantly better than the DOH group in both conditions [Fingerspelling: $F(1, 18) = 10.814$, $p = .004$; Sign: $F(1, 18) = 14.905$, $p = .001$]. There was a moderate effect size for both conditions (Fingerspelling = .453, Sign = .375).

The 21 participants represented seven different reading levels, which precluded treating reading as a factor in the larger ANOVA. Rather, a Pearson correlation (two-tailed) was calculated using reading level and the total sum score from the Fingerspelling and the Sign conditions. The correlations were not significant (Fingerspelling: $r = .35$, $p = .119$; Sign: $r = .278$, $p = .222$).

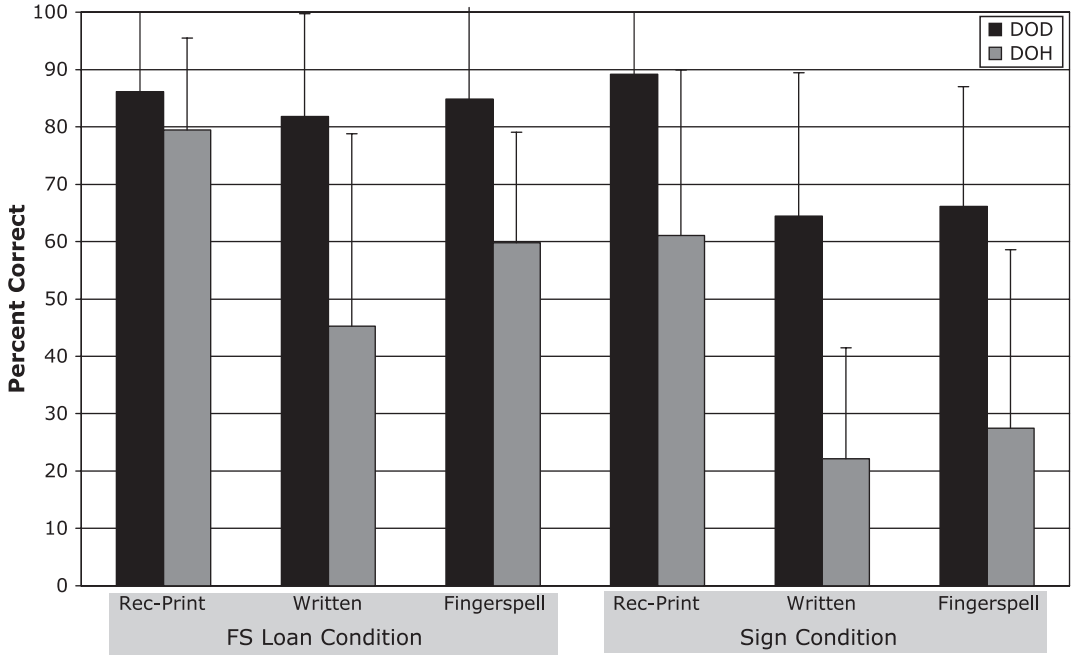

Figure 2 Average percent correct for both conditions for each test.

Discussion

In this study, deaf children were taught new English vocabulary in two conditions, one where signs were matched with printed words and another where lexicalized fingerspelling was used in addition to the print and sign. The Fingerspelling condition incorporated phonological rules that lexicalize fingerspelling, creating sign-like forms that provided a movement envelope, which sometimes contained more semantic information. Results show that the children were more likely to recognize and produce new words in print and to be able to fingerspell them, when taught in the Fingerspelling condition than when taught using an approach that linked signs with their orthographical representation, the Sign condition. However, the two conditions were highly correlated with each other (.94) indicating that although performance was better in the fingerspelling condition, both tasks appear to utilize similar underlying skills. Children who learned better in one condition also learned better in the other. The Fingerspelling condition simply allowed the child to establish a print–sign link more reliably, which facilitated learning. The effect size was large (.73) indicating that the differences between the two conditions were not only significant but also yielded large differences in learning. Children showed an average improvement of 28% in their ability to fingerspell, 20% in their ability to write the word, and 10% in their ability to recognize the printed word, when compared with the condition where the sign was paired with print alone. The improvement in learning was especially marked for the DOH students who were 32% better in their ability to fingerspell a word, 23% better in their ability to write a word, and 18% better in their ability to recognize the word in print. Of course, the higher scores on the Fingerspelling test for the Fingerspelling condition may also be a result of direct practice with the fingerspelled version. However, the higher scores in writing the word and recognizing the word in print show that the benefits are more general. It is important to recall that the students did not have practice writing the word in the Fingerspelling condition; they imitated the sign, matched fingerspelling fonts with the written word, and fingerspelled the word. Despite the fact that students did have practice writing the word in the Sign condition, they demonstrated better learning for writing the word in the Fingerspelling condition, where there was no practice.

