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Puente, Anibal, 1945-
Alvarado, Jesus M.
Herrera, Valeria.

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Fingerspelling and Sign Language as Alternative Codes for Reading and Writing Words for Chilean Deaf Signers

THE STUDY examined the role of sign language and fingerspelling in the development of the reading and writing skills of deaf children and youth. Twenty-six deaf participants (13 children, 13 adolescents), whose first language was Chilean Sign Language (CHSL), were examined. Their dactylic abilities were evaluated with tasks involving the reading and writing of dactylic and orthographic codes. The study included three experiments: (a) the identification of Chilean signs and fingerspelled words, (b) the matching of fingerspelled words with commercial logos, and (c) the decoding of fingerspelled words and the mapping of these words onto the writing system. The results provide convergent evidence that the use of fingerspelling and sign language is related to orthographic skills. It is concluded that fingerspelling can facilitate the internal representation of words and serve as a supporting mechanism for reading acquisition.

Aníbal Puente, Jesús M. Alvarado, and Valeria Herrera

Puente and Alvarado are both professors of psychology, Faculty of Psychology, Complutense University of Madrid, Spain, Somosaguas Campus. Puente is in the Department of Cognitive Processes; Alvarado is in the Department of Methodology of the Behavioral Sciences. Puente and Alvarado are also researchers with the Institute for Biofunctional Studies, Complutense University of Madrid. Herrera is an associate professor of education, Postgraduate School, Metropolitan University of Santiago, Chile.

Deaf people use systems of communication based on sign language and fingerspelling. In sign language, lexical units are made up of a finite set of hand configurations, spatial locations, and movements. Manual spelling, or "fingerspelling," is a system based on the alphabet in which each letter is represented by a unique and discrete movement of the hand. The signing Deaf community integrates fingerspelling into sign language for many reasons: when a concept lacks a specific sign, for proper nouns, for loan signs, or when signs are ambiguous. Additionally, fingerspelling is used to form distinctions within a semantic category. In some sign languages—for example, American Sign Language (ASL) and Swedish Sign Language—a fingerspelled word often demonstrates a semantic contrast with an existing sign, thus making use of borrowed vocabulary to expand the lexicon of the deaf.

The acquisition of fingerspelling was examined by Padden and Hanson (1999) in a study involving deaf children between the ages of 8 and 14 years. That study confirmed that younger children made more mistakes than older children when writing fingerspelled words—a difference that was more pronounced for low-frequency words. Younger children understood the words (including uncommon ones), but they had difficulty

writing them. This indicates that the ability to write fingerspelled words requires more training, which younger children lack.

Preschool-aged deaf signers begin using simple handshapes that represent words, and then spell out words letter by letter (Maxwell, 1984; Padden & Le Master, 1985). This group is able to store short dactylic representations and to memorize simple handshapes, but productive fingerspelling (series of complex handshapes), which is necessary for constructing the dactylic representations of words, does not appear until knowledge of written words has been attained. A noteworthy finding of several studies (Musselman, 2000; Padden & Ramsey, 2000; Ramsey, 2004) is that the development of fingerspelling is not observed in orally educated populations; its development is much more relevant in groups who have a good command of sign language. Perhaps one of the most interesting discoveries regarding the early use of fingerspelling by deaf children is the fact that they are aware of the movements of fingerspelled words before being able to associate these words with their written form (Akamatsu, 1985; Maxwell, 1984, 1986, 1988).

The idea of using fingerspelling and sign language as elements of a strategy designed to teach the deaf to read is controversial. The main difficulty in teaching the deaf to read arises from the fact that, in order for the reader to acquire both specific and nonspecific reading skills, he or she must develop a phonological awareness that will make it possible to think about and manipulate the structural aspects of spoken language (Hoover & Gough, 1990). A bilingual education model has been proposed to compensate for deaf students' deficiencies in this respect. Children are exposed to a communication system combining signs—borrowed from sign language—and spoken language. This system is easier to master than pure oral language because of the use of signs. Cummins (2001) and other advocates of bilingual education (e.g., Evans, 2004) claim that the reading and writing skills acquired in a first language form the foundation for the strong development of a second language. Though this model has been proved among the bilingual hearing, Chamberlain and Mayberry (2000) have widened it in order to explain sign language and reading acquisition in the deaf.

