OXFORD

Journal of Deaf Studies and Deaf Education, 2017, 1–8

doi:10.1093/deafed/enw071
Editorial

EDITORIAL

In Memoriam: Amy Hile

The field of deaf studies and deaf education lost a strong advocate for bilingual education with the sudden loss of Dr. Amy Hile. Her research and influence in the area of bilingual studies was clearly on the radar of many with an interest in bilingualism. Amy had just completed a review of the literature that she hoped to submit prior to her untimely death. At the encouragement of her colleagues and with the permission of her family, we considered publication of this review in her memory. As editor, I took the liberty of changing some minor grammatical issues such as verb tense and pronoun use, and one of the Associate Editors reviewed the content but did not change the wording in any way. Nor did we send the document out for peer review. Thus, with the exception of the changes mentioned, this document is written in Dr. Hile's words, unedited. We submit this draft document in her memory on behalf of a grateful field.

Sincerely,

Susan R. Easterbrooks

Editor

Signing Deaf Children's Acquisition of Fingerspelling by Amy Hile

Abstract

Fingerspelling is known to be acquired by deaf children of signing deaf parents including the acquisition of American Sign Language (ASL), and reviews of ASL acquisition among deaf children of signing deaf parents reveal that it follows a developmental pattern similar to that of spoken language acquisition (Meier, 1991; Newport & Meier, 1985; Schick, 2003). There is also research on the development of fingerspelling, such as case studies (Akamatsu, 1982; Blumenthal-Kelly, 1995; Maxwell 1998; Padden 1991, 1996b; Padden & LeMaster, 1985) and systematic studies of larger groups that show that fingerspelling develops embedded within the context of deaf children's development of ASL and that it is integrated into home literacy practices by deaf parents and/or into classroom practices (Akamatsu, 1982; Blumenthal-Kelly, 1995; Maxwell, 1998; Padden & Ramsey, 2000). Studies have also been conducted on school-age deaf children, showing that fingerspelling skills are predictive of English vocabulary skills and the ability to learn fingerspelling (Allen, 2015); Mayberry & Waters, 1987; Haptonstall-Nykaza & Schick, 2007; Sedey, 1995). Here is what we already know about signing children's fingerspelling acquisition.

Fingerspelling is an important aspect of ASL (Brentari & Padden, 2001; Padden, 1998), as well as other signed languages (Brennan, 2001), consisting of a manual alphabet that is used for verbatim representation of English orthography. Fingerspelling use in ASL is complex. Many people view fingerspelling as a means to convey proper nouns such as names of people, months, places, and holidays, as well as English words that do not have a sign equivalent (see Battison, 1978; Wilcox, 1992). In reality, fingerspelling is used in many different ways in ASL, and its use shows that it is well-integrated into the language and it not just a system to borrow English words (Brennan, 2001; Brentari & Padden, 2001; Padden, 1998).

Since fingerspelling is often viewed as an extension of learning to read, rather than a part of the language, it is not heavily emphasized in programs serving preschool and school-age deaf and hard-of-hearing children (Akamatsu & Stewart, 1989; Grushkin, 1998; Humphries & MacDougall, 1999; Padden & Ramsey, 2000). With teachers who have native-like ASL skills and experience with the Deaf community, the use of fingerspelling is embedded in daily classroom instruction and interaction, as a natural part of the language. We know that native-like ASL signing teachers use fingerspelling more frequently than teachers who use ASL as a second language (Padden & Ramsey, 2000).

Clearly from a cultural perspective and from a literacy perspective, fingerspelling is an essential skill. While we have a fairly good understanding of fingerspelling skills in the earliest stages of development, such as from 1 to 6 years, our understanding of the range of fingerspelling skills among school-age signing children is more limited. We need more information about what school-age children know, and how well they learn fingerspelling. This type of information will be instrumental in identifying and assessing signing students' comprehension and use of fingerspelling in signed discourse and how they connect it to English print.

How Fingerspelling is Used in ASL Lexicon

It was originally thought that fingerspelling was not part of ASL but rather a manual representation of English orthography or a secondary system derived from English (Klima & Bellugi, 1979). For instance, signers often classify fingerspelling as English

when asked (Padden, 1998). In contrast, Padden (2006) describes fingerspelling as an integral part of ASL lexicon and does not consider fingerspelling to be English:

> This is a misleading characterization for three reasons: (1) it incorrectly assumes that fingerspelled words exist in place of signs, when in fact, they can coexist with already existing signs. (2) It describes fingerspelled words as English words. A more accurate description is one, which recognizes fingerspelled words as existing within the ASL lexicon as a category of borrowed or "foreign" vocabulary (Brentari, 2001; Brentari & Padden, 2001; Padden, 1988). And (3) it incorrectly views fingerspelling primarily as a means of translation. ASL signers could translate words into signs; instead, they maintain an active lexicon of fingerspelled words that exist stably in that category. (p. 192).

Fingerspelling is used in ASL in many different ways. It can represent English words, using what is called neutral fingerspelling. Fingerspelling is also used as a complex sign, but its phonological structure is considerably altered. We also find fingerspelling in abbreviations, initialized signs, and sign-fingerspell compounds.