Unlike previous studies, which found a direct relationship between receptive fingerspelling abilities and reading skills (Mayberry, Waters, Chamberlain, & Hwang, 2005; Sedey, 1995), this study did not show a correlation between performance and the reading level that was provided by the school. For example, Mayberry et al. found that written word recognition is faster and more accurate than recognition of fingerspelled words up to a reading grade level of 5 to 6. However, the fingerspelling was presented as single letters, one at a time, without the typical phonological movement that occurs in neutral fingerspelling. As important, fingerspelling in the this study was more lexicalized, with movement patterns different than those in neutral fingerspelling. Mayberry et al. may be tapping into a more advanced stage of fingerspelling, when children can more effectively link neutral fingerspelling with the orthographic counterpart. It is possible that the lack of correlation between reading and learning new words in this study was because we were tapping into earlier appearing lexicalized fingerspelling skills. We view the fingerspelling used in this study as more lexicalized and sign-like rather than a simple 1:1 representation of a handshape with an English grapheme. The results found by Mayberry et al. would suggest that the 1:1 type fingerspelling might be more difficult for younger children, particularly at lower reading levels. In addition, the reading measure used in this study, the school's reported reading level, may not be a robust or accurate measure of the child's reading ability, which would affect a correlation. Given this, we are reluctant to interpret our lack of correlation to mean that reading is not relevant but it does suggest that further exploration of how reading, lexicalized fingerspelling, and neutral fingerspelling are related.

The findings support the premise that deaf children benefit when they are taught using methods borrowed from ASL. The methods used in this study were gleaned from the deaf children who used them in the preliminary study (Haptonstall-Nykaza, 2004), who had obviously learned them from Deaf adults and peers, what Padden (2006) calls *indigenous strategies*. Deaf adults are often bilingual in ASL and English, and studies have shown that they intuitively teach deaf children fingerspelling by incorporating it early (Akamatsu, 1982; Erting et al., 2000; Kelly, 1995; Padden, 1991) and contrasting it with signs (Humphries & MacDougall, 2000; Kelly, 1995). This study shows that word learning is facilitated by incorporating phonological patterns that lexicalize fingerspelling, which capitalizes on naturally appearing methods found among deaf adults.

Not surprisingly, the deaf children who had deaf parents learned more new words in both conditions than the students with hearing parents. However, the performance of the DOH students shows good learning performance. In addition, the lexicalized fingerspelling helped them to perform more like the DOD students. In the Sign condition, the DOH students performed at 50% of the DOD students' score, but in the Fingerspelling condition, they performed at 73%.

These findings are consistent with the reading model advanced by Chamberlain and Mayberry (2000). The lexicalized fingerspelling method strengthens the cognitive representations needed for establishing links between print and sign. The lexicalized fingerspelling method provided a direct and explicit link between the sign and the English print. The sign provided the semantic link, whereas the one-to-one fingerspelling to print provided the phonological–orthographic link, as illustrated in Figure 1b.