The direct application of the bilingual theory to signing deaf readers has been criticized and discussed by Mayer and Wells (1996). Their main criticism relates to the idea that one cannot learn to read with a knowledge of sign language alone, without the aid of some intermediary mechanism. This is because of the lack of equivalence between ASL and English. Mayer and Wells emphasize that sign language has no written form and that the deaf generally lack access to spoken language. Alegria (2003) points out that writing represents spoken language and that the processing of writing requires the use of spoken-language devices that are absent in sign language. Spoken language and sign language are intrinsically different in all formal aspects of language, that is, in their phonology and their syntax. As a consequence, interaction between the two is not immediate.

We suspect that fingerspelling can act as a complementary means of decoding in reading processes, and perhaps aid in the development of phonemic awareness in signing deaf children, though it is a manual system for representing the alphabetic rather than phonemic units of language. Fingerspelling cannot wholly replace sign language because it is too cumbersome to use as an exclusive system. But it is not merely a representational system, either—it is an odd, language-like system with properties that are unlike those of either spoken or signed languages.

If one considers fingerspelling as a possible means of gaining access to the internal lexical coding system—which can be used to foster word identification and, subsequently, reading—it becomes clear that deaf readers should develop metalinguistic skills that will allow them to become aware of the individual handshapes that make up fingerspelled words. This ability is related to early reading achievement and also affords deaf readers advantages related to phonological representation (i.e., memory durability and prompts for word identification).

Grapho-phonological conversion rules facilitate the creation of an association between a written word and its pronunciation. If this association does not exist, or if it becomes altered, children cannot analyze the phonology of words, nor recognize pseudowords or unfamiliar words (Foster & Chambers, 1973; Waters & Doehring, 1990; Waters, Seidenberg, & Bruck, 1985). As a consequence, children with these deficiencies attain only low levels of reading achievement due to the fact that they possess only a lexical route, and lack the sublexical (or phonological) route, which would allow them to decode written words (Goswami & Bryant, 1990; Morais, Alegria, & Content, 1987; Stanovich, 1986).

An interesting question is how the deaf, who sign but do not use phonological codes, can recognize words. J. Locke and V. Locke (1971) found that deaf people who lack intelligible oral expressive skills use fingerspelling when asked to recall series of printed letters. Hanson, Liberman, and Shankweiler (1984) confirmed and expanded upon this finding in an experiment on serial memory involving children between the ages of 6

and 11 years. As in the work of J. Locke and V. Locke, the participants in the study by Hanson and colleagues were given series of letters with visual, dactylic, and phonological similarities, along with control series. The results provide evidence that the deaf use fingerspelling as a permanent and relevant linguistic codification system. What is more, Hanson and colleagues found that deaf students considered to be skilled readers make more frequent use of fingerspelling than deaf people with inferior reading skills.

Following the same line of thought pursued by Hanson and colleagues (1984) and J. Locke and V. Locke (1971), Treiman and Hirsh-Pasek (1983) pointed out that just as hearing people are able to decode unfamiliar written words by referring to the meanings of more familiar spoken forms, the deaf can decode written words using fingerspelling. In a previous study, Hirsh-Pasek and Treiman (1982) had confirmed that novice deaf readers could distinguish signs using fingerspelling. They had also discovered that while hearing children can segment spoken words into phonemes, deaf children who sign can segment dactylic representations (fingerspelled words) into graphemes.

The findings of Hirsh-Pasek and Treiman (1982) have prompted some researchers to propose exchanging the grapho-phonological converter, which is absent or deficient in the deaf, for the handshape-grapheme converter. This converter allows the deaf to segment written words into discrete units, letters (Asensio, 1989), to reinforce their orthographic skills (Dodd, 1980; Hanson, 1982), to read unfamiliar words (Maxwell, 1984), and to obtain a certain level of phonological understanding (Leybaert, 2000).

One instance in which teachers use fingerspelling is the teaching of chaining sequences, which show the relationship among a sign, a written word, and a fingerspelled word. The systematic use of fingerspelling to teach reading offers deaf readers not only the opportunity to practice their fingerspelling skills but also the convenience of learning the regular orthographic sequences that characterize words. Fingerspelling allows the deaf to practice using the morphological forms common in some sign languages. It remains unclear whether fingerspelling and chaining structures alone are sufficient means by which to master reading, or whether they serve merely as supporting strategies.

In a series of experiments, Hirsh-Pasek (1987) discovered that fingerspelling can be used as a strategy for identifying words. Even so, she recognized the limitation it presents: It is a very poor tool for learning syntax. Hirsh-Pasek concluded that fingerspelling can provide deaf readers with a means by which to connect at least part of their language with writing. But given that the number of fingerspelled words regularly used in sign language is small, one could wonder how the dactylic system benefits deaf readers. Hirsh-Pasek then developed the idea of *bilexicalism*, that is, teaching the fingerspelling of words from their signed vocabulary and teaching learning concepts through sign language and fingerspelling. As a doubly reinforcing mechanism, bilexicalism could promote both vocabulary and reading. Padden and Ramsey (1998) believe that fingerspelling is connected to reading and writing by virtue of a code in the alphabetic system, and that this connection makes it possible to create an association between the characteristics of sign language (especially fingerspelling) and the characteristics of written language.

Previous studies of bilexicalism have been conducted mainly in ASL; similar studies involving the sign language used in Chile do not exist. We feel that comparing results from other populations with those obtained from the deaf Chilean population provides the opportunity for an important contribution.

In Chile, the first schools for the deaf to introduce the formal use of fingerspelling did so through implementation of the Rochester Method. By the beginning of the 20th century, the most highly regarded and widely extended model for the education of the deaf was the oral model, and all forms of manual language were therefore not taught. In the 1970s, the Total Communication model was put into use. This new conception of deaf education incorporated gesticular communication and, with it, a new regard for fingerspelling. Current educational approaches are based mainly on bilingualism, which gives equal importance to oral language and Chilean Sign Language (CHSL) used separately.

Up to now, no formal investigations into the use of sign language and fingerspelling have been carried out in Chile. Though the general literature on the subject can serve as a guide, there is one aspect that differentiates CHSL from other sign languages: CHSL is framed by the characteristics of the Spanish language, which differs from English in that it is a transparent language (its grapheme-phoneme correspondence is highly regular). Consequently, fingerspelling might be more effective in developing reading in deaf children from Spanish-speaking environments, although it still would have benefits for children from English-language environments. This structural difference between the two languages could give rise to different reading mechanisms for English-speaking and Spanish-speaking deaf readers. The rationale for this difference rests on the assumption that the regularity of rules in the grapheme-to-phoneme

translation in shallow orthographies would never force readers to develop a reading strategy based on these orthographies' graphemic codes (Coltheart, 1978; Conrad, 1979; Flaherty & Moran, 2004). Some researchers do not share this assumption (Perfetti, Bell, & Delaney, 1988; Sebastián-Gallés, 1991)

The aim of the present study was to examine whether deaf readers whose first language is CHSL use fingerspelling to identify words, whether this ability is related to reading and spelling, and whether fingerspelling can provide a visual feedback that could constitute an advantage for orthographic skills. More generally, our main objective was to understand the effectiveness of fingerspelling in the acquisition or development of reading skills in the deaf. The study included three experiments: (a) the identification of Chilean signs and fingerspelled words, (b) the matching of fingerspelled words with commercial logos, and (c) the decoding of fingerspelled words and their mapping onto the writing system.

Experiment 1: Identification of Chilean Signs and Fingerspelled Words

If fingerspelling mediation is to prove a productive decoding system, then the deaf must possess, at least, the ability to differentiate between handshapes that represent fingerspelled words and those that represent signed words. That is, if they cannot tell the differences between signed words and fingerspelled words, then they will not be able to effectively use a decoding system that maps fingerspelled rather than signed handshapes onto graphemes. In the present study, we evaluated the participants' ability to recognize signs and fingerspelled words and, indirectly, to explore the relationships that exist between these two language types.

Method

Participants

The present study was carried out in Santiago de Chile, at the Jorge Otte Gabler Public School for the Deaf, which has spent 7 years developing a bilingual educative model with its students. The school serves a deaf population of more than 120 students between the ages of 2 and 18 years, the majority from lower-middle-class families. The school's teachers and teacher's aides were either deaf users of CHSL or were hearing and fluent in CHSL. Tests were administered to a selection of students who met five strictly applied requirements:

1. a hearing loss of at least 80 dB or greater in the better ear
2. the absence of disabilities other than hearing loss
3. the use of CHSL as a first language
4. a knowledge of the names of the letters of the printed alphabet
5. a knowledge of the relationship between each printed letter and its dactylic representation (the students' teachers were consulted in this regard)

The participants were separated into two groups on the basis of age and academic level: (a) *children*: a younger group made up of 13 participants between the ages of 7 and 10 years and enrolled in the second and third grades; (b) *adolescents*: an older group made up of 13 teenagers between the ages of 12 and 15 years and enrolled in the fifth through seventh grades.

Procedure and Stimuli

Tests were performed individually and took place in the mornings at the school itself, in a separate room from the study participants' classrooms. Participation in the tests was voluntary, with prior parental authorization having been secured through a written document. The task consisted of deciding whether a stimulus was a CHSL sign or a pseudosign (an ASL sign not used in CHSL), or a fingerspelled word or a fingerspelled pseudoword (see Figure 1). This was a highly difficult task because there are some strong similarities between CHSL and ASL; also, identical signs exist in both languages (see *science* in Figure 1). The CHSL pseudosigns used in Experiment 1 were signs taken from ASL (the participants did not know ASL).

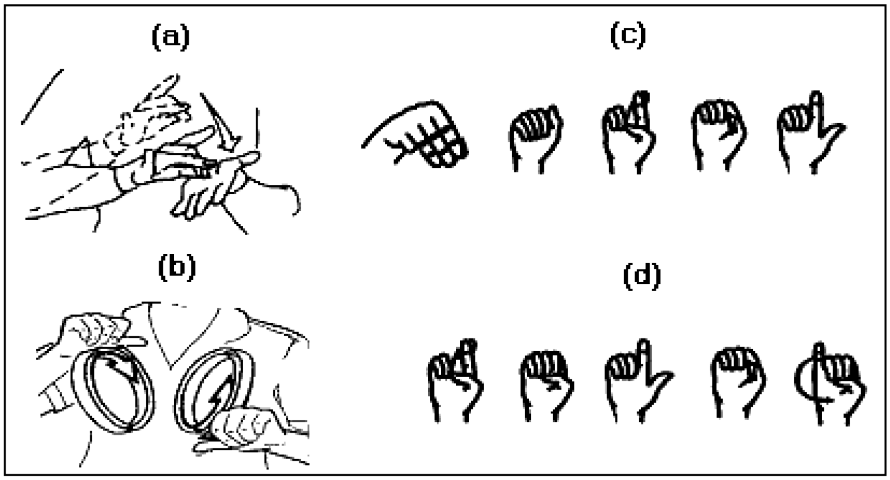
So that sign recognition and fingerspelling recognition could be measured, a total of 20 stimuli were displayed on a screen at random. A computer program (for a Compaq Armada 100s laptop with a 12-in TFT screen) was designed specifically for the experiment, displaying the images on the screen and registering the study participants' responses. Responses were made with a computer mouse: a left-button click for an affirmative response or a right-button click for a negative response. As training for the task, several trial runs were performed with each participants, using stimuli that did not appear in the actual test. The instructions for the task had been previously communicated to the participants in CHSL.

Results

Figure 2 shows that the adolescents performed well with the four types of stimuli. However, the children—the less educated group—despite performing well in the identification of signs and adequately in the identification of fingerspelled words, had great difficulty identifying pseudosigns and fingerspelled pseudowords.

A within-subjects repeated-measures

Figure 1
Examples of the Four Presentation Modes Used in Experiment 1



Note. (a) a pseudosign whose formative parameters do not correspond to those of Chilean Sign Language (CHSL); (b) the sign for the word *science* in CHSL; (c) the fingerspelling of the pseudoword *marol* (this word does not exist in Spanish); (d) the fingerspelling of the word *reloj* ("watch" in Spanish).

analysis of variance (ANOVA) was performed in order to analyze whether there were any differences in stimuli recognition based either on age or on the type of stimuli that were presented (signs, pseudosigns, fingerspelled words, and fingerspelled pseudowords). The analysis revealed that there were differences in the recognition of stimuli between age groups ($F_{1.28} = 99.81, p < .01$) and between the four types of stimuli ($F_{3.72} = 9.03, p < .01$), and that there was an interaction between the variables "age group" and "type of stimuli" ($F_{3.72} = 9.60, p < .01$).

Additionally, the conditioned probabilities for sensitivity (the ability to correctly differentiate between an CHSL sign and a fingerspelled word) and for specificity (the ability to correctly identify a pseudosign or a fingerspelled pseudoword) were measured separately. Figure 3 shows that sensitivity levels for signs were very high in both groups and slightly lower for fingerspelling, more so for the children. With respect to specificity, the adolescents showed a much higher level than the children for both types of stimuli.

Two ANOVA tests were carried out in order to contrast the statistical significance of the two factors—age group (children or adolescents) and type of stimuli (signed words or fingerspelled words)—for the variables "sensitivity" and "specificity."

Sensitivity

The only statistically significant difference we found was related to the type of stimuli, that is to say, between the total proportion of correctly identified signs and fingerspelled words ($F_{1.24} = 15.19, p < .01$). No differences related to age were found ($F_{1.24} = 2.57$, *ns*), nor was there any interaction between age and type of stimuli ($F_{1.24} = 2.52$, *ns*). Therefore, the small difference between age groups in the recognition of fingerspelled words was not considered significant.

Specificity

The differences in the recognition of pseudosigns and fingerspelled pseudowords between age groups (see Figure 3) was statistically significant ($F_{1.24} = 57.54, p < .01$). The differences between types of stimuli (pseudosigns or fingerspelled pseudowords) were not statistically significant ($F_{1.24} = 1.63$, *ns*), nor was the interaction between specificity and age. The differences in the recognition of the two different types of stimuli within the group of children are therefore not considered significant.

Figure 2
Correct Responses in the Identification of the Four Stimuli Types

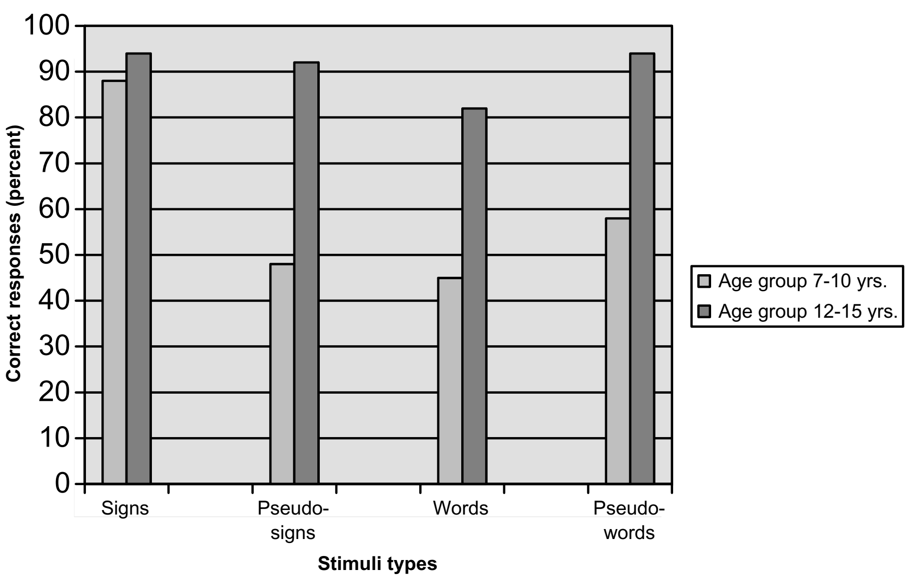
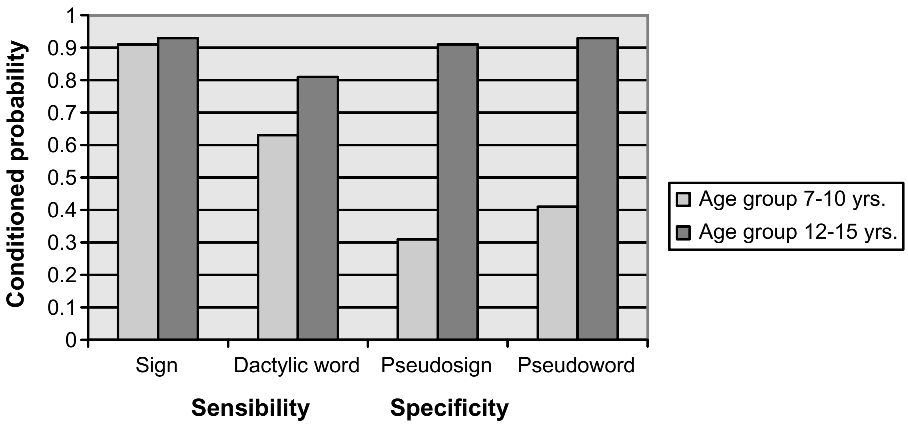


Figure 3
Conditioned Probability of Sensibility and Specificity in the Identification of Signs and Dactylic Words



Discussion

The results show that the main difference between the groups of different ages and academic levels is determined not so much by a lack of knowledge of languages (i.e., the ability to recognize signs and fingerspelled words) but by the children's limited ability to recognize pseudosigns and fingerspelled pseudowords. What is more, the fact that, overall, the children showed less ability to recognize fingerspelled words than to recognize signs (see Figures 2 and 3) indicates a later and as yet incomplete mastery of fingerspelling. Our results are in agreement with those obtained by Hirsh-Pasek (1987), which show that children make more mistakes than adolescents in tasks involving the recognition of signs and fingerspelling. Hirsh-Pasek found a significant main effect for age: Children made more mistakes and took more time to recognize signs and fingerspelling than older students. Despite this expected difference, the children on this task responded correctly 68% of the time. These data are similar to those obtained by our own investigation comparing the recognition of signs and the recognition of fingerspelled words. In our experiment, we confirmed that the younger and less educated participants recognized signs 62% of the time and fingerspelling 52% of the time, versus 93% and 87% of the time for the older, more educated students.

In Hirsh-Pasek (1987), the study participants performed better in fingerspelling recognition than in the recognition of words signed in ASL. The participants in our study, however, showed a greater command of sign language than of fingerspelling, as can be observed not only in the number of correct responses but in the time taken to complete the tasks. Specifically, they took 25% longer to identify fingerspelled words than they took to identify signs. This minor discrepancy between our findings and those of Hirsh-Pasek (1987) can be explained by the fact that our study participants had received more training with sign language and that their familiarity with fingerspelling was more recent and less systematic (Battison, 1978; King & Quigley, 1985). In any case, if fingerspelling is an important part of sign language, and if, in addition, it could serve as a mediator between sign language and written language, it would be of interest to know how the deaf use their dactylic abilities in connection with reading skills. We addressed this question in Experiment 2.

Experiment 2: Matching Fingerspelled Words With Commercial Logos

The primary aim of the second experiment was to evaluate study participants' ability to read fingerspelled words in two different modes of presentation (printed and manual) and their ability to correctly match these fingerspelled words to their corresponding logos. To this end, two aspects were evaluated: (a) participants' capacity to decode fingerspelled words, and (b) whether their use of fingerspelling was influenced by a task's presentation mode—either printed material or communication with a signing expert.

An additional goal of the second experiment was to provide a basis for designing efficient strategies for dactylic learning. Experiment 2 was similar to the experiment in Hirsh-Pasek (1987), the main difference being the inclusion, in this experiment, of a "printed dactylic" presentation mode that served to determine whether fingerspelling storage capacity (not required in the "printed" mode) could be used to differentiate between skilled and novice readers.

Method

Participants

Twenty-four students, drawn from the original 26, took part in Experiment 2. They were divided into four groups: 6

children with low-level reading skills, 6 children with high-level reading skills, 6 adolescents with low-level reading skills, and 6 adolescents with high-level reading skills. Reading level was determined by the students' teachers. The study participants were separated according to reading level in order to avoid confusion regarding age level.

Procedure

A list of 24 dactylic representations of the names of well-known products in Chile and a list of their corresponding logos, 24 of which corresponded to the fingerspelled words, were made. To select the stimuli, a list of logos of 40 brands found in Chile was given to four deaf judges, who then selected the best-known of these logos. These judgments determined the selection of stimuli for the experiment. A 30 cm × 40 cm piece of poster board was divided into two vertical columns. The 28 logos of the following products appeared in the first column: Nido, Ekono, Capri, Carozzi, Lan Chile, Sony, Virginia, Watts, Falabella, Camper, Condorito, Puma, *El Mercurio*, Chilevisión, Chef, Adidas, Leche Sur, Malloa, Nescafé, Lucchetti, Omo, Nestlé, Bata, Tucapel, Coca-Cola, Telefónica, Milo, and Zuko. The names of 24 products appeared as dactylic representations in the second column.

The task consisted of matching the word and its logo image. In the "printed dactylic" presentation mode, the experimenter selected a word printed in fingerspelling at random and the study participant was asked to point to the corresponding logo. The instructions, given in CHSL to each participant, were "Match the fingerspelled word and its corresponding logo." This task was designed to measure command of fingerspelling in four different presentation conditions (see Figure 4):

Figure 4
Examples of Three Logos and Three Dactylic Representations

Note. The task consists of matching each logo with its corresponding dactylic representation: Bata with B, Omo with C, and Milo with A.

1. Printed dactylic (PD): The experimenter pointed to one of the words printed in fingerspelling and asked to student to point to the corresponding logo.
2. Manual dactylic (MD): The experimenter spelled a word with fingerspelling, and the student pointed to the corresponding logo.
3. Printed dactylic with practice (PDp): The student repeated the PD task, and his or her performance was evaluated following practice.
4. Manual dactylic with practice (MDp): The student repeated the MD task, and his or her performance was evaluated following practice.

The study participants performed the four tasks in the following order: PD, MD, PDp, and MDp. For each task, they were presented with the same 24 dactylic representations in random order, and their responses were marked on a response sheet. For each of the four tasks, the participants were instructed, "Pay attention to the fingerspelling of each word before pointing to the appropriate logo."

Results

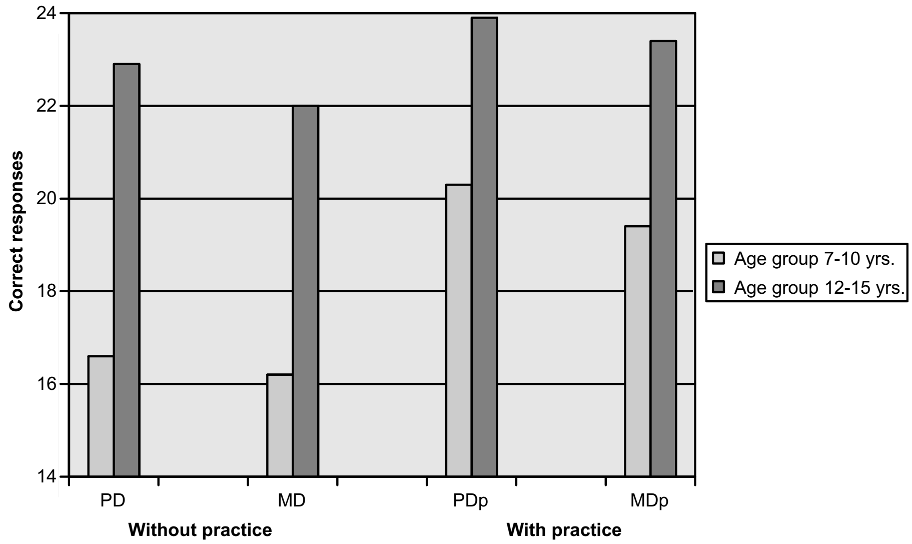
The children correctly identified an average of 18.12 logos, while the adolescents correctly identified an average of 23.60 logos. In terms of reading level, the study participants with low-level reading skills correctly identified an average of 19.48 logos, while those with high-level reading skills correctly identified an average of 21.71 logos.

We performed a repeated-measures ANOVA in order to evaluate the differences, that is to say the effects, of "age group" and "reading level" on the four presentation modes. The ANOVA results show that there were statistically significant differences with respect to age group ($F_{1,20} = 27.55, p < .001$) and reading level ($F_{1,22} = 5.62, p = .028$), and among the four fingerspelling presentation conditions ($F_{3,60} = 51.30$,

$p < .001$). Bonferroni post hoc analysis revealed that the differences between the sets with practice and those without were statistically significant (the difference between the PD sets with and without practice was 2.41, $p < .001$, and the difference between the MD sets with and without practice was 2.29, $p < .001$), and that there was no difference between the different presentation conditions (printed and manual).

We also evaluated the interactions between "presentation mode" and "age group" ($F_{3.60} = 9.40$, $p < .001$), and between "presentation mode" and "reading level" ($F_{3.60} = 2.96$, $p = .030$). The interaction between presentation conditions and age group (see Figure 5) is explained by the fact that the effects of practice on performance were significantly stronger in the younger group. The interaction between presentation conditions and reading level (see Figures 5 and 6) is explained by the greater difficulty the study participants with low-level reading skills experienced with the manual presentation mode versus the printed presentation mode.

Figure 5
Correct Responses in the Fingerspelling Presentation Modes, by Age Group



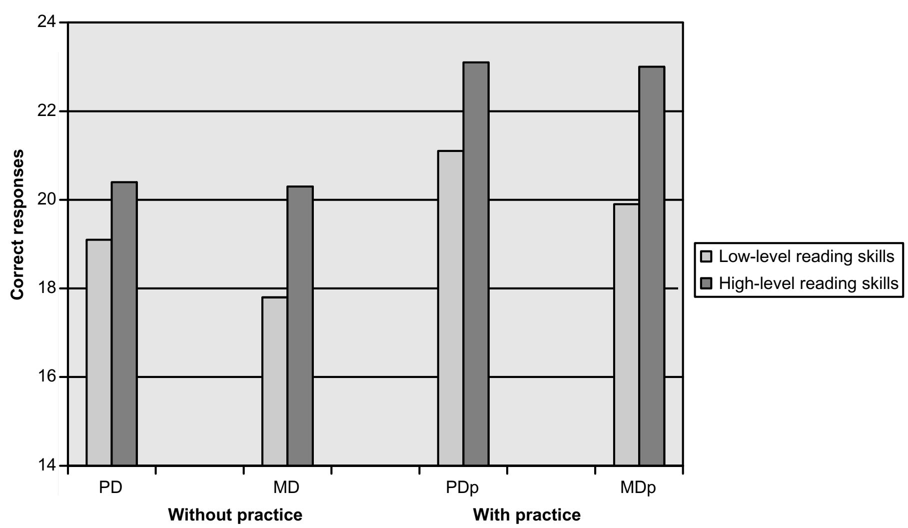
Notes. PD, printed dactylic. MD, manual dactylic. PDp, printed dactylic with practice. MDp, manual dactylic with practice.

Discussion

The differences in the fingerspelling recognition task—which consisted of matching fingerspelled words with product logos—can be explained by the study participants' ages and reading levels.

We found that it was slightly more difficult for participants to follow the dactylic sequences made by the experimenter (MD) than to follow those printed on a sheet of paper (PD), but this difference did not reach a statistically significant level. This finding suggests that memory storage is not a problematic element in the processing of fingerspelled words. We know that fingerspelling is a representation of the alphabet, in which each letter is manually represented by a single, discrete handshape. This may imply that fingerspelled words are processed as a series of individual handshapes. Yet experimental evidence indicates otherwise. From research on the speed of fingerspelling recognition and the results of memory tasks that require individual letter reporting, one may conclude that these fingerspelled words are processed as whole units or as meaningful subunits within words (Hanson, 1982). Thus—to strike a parallel with spoken languages—deaf people are no more likely to process fingerspelled words as a sequence of

Figure 6
Correct Responses in the Fingerspelling Presentation Modes, by Reading Skill Level



Notes. PD, printed dactylic. MD, manual dactylic. PDp, printed dactylic with practice. MDp, manual dactylic with practice.

individual handshapes than are hearing people to process spoken words as a sequence of discrete phonemes.

With regard to practice, we can therefore affirm that in our sample of deaf signers learning was very fast (the results improved significantly in the second session), and was independent of the presentation conditions, a finding that should be taken into consideration in the establishment of training programs designed to teach fingerspelling. The facility with which fingerspelling can be learned explains the fact that it is infrequently observed to be a first language—not only is it too awkward to implement exclusively, but it