Neutral fingerspelling

ASL signers use canonical fingerspelling to represent many words in ASL. The person holds his hand besides near his shoulder, and articulates each letter clearly. Often, the hand will move right with each letter, as if the word were being typed on a page. Neutral fingerspelling is used for personal names, and other proper nouns such as the names of cities, areas, and regions, as well as names of companies and brand names (Padden, 2006). It is also used when introducing new technical terms or words you think the listener may not know. Thus, ASL does borrow English words through neutral fingerspelling. In print, neutral fingerspelling is represented using hyphens to show that a word has been fingerspelled (V-A-R-I-A-N-C-E) and signs are represented using capital letters, as in STATISTICS. Non-native signers often only use this type of fingerspelling.

Lexicalized fingerspelling

ASL creates new signs by using fingerspelling, but as the fingerspelled word becomes more nativized, it is altered phonologically (Battison, 1978; Padden, 1998). Loan signs result from a reduction in the movements of specific fingerspelled words such that they begin looking very signlike. "#JOB"[1] is an example of a loan sign that has become lexicalized into a sign from the fingerspelled form. In its lexicalized fingerspelled form, this sign is performed with specific movements, "J-B", missing the handshape "O". In other lexicalized fingerspelling, letters may be altered in form from neutral fingerspelling. "#BANK" is an example of a lexicalized fingerspelled sign that does not drop any handshapes but differs in the movement; "B" and "K" are clearly articulated as opposed to the handshapes in between them, "A" and "N". "A" and "N" are articulated in a reduced phonological form during the course of movement where the hand bends down and up in a short and sharp movement.

Lexicalized fingerspelled signs occur across all word categories including nouns, verbs, adjectives, conjunctions, interjections and wh-words (Padden, 1998). An interesting phenomenon about the lexicalized fingerspelling category is that fingerspelled items and lexicalized signs can distinguish nouns and verbs. An example of a pair is the noun, "F-A-X," and the lexicalized fingerspelled verb, "TO-FAX", both involve fingerspelling. The noun is used to refer to a paper that is faxed and is produced near the shoulder. The lexicalized fingerspelled verb is used to represent the action of faxing a paper to another location. This lexicalized sign is reduced to two handshapes, "F" and "X," performed with a directional movement to the destination point to which the paper is being faxed (Padden, 1998). Similarly, the noun, R-E-N-T, refers to a rental payment, while the verb, #RENT, usually means to rent (Brentari & Padden, 2001; Padden, 1998). In addition to fingerspelling entire words, ASL has fingerspelled items derived from abbreviations or shortened words in English using lexicalization (Blumenthal-Kelly, 1995; Padden, 1991, 1998). Examples of abbreviation signs are "A-P-T" for apartment and "R-E-F" for refrigerator.

Abbreviation signs

There is a variation in this category in that a two-word compound in English can be represented by an ASL sign utilizing the two handshapes and corresponding to the first letters of the English words, as in SENIOR-CITIZEN and SOCIAL-WORK (Brentari & Padden, 2001; Padden, 1998, 2006).

Initialized signs

An initialized sign utilizes a handshape that corresponds to the first letter of a written word, such as CITIZEN or UNIVERSITY. Some initialized signs such as colors, trait and status are categorized according to semantics or root. For example, all words that are associated to the concept of a "group" have the same location and movement but the handshape of each varies, e.g., group—family, association, group, team, social, and department (Padden, 1998, 2006).

Signed-fingerspelled compounds

With this category, usually the first segment of a compound is signed while the second segment is fingerspelled (e.g., BLACK +M-A-I-L) (Brentari & Padden, 2001; Padden, 1998).

In summary, the ASL lexicon contains several categories of word formation that make use of fingerspelling in various and complex ways. Many of these fingerspelled words become native signs, undergoing phonological alteration.

The Acquisition of Fingerspelling

Five percent of deaf children are born to deaf parents (Mitchell & Karchmer, 2004) in the United States while the deaf children born to hearing parents (95%) outnumber those with Deaf parents.[2] American Sign Language is the preferred language of the Deaf population. Those deaf children who are born to hearing parents, often do not have ASL as a primary language. In fact, many deaf children with hearing parents have never been exposed to ASL when they are young in contrast to deaf children with Deaf parents. Many hearing families are faced with difficult decisions about their deaf child's language/communication system (sign or spoken language) and educational programming choices (see Marschark, 2007). When it comes to studying the language development among deaf children, there are many factors associated with their language development such as: parental hearing status (Deaf vs. hearing), type of communication or language (e.g., ASL, MCE, spoken English, cued speech[3]), age of identification of the child's hearing loss, age of language exposure, and other conditions that may affect language development (Marschark, 2007).

The occurrence of the first sign by deaf children of signing, deaf parents can appear as early as 8 months (Petitto, 1985). By the time a deaf child of deaf parents reaches age 2, sequences of

three or four signs have been observed (Anderson & Reilly, 2002; Petitto, 1985; Schick, 2002). First early attempts at fingerspelling appear around 13-months old according to parental reports and other research studies (Akamatsu, 1982; Anderson & Reilly, 2002; Blumenthal-Kelly, 1995; Erting, Thumann-Prezioso & Benedict, 2000; Maxwell, 1988; Padden, 1991; Padden & LeMaster, 1985).

Children's awareness of fingerspelling

Children show early awareness that fingerspelling may be different from signing. Padden and LeMaster (1985) reported that the children in their study distinguished the appropriateness of the signing versus fingerspelling in different contexts. When a child (4;7) was asked a question such as "What's that?", the child replied with sign. If a child was asked the name of something, "What's the name of that?" (WHAT NAME THAT-ONE?"), the child would attempt to fingerspell a word. Padden and LeMaster reported that deaf children across an age range, provided different reactions when asked to "name" some objects. In their study, a young child (2;9) produced fingerspelled items happily when requested; another child (2;11) became distracted after fingerspelling, and lastly, an older child (4;7) became agitated when asked to fingerspell. That child was cooperative when being shown the pictures of objects such as animals. However, her signing was impatient and she fidgeted when fingerspelling the sequences of the handshapes in the item corresponding to the given picture in the production task. Padden and LeMaster speculated that the youngest children were happy to fingerspell because they viewed it as a sign, and were relatively unconcerned about errors. Older children become more reticent to fingerspell, presumably because they are more aware that there are correct handshapes and sequences.

Developmental stages in fingerspelling

Padden has proposed that there are three stages in the development of fingerspelling, from the occurrence of first attempts at fingerspelling to fingerspelling fluency (2006). The first stage of fingerspelling development proposed by Padden (1991; 2006) is where children can produce fingerspelling, with a sequence of at least three hand configurations, and often with sign-like movement patterns rather than clearly articulated handshapes (Akamatsu, 1985; Blumenthal-Kelly, 1995; Maxwell, 1988; Padden & LeMaster, 1985).

Padden (1991) conducted a natural observational study with six deaf children of signing, Deaf parents from the ages of 2;1 to 4;9 years. One child, at age 2;9, produced fingerspelled sequences consisting of one to three alphabetic handshapes. When ask to fingerspell her dog's name (Sasha), the child produced "U-B-A." The child was attempting to sequence the handshapes although her choice of handshapes to represent the dog's name was incorrect. Maxwell (1988) observed a similar behavior when she conducted a case study on the use of fingerspelling by a deaf child (age 1;6 to 6;6) of Deaf parents, based on 100 hours of interaction with her parents over a six-year period. Maxwell's subject, Alice, produced sequences of up to three hand configurations in her attempts to replicate fingerspelling at age 2;9. In Alice's first attempt to fingerspell, she wiggled her hand but could not produce the correct hand configurations sequentially (age 2;9). A similar finding was also reported by Blumenthal-Kelly (1995) in an investigation of fingerspelling acquisition of a deaf child of Deaf parents from age five weeks to 4;4 years. At age two, the deaf child fingerspelled her first word, C-H-P, to refer to *potato chips* during a conversation with her dad. That child fingerspelled "chip" sequentially but dropped a handshape, "I."

Akamatsu (1982) also reported a similar finding in her case study of three native-signing hearing children (aged 3;8 to 5;2 years) of Deaf parents where they engaged in both imitated and spontaneous interactions. Akamatsu observed that the hearing children's initial and final handshape configurations in a sequence were more likely to be correct than the middle handshapes. In general, the children produced a gestalt of the word when imitating the fingerspelling of a whole word. They produced fingerspellings that were sign-like. This finding concurs with results from the Padden and LeMaster (1985) study examining six deaf children. Certain movements in the components of fingerspelling appear to be salient to children as they are learning to fingerspell and they reported behaviors where the child attempts to fingerspell, reinforce the belief that the child views a fingerspelled entity as a sign. In other words, they do not pay attention to the execution of each handshape in the given fingerspelled word and, particularly in early development, they may perceive fingerspelled words as phonologically-complex signs.

Akamatsu (1982) coined the term *movement envelope* to describe the movement of the hand while fingerspelling, both in representing individual letters as well as movement from letter to letter. Akamatsu described the movement envelope as a four-dimensional entity, where shape changes over time as a signer proceeds through a fingerspelled word. Akamatsu noted that some of the children's fingerspelled utterances were unintelligible despite clear handshapes, while others were intelligible despite unclear handshapes. She concluded that the children were analyzing the fingerspelling as a complex sign rather than as a group of manually represented letters. 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. In sum, in early development fingerspelled words are produced and perceived as whole units rather than as sequences of individual handshapes.

There are also errors due to handshapes being replaced by another/others in early fingerspelling. For example, Padden and LeMaster (1985) reported an error when a deaf child (age 2;7) attempted to fingerspell the name of a relative named "Dee." The child was not able to form the handshape "D" and so used the handshape "L" (a visually similar letter, but perhaps phonologically simpler) instead. As a result, the child fingerspelled L-E-E. Another common developmental error is dropping a handshape from the whole word. For example, a child (age 2;0; Padden, 2006) attempted to fingerspell "R-I-C-E" but fingerspelled "I-C-E" instead. Padden theorized that young children (2;0-3;0) are able to detect small movements that correspond with each handshape during the execution of the word and try to copy the movement in forms but are not able to use all handshapes or switch the positions of the handshapes.

The second stage of fingerspelling development proposed by Padden (1991, 2006) focuses on a shift of attention to individual letters when attempting to fingerspell. In this stage, children seem to be more aware of individual letters, as if representing the movement envelope is no longer sufficient. In Padden's study (1991), the 4-year-old children began to attend more to the choice of hand configuration than the sequence of hand configurations. For example, when a child aged 4;9 was asked to fingerspell "C-A-T", she produced the hand configurations "C-R-I" and "C-N-I", accurately producing the initial "C" handshape but the rest of the sequence varied in hand configurations even though the numbers of handshapes were correct. Children were also able to

produce sequences when handshapes are repeated as letter repetition such as the "E-E" sequence (as in "T-R-E-E" and "G-R-E-E-N"). Many children in Padden's study correctly replicated the "E-E" sequence. Interestingly, some children produced the characteristic repetitive handshape movement but incorrectly selected the handshapes to be doubled. Maxwell (1998) reported that her deaf subject at age 3;5 attempted to spell *ice*, "E-C-I", "I-E-C" and "I-C-E", obviously having difficulty with handshape sequence but correct in the individual handshape. Another example, reported by Maxwell, was produced by Alicia at age 3;9, who fingerspelled "P-A-J" in an attempt to fingerspell a common abbreviated fingerspelling item, *pajamas*, used by deaf adults. Other researchers have observed similar behaviors (Akamatsu, 1982; Blumenthal-Kelly, 1995; Maxwell, 1998).

The third stage of fingerspelling development is when the child has finally mastered full neutral fingerspelling, including the appropriate handshapes, in the correct sequence, with correct movement. Padden (2006) terms this a *convergence of skills* and she describes this stage as one where the child has mastered and aligned several essential skills, such as writing a word, fingerspelling it, as well as understanding the word when someone else fingerspells it. For Padden, there is an integration of the perceptual, the articulatory production, and the written form, which she speculates happens by third grade for native signers. Mayberry and Waters (1991) provide data on deaf children moving into this stage in a study that examined the acquisition of fingerspelling and reading skills in 43 deaf children, from both deaf and hearing families. Mayberry and Waters labeled this stage of fingerspelling development *fingerspelling synthesis*, and it occurs when children constructed neutral fingerspelled words as a whole entity rather than a string of separate handshapes. Mayberry and Waters claimed that the 7- to 9-year old participants in their study were at Padden's proposed second stage of fingerspelling development as they were still producing fingerspelling as whole entities with errors. That is, these younger children were not yet successful at fingerspelling an item as a specific sequence of handshapes. Mayberry and Waters results show that the participants needed more time to fingerspell words as the number of letters in the words increased. The oldest children (aged 13 to 15 years) had no difficulty producing fingerspelled neutral items fluently regardless of the number of letters in each word.

However, it is not clear if the characterization of the third stage is correct. Padden identified the first two stages of fingerspelling development based on her deaf subjects' fingerspelling use between the ages of 2;1 to 4;9. It may be inaccurate to describe the third stage of fingerspelling development only as an attempt to fingerspell an item as a whole, as in neutral fingerspelling. We know little about how lexicalized fingerspelling develops. In reality, it is likely that reaching mastery is more complex. It is also possible that what Padden describes as stage two behavior, at 2 to 4 years old, may differ from what Mayberry and Water's observed in 7- to 9-year old participants.

In summary, the broad stages of fingerspelling development that have been proposed are characterized by: Stage 1: minimal sequences of hand configurations and a focus on movement envelopes; Stage 2: attention to hand configuration, but with omissions and incorrect order; and Stage 3: convergence of fingerspelling skills or fingerspelling synthesis. A number of studies have described fingerspelling acquisition among young children learning ASL between the ages of 2 to 9 years. Only one study has examined fingerspelling by older children, ages 13 to 15 years (Mayberry & Waters, 1991). However, there are several age gaps in these studies that do not allow for a full account of developmental trends in deaf children's fingerspelling acquisition.

Fingerspelling and literacy practice at home

Deaf parents use strategies to teach the relationship between ASL signs, fingerspelling, and English orthography in their home literacy practices (Erting *et al.* 2000; Maxwell, 1998; Padden, 1991, 1996b). In the studies conducted by Maxwell (1998) and Padden (1991, 1996b) children, ages 2 to 3, used initialized signs to refer to immediate family members and relatives, with fingerspelled names following after as in adult ASL. The parents provided name signs for immediate family members and used neutral fingerspelling for some names, indicating that the parents expected the child to focus on how the name was spelled. Similarly, Blumenthal-Kelly (1995) reported a home literacy practice in an interaction between a deaf mother and her deaf daughter (3;4), where the mother explicitly focused on the relationship between lexicalized fingerspelling and English orthography. The mother held up index cards with printed English words and encouraged her daughter to fingerspell the words. The daughter could produce handshapes that matched the letters but could not tell what the sequence of handshapes represented, even when she produced the handshapes. However, when the mother produced the lexicalized fingerspelled words (e.g., #R-I-C-E and #S-E-E-D), her daughter recognized by responding using the same lexicalized words.

Finally, there is a pervasive home literacy practice that deaf parents use, commonly referred to as *sandwiching* (Blumenthal-Kelly, 1995; Humphries & MacDougall, 1997). Blumenthal-Kelly (1995) observed that the deaf parents often *sandwiched* fingerspelled words with their corresponding sign by combining signs and fingerspelling of the same or similar meanings (e.g., NUN, #NUN, FLY, #FLY). The varied use of combined signs and fingerspelling are termed either a full sandwich or a half sandwich. A full sandwich is an ASL phrase or sentence in which the initial word is fingerspelled, the second word is signed, and the final word is fingerspelled (or vice versa) such as #DO TODAY #DO. A half sandwich is an ASL phrase in which the initial word is fingerspelled, and the next word is signed (or vice versa) such as PONYTAIL #PONYTAIL. It appears that the parents used *sandwiching* for showing the connections between signs and their fingerspellings. In a case study (Blumenthal-Kelly) beginning when the child was five weeks old until she was 4;4 years old, which included 31 hours of videotaped interactions at home, she described an example of *sandwiching* from a case study of one deaf child of Deaf parents, at 21 weeks, where her father signed and fingerspelled, RELAX, #RELAX.

In sum, deaf parents demonstrate pervasive home literacy practices that show how they are fostering their signing children's development in signing, fingerspelling and literacy before their children begin school. Deaf teachers use a similar strategy in the classroom where they show a relationship between a sign, a printed word, and a fingerspelled word. A teacher might fingerspell a certain word then point the printed word on the board or produces a sign then fingerspell the word (Humphries & MacDougall, 1997; Padden & Ramsey, 2000), capitalizing on this practices developed through situated learning in the Deaf community.

Fingerspelling Use by Teachers

Fingerspelling development continues when deaf children start school. Exposure to new fingerspelled words and continuous

fingerspelling use by the teachers appear to play an important role in deaf children's vocabulary and language acquisition and as a bridge to literacy skills. As we saw with parents, indigenous literacy practices used by deaf teachers show how deaf individuals view and teach fingerspelling. A strategy commonly used by deaf teachers (in elementary grades) with deaf children is called "*chaining*" (MacDougall & Humphries, 1999; Padden, 1996a). This strategy, "*chaining*" connects fingerspelled items to their signs and written representations. As observed by Ramsey and Padden (2000), a deaf teacher, in a lesson on volcanoes, fingerspelled "V-O-L-C-A-N-O", then pointed to the same word written on the board, then used an initialized sign, "VOLANCO". The chaining method is a rapid sequence to show the association between fingerspelling, print, and sign representation of a word. Ramsey and Padden reported that deaf teachers use this "*chaining*" method more frequently than hearing teachers (Deaf teachers $M = 30$ and hearing teachers $M = 5.5$). Padden (1996a) speculated that deaf teacher(s) using this "*chaining*" method as a way of moving between languages and systems, from ASL to fingerspelling to print and vice versa. In other words, it is a practice of showing both languages as equivalents through the ways.

Despite the importance of fingerspelling to vocabulary and literacy development, there is evidence that the use of fingerspelling varies among teachers of the deaf, particularly those who may not understand how fingerspelling is integrated in sign language and how it develops. Akamatsu and Stewart (1989) observed classroom teaching in a simultaneous communication environment (where teachers sign and speak at the same time), focusing on the teacher's use of fingerspelling. They reported that the preschool teachers of the deaf fingerspelled much less than the teachers of older children. If the preschool teachers used fingerspelling, they tended to use a small set of fingerspelled vocabulary repeatedly. Padden and Ramsey (2000) reported that Deaf teachers, in their study, have an average of 176 fingerspelled words in contrast to the average number of 75 fingerspelled words by hearing teachers. These data show us that non-native signers may view fingerspelling as an extension of English literacy, which means that its use is curtailed until children begin acquiring English orthography. These practices are in contrast with those we observe in home and school literacy practices of deaf individuals who have a deeper understanding of fingerspelling and its complex role in ASL and not just English. In contrast, hearing educators of deaf students have a tendency to avoid using fingerspelling or use it at a much lower frequency with their students, despite significant correlations between fingerspelling comprehension and use of ASL fingerspelling vocabulary (Akamatsu & Stewart, 1989; Grushkin, 1998; Padden, 1999).

Utilizing ASL to learn English: A bilingual model

Unlike some deaf children, hearing children have access to the phonological system of their spoken language. Research has show strong connections between hearing children's phonological systems and awareness of phonological regularities in reading development (see Snow, Burns & Griffin, 1998). Some Deaf children do not have access to the phonology of the spoken language in order to form a connection between phonology and the writing system. Obviously, deaf children's ability to read in English presents a challenge to educators and researchers as they hypothesize about the relationship between ASL, and its visual phonology, and English, with its auditory phonology.

Some research examined whether ASL, as a deaf children's first language, could be used to mediate the development of reading in English (Chamberlain, Morford & Mayberry, 2000; Padden & Ramsey, 2000; Strong & Prinz, 1997). Here, ASL-signing deaf children who learn to read and write in English as a second language are considered bilingual. A bilingual education model for deaf children has been proposed using the concept where deaf children gain competency in their first language, namely ASL, thus leading to the acquisition of the second language, which is English (Hoffmeister, 2000; Strong & Prinz, 1997). The model was adopted from the Linguistic Interdependence Theory (Cummins, 1989, 1991) regarding first and second language competency. This theory and the model present a challenge, as the modalities in both languages are different and considered by some to be a barrier rather than a bridge between those languages (Mayer & Wells, 1996).

One possible bimodal bilingual bridge to this challenge is the automatization of phonology, regardless of the modality (see of Kuhl & Rivera-Gaviola, 2008). Recent evidence (Mayberry, Chen, Witcher & Klein, 2011) shows that early acquisition of ASL leads to neural activation in the classic brain language areas in contrast to those who acquired ASL later in life. In addition, Pénicaud,Klein, Zatorre, Chen, Witcher, Hydes & Mayberry (2013) found that later acquisition of ASL lead to structural changes in brain tissue within the tissues related to language processing. These neuroscience findings demonstrate that the brain is seeking statistical regularities in the early months of life (between 6 and 8 months where all auditory and visual phonemes are babbled – to 10 to 11 months were only the phonemes within the child's home language are babbled) and the brain itself is not specific to either auditory or visual stimulation. Rather, the brain is seeking statistically regular rhythmic patterns to set-up the language processing tissues and can do this effectively with either auditory phonology or visual phonology.

There is some evidence that sheds light on how deaf readers decode printed materials using fingerspelling, supporting the more recent neuroscience results. Deaf readers used fingerspelling to attempt to recall letters or words and rehearse fingerspelling the words (Bonvillian, 1983; Locke & Locke, 1971). Deaf children also connected fingerspelled handshapes to written words like hearing children do with phonemes (Hirsh-Pasek, 1987) and attempt to make connections to printed words that they attempting to comprehend. Fingerspelling also plays an important role when deaf readers fingerspell the words they typically do not recognize in a previous task (Chamberlain & Mayberry, 2000; Ross, 1992), again showing the intuitive use of fingerspelling as a phonetic/morphemic/orthographic decoding tool (Gaustad & Kelly, 2004).

Fingerspelling and writing connections

Fingerspelling and writing are connected in unique ways for Deaf children. Deaf children use a specific strategy to connect fingerspelling to printed words. Padden (1996b) found evidence of deaf children, aged 4 through 10, fingerspelling common words based on the rule positions of their graphemes, instead of by phonemic means. Deaf children's errors in their writing, (i. e., "hosue" for house), as pointed out by Padden, involved transpositions, deletions, and substitutions of the letters that were not phonetically based but related to the positional rules. Padden theorized that the attempts made by the children are similar to typing errors, in which letters are transposed, substituted, and deleted. There were no samples of invented spelling and addition attempts made by the children during the spontaneous task or if the children provided samples of newly learned written words in this study (Padden, 1996b). Lastly, the children in the Padden study were, mostly, four-, five-, and six-year-olds

and that their attempts showed their awareness of the orthographic structure, but not of morphological forms that are represented in written forms.

Other than attempting to write the fingerspelled words, deaf children are learning another skill—watching a fingerspelled word then writing down the word. This is taught continuously throughout the elementary school years. As observed by Padden (1996b), some children insisted that they be shown the fingerspelled word, letter by letter so that they can write the word, letter by letter. Some children could watch a fingerspelled word being fingerspelled as a whole then write down the word. Padden observed specific behaviors in the children when they were engaged in their written assignments. Some of them were quick to write down the first letter but then waited to come up with the remaining letters to complete a word; some children fingerspelled a word first before writing it down; and some of them interrupted themselves in middle of the writing assignment to fingerspell the word then resume the writing. These spontaneous behaviors demonstrate that these children have more to teach us about the connections between fingerspelling and reading. In a longitudinal ethnographic study conducted on early deaf Swedish signers by Roos (2013), several themes were identified related to transitioning from fingerspelling to printed words: (i) exploring and learning fingerspelling in literacy practices; (ii) exploring the direction of writing and fingerspelling; practicing and memorizing words; (iii) decoding words, recalling from memory; and (iv) fingerspelling as a tool for exploring the relationship between letters, words, signs, and mouth movements (p. 170).

We know that signing deaf children acquire fingerspelling when it is a common practice in the home environment and they go through the stages of development to the point where they reach mastery in fingerspelling. Future research directions should address the findings and the implementation of strategies to be used with signing deaf children with parents who are also acquiring ASL. Deaf children's strategic use on connecting fingerspelled words to printed words needs to be studied in-depth as the findings can be used to develop strategies for teachers and parents use at home and in the classroom. Last but not the least, deaf teacher's use of fingerspelling in academic subjects across grades need to be studied in order for the teacher preparation program curriculums to incorporate fingerspelling strategies for future teacher-candidates. At this point, there is so much that we have to learn about deaf children's fingerspelling acquisition and use.

Notes

1. The symbol of lexicalized fingerspelling, "#", will be used in this paper to indicate lexicalized fingerspelling.
2. "Deaf" refers to culturally deaf, while "deaf" refers to individuals, who are deaf but not necessarily culturally deaf.
3. Other than ASL, parents are faced with choices on whether their deaf child should use systems to make English visibly accessible such as Manually Coded English (MCE) which use initialized signs in English order sentences, using certain handshapes and locations near a mouth for Cued Speech and spoken English which is in spoken form only.

Conflicts of Interest

No conflicts of interest were reported.

References

Akamatsu, C. T. (1982). *The acquisition of fingerspelling in pre-school children*. Unpublished doctoral dissertation, University of Rochester, Rochester.

Akamatsu, C. T., & Stewart, D. A. (1989). The role of fingerspelling in simultaneous communication. *Sign Language Studies*, 65, 361–374.

Allen, T. (2015). ASL Skills, Fingerspelling Ability, Home Communication Context and Early Alphabetic Knowledge of Preschool-Aged Deaf Children - ProQuest. *Sign Language Studies*, 15(3), 233–265.

Anderson, D. (2006). Lexical development of deaf children acquiring signed languages. In: B. Schick, M. Marschark, & P. E. Spencer (Eds.), *Advances in the sign language development of deaf children* (pp. 135–188). Oxford University: New York.

Anderson, D., & Reilly, J. S. (2002). The Macarthur communicative development inventory: Normative data for American Sign Language. *Journal of Deaf Studies and Deaf Education*, 7, 83–106.

Battison, R. (1978) *Lexical borrowings in American Sign Language*. Linstok Press: Silver Spring, MD.

Bialystok, E. (2006). Bilingualism at school: Effect on the acquisition of literacy. In: P. McCardle, & E. Hoff (Eds.), *Childhood bilingualism: Research on infancy through school age* (pp. 107–123). Multilingual Matters LTD: Toronto.

Bialystok, E., Luk, G., & Kwan, E. (2005). Bilingualism, biliteracy, and learning to read: Interactions among languages and writing systems. *Scientific Studies of Reading*, 9, 43–61.

Blumenthal-Kelly, A. (1995). Fingerspelling interaction: A set of deaf parents and their deaf daughter. In: C. Lucas (Ed.),. *Sociolinguistics in deaf communities* (pp. 62–73). Gallaudet University Press: Washington, DC.

Bonvillian, J. D. (1983). Effects of signability and imagery on word recall of deaf and hearing students. *Perceptual Motor Skills*, 56, 775–791.

Brennan, M. (2001). Making borrowings work in British sign language. In: D. Brentari (Ed.),. *Foreign vocabulary in sign languages: A cross-linguistic investigation of word formation* (pp. 49–85). Lawrence Erlbaum: Mahwah, NJ.

Brentari, D., & Padden, C. A. (2001). Native and foreign vocabulary in American Sign Language: A lexicon with multiple origins. In: D. Brentari (Ed.),. *Foreign vocabulary in sign language: A cross-linguistic investigation of word formation* (pp. 86–104). Lawrence Erlbaum: Mahwah, NJ.

Chamberlain, C., & Mayberry, R. I. (2000). Theorizing about the relation between American Sign Language and reading. In: C. Chamberlain, J. Morford, & R. Mayberry (Eds.), *Language acquisition by eye* (pp. 221–259). Lawrence Erlbaum: Mahwah, NJ.

Cummins, J. (1989). A theoretical framework for bilingual special education. *Exceptional Children*, 56, 111–119.

Cummins, J. (1991). Interdependence of first- and second-language proficiency in bilingual children. In: E. Bialystok (Ed.),. *Language processing in bilingual children* (pp. 70–89). Cambridge University Press: New York.

Dunn, L., & Dunn, L. (2007) *Peabody picture vocabulary test* (4th ed.). American Guidance Services: Circle Pines.

Erting, C. J., Thumann-Prezioso, C., & Benedict, B. (2000). Bilingualism in a deaf family: Fingerspelling in early childhood. In: P. E. Spencer, C. J. Erting, & M. Marschark (Eds.), *The deaf child in the family and at school: Essays in honor of Kathryn P. Meadow-Orlans* (pp. 41–54). Lawrence Erlbaum: Mahwah, NJ.

Genesee, F. (2006). Bilingual first language acquisition in perspective. In: P. McCardle, & E. Hoff (Eds.), *Childhood bilingualism:*

Research on infancy through school age (pp. 45–67). Multilingual Matters LTD: Toronto.

Genesee, F., & E. Nicoladis (1995). Language development in bilingual preschool children. In: E. E. Garcia, & B. MacLaughlin (Eds.), *Meeting the challenge of linguistic and cultural diversity in early childhood education* (pp. 18–33). Teachers College Press: New York.

Gentry, R. (1982). An analysis of developmental spelling in "GNYS AT WRK". *The Reading Teacher*, 36(2), 192–200.

Grushkin, D. A. (1998). Lexidactylophobia: The (irrational) fear of fingerspelling. *American Annals of the Deaf*, 143, 404–415.

Haptonstall-Nykaza, T. S., & Schick, B. (2007). The transition from fingerspelling to English print: Facilitating English decoding. *Journal of Deaf Studies and Deaf Education*, 12, 172–183.

Hirsh-Pasek, K. (1987). The metalinguistics of fingerspelling: An alternative way to increase vocabulary in congenitally deaf readers. *Reading Research Quarterly*, 22, 455–474.

Hoffmeister, R. (2000). A piece of the puzzle: ASL and reading comprehension in deaf children. In: C. Chamberlain, J. Morford, & R. Mayberry (Eds.), *Language acquisition by eye* (pp. 143–169). Lawrence Erlbaum: Mahwah, NJ.

Humphries, T., & MacDougall, F. (1999). Chaining and other links: Making connections between American Sign Language and English in two types of school settings. *Visual Anthropology Review*, 15, 84–94.

Jamieson, J. R. (2003). Formal and informal approaches to the language assessment of deaf children. In: M. Marschark, & P. E. Spencer (Eds.), *Oxford handbook of deaf studies, language, and education*. Oxford University Press: New York.

Johnson, R. E. (1994) The structure of fingerspelling, fifth international teleclass. Waubonsee Community College: Chicago, IL.

Klima, E., & Bellugi, U. (1979) *The signs of language*. Harvard University Press: Cambridge.

Locke, J. L., & Locke, V. L. (1971). Deaf children's phonetic visual and dactylic coding in a grapheme recall task. *Journal of Experimental Psychology*, 89, 671–684.

Marschark, M. (2007) *Raising and educating a deaf child* (2nd ed.). Oxford University Press: New York.

Maxwell, M. M. (1998). The alphabetic principle and fingerspelling. *Sign Language Studies*, 61, 377–404.

Mayberry, R. I., & Waters, G. A. (1991). Children's memory for sign and fingerspelling in relation to production rate and sign language input. In: P. Siple, & D. Fischer (Eds.), *Theoretical issues in sign language research* (pp. 211–229). University of Chicago Press: Chicago.

Mayer, C., & Wells, G. (1996). Can the linguistic interdependence theory support a bilingual-bicultural model of literacy education for deaf children? *Journal of Deaf Studies and Deaf Education*, 1, 93–107.

Meier, R. (1991). Language acquisition by deaf children. *American Scientist*, 79, 60–70.

Mitchell, R. E., & Karchmer, M. A. (2004). Chasing the mythical ten percent: parental hearing status of deaf and hard of hearing students in the United States. *Sign Language Studies*, 2, 138–163.

Moeller, M. P. (2000). Early intervention and language development in children who are deaf and hard of hearing. *Pediatrics*, 106, e43.

Moeller, M., Osberger, M., & Eccarius, M. (1986). Language and learning skills of hearing-impaired students. In Receptive language skills (pp. 41–53). ASHA Monographs, 23.

Newport, E., & Meier, R. (1985). The acquisition of American Sign Language. In: D. I. Slobin (Ed.),. *The crosslinguistic study of language acquisition* (pp. 881–938). Lawrence Erlbaum: New York.

Padden, C. (1991). The acquisition of fingerspelling by deaf children. In: P. Siple, & S. Fischer (Eds.), *Theoretical issues in sign language research* (pp. 193–210). University of Chicago Press: Chicago.

Padden, C. (1996a). From the cultural to bicultural: The modern deaf community. In: I. Parasnis (Ed.),. *Cultural and language diversity and the deaf experience* (pp. 79–98). Cambridge University Press: New York.

Padden, C. (1996b). Early bilingual lives of deaf children. In: I. Parasnis (Ed.),. *Cultural and language diversity and the deaf experience* (pp. 99–116). Cambridge University Press: New York.

Padden, C. (1998). The ASL lexicon. *Sign language and linguistics*, 1, 35–53.

Padden, C. (2006). Learning to fingerspell twice: Young signing children's acquisition of fingerspelling. In: B. Schick, M. Marschark, & P. Spencer (Eds.), *Advances in the sign language development of deaf and hard-of-hearing children* (pp. 189–201). Oxford University Press: New York.

Padden, C., & LeMaster, B. (1985). An alphabet on hand: The acquisition of fingerspelling in deaf children. *Sign Language Studies*, 47, 161–172.

Padden, C., & Ramsey, C. (1998). Reading ability in signing deaf children. *Topics in Language Disorders*, 18, 30–46.

Padden, C., & Ramsey, C. (2000). American Sign Language and reading ability in deaf children. In: C. Chamberlain, J. P. Morford, & R. I. Mayberry (Eds.), *Language acquisition by eye* (pp. 165–189). Lawrence Erlbaum: Mahwah, NJ.

Paul, P. V., & Quigley, S. P. (1994) *Language and deafness* (2nd ed.). Singular Publishing Group, Inc: San Diego.

Pearson, B. Z., Fernandez, S. C., & Oller, D. K. (1993). Lexical development in bilingual infants and toddlers: Comparisons to monolingual norms. *Language Learning*, 43, 93–120.

Pearson, B. Z., Fernandez, S. C., & Oller, D. K. (1995). Cross-language synonyms in the lexicons of bilingual infants: One language or two? *Journal of Child Language*, 22, 345–368.

Petitto, L. (1985) *From gesture to symbol: The relation of form to meaning in ASL personal pronoun acquisition*. Linstok Press: Silver Spring, MD.

Prezbindowski, A. K., & Lederberg, A. R. (2003). Vocabulary assessment of deaf and hard-of-hearing children from infancy through the preschool years. *Journal of Deaf Studies and Deaf Education*, 8, 383–399.

Ramsey, C., & Padden, C. A. (1998). Natives and newcomers: Gaining access to literacy in a classroom for deaf children. *Anthropology & Education Quarterly*, 29, 5–24.

Read, C. (1971). Pre-school children's knowledge of English phonology. *Harvard Educational Review*, 41, 1–34.

Read, C. (1975). Lessons to be learned from the pre-school orthographer. In: E.H. Lenneberg, & E. Lenneberg (Eds.), *Foundations of language development* (Vol. 2, pp. 329–346). Academic Press: New York.

Roos, C. (2013). Young Deaf Children's Fingerspelling in Learning to Read and Write: An Ethnographic Study in a Signing Setting. *Deafness & Education International*, 15(3), 149–178.

Ross, D. S. (1992). *Learning to read with sign language: How beginning deaf readers related sign language to written words*. Unpublished master's thesis, McGill University, Montreal, Quebec.

Schick, B. (2002). The expression of grammatical relations in deaf toddlers learning ASL. In: G. Morgan, & B. Woll (Eds.), *Directions in sign language acquisition* (pp. 143–158). John Benjamins Publishing Co: Amsterdam, The Netherlands.

Schick, B. (2003). The development of American sign language and manually coded English systems. In: M. Marschark, & P. Spencer (Eds.), *Oxford handbook of deaf studies, language, and education* (pp. 219–231). Oxford University Press: New York.

Sedey, A. L. (1995). *Fast mapping of novel fingerspelled words by profoundly deaf students*. Unpublished doctoral dissertation, University of Wisconsin, Madison.

Snow, C. E., Burns, S., & Griffin, P. (1998) *Preventing reading difficulties in young children*. National Academy Press: Washington, DC.

Strong, M., & Prinz, P. M. (1997). A study of the relationship between American Sign Language and English Literacy. *Journal of Deaf Studies and Deaf Education*, 2, 37–46.

Swanson, C. B. (2003). *Keeping count and losing count: Calculating graduation rates for all students under NCLB accountability*. Report No. ED480915. Washington, D.C.: Urban Institute.

Wilcox, S. (1992) *The phonetics of fingerspelling*. John Benjamins: Philadelphia.

Woodcock, R. W., & Mather, N. (1989, 1990) *Woodcock-Johnson tests of achievement – revised*. DLM Teaching Resources: Allen, TX.