Practically speaking, the deaf students were observed using fingerspelling in the same ways as reported in the research on the decoding strategies of deaf children. Although some of the fingerspelling strategies were modeled at the suggestion of the trainer, the students themselves spontaneously generated many others. As in previous research (Bonvillian, 1983; Locke & Locke, 1971; Ross, 1992), the students universally used fingerspelling to rehearse words, as to pronounce, or introduce the unfamiliar word to themselves. The students also fingerspelled when they were trying to memorize the words, connecting the handshapes one-on-one to the printed letters in the same way that hearing children use phonemes (Hirsh-Pasek, 1987). Last, similar to what Schaper and Reitsma (1993) observed, they used fingerspelling when attempting to remember words during testing, regardless of the type of testing, print, or fingerspelling.

These results also provide support for the Linguistic Interdependence model that proposes that deaf

children can effectively use their knowledge of ASL to learn English literacy skills (see Hoffmeister et al., 1997; Strong & Prinz, 1997). Even when the subjects were trained with the Fingerspelling method, where no writing occurred, they were better able to recognize and write English words than when they were trained with the Sign condition, where they produced the words using magnetic letters. This study shows that ASL has naturally created mechanisms that provide links between signs and English print.

We believe that these data support Padden's (2006) hypothesis that deaf children learn to fingerspell twice. All the children in this study were exposed to fluent native signers of ASL, including parents, teachers, and peers. The youngest child in the study was 4 years old, an age that Padden identifies as beginning to enter the second phase of learning to fingerspell, making explicit connections between fingerspelling and print. That is, all these students most likely had well-established lexicalized fingerspelling skills. This study shows that they were able to use these skills to learn new English print.

This study has a great deal of relevance to educational models, including those that use English sign systems. Akamatsu and Stewart (1989) found that preschool teachers of deaf children fingerspelled much less than teachers of older children. In addition, they tended to fingerspell a small set of words. We also know that many educational interpreters have fingerspelling skills that are in the range of an advanced beginner (Schick, Williams, & Kupermintz, 2006). These results indicate that teachers and educational interpreters should incorporate fingerspelling in their signing in order to facilitate development in students from the earliest stages of language learning, even prior to the acquisition of word recognition in print. We view the lexicalized fingerspelling as more lexical-like, which is more easily linked with the sign. The results found by Mayberry et al. (2005) indicate that the simple 1:1 linkage may be more difficult for children, particularly at the lower reading levels.

We believe this study and others indicate that fingerspelling may help provide a phonological link with print. We know this study also leaves unanswered questions about the relationship between neutral fingerspelling skills, lexicalized fingerspelling skills, and reading that are worthy of further study, especially given the large effect sizes found in both the preliminary study reported, using neutral (but corrupted) fingerspelling and using lexicalized fingerspelling.

Appendix: Word Lists for the Study

List A	List B
Reading level 1	
MOP	BAT
FAN	JAM
DOLL	BELL
BOOK	DOOR
Reading level 2	
MOP	BAT
FAN	JAM
BELL	DOLL
CLOWN	CLOCK
Reading level 3	
MOP	JAM
DIAL	PAIL
CLOCK	CLOWN
LEMON	BACON
Reading level 4	
PAIL	DIAL
CHAIN	CHIEF
FLOCK	FROST
SADDLE	GREEDY
POLITE	CRADLE
Reading level 5	
DIAL	PAIL
FLOCK	FLUID
CHEAT	CHEER
SADDLE	CRADLE
GREEDY	POLITE
PERFUME	SPATULA
Reading level 6	
SCATTER	QUARREL
PENALTY	SINCERE
RELIABLE	VALIDATE
SANITARY	PHYSICAL
SYMPATHY	WARRANTY
HALITOSIS	COURTEOUS
List 7	
SCATTER	QUARREL
PENALTY	SINCERE
RELIABLE	VALIDATE
SANITARY	PHYSICAL
SYMPATHY	WARRANTY
HALITOSIS	COURTEOUS
TRANSPARENT	STATIONERY
UNCONSCIOUS	EXAGGERATE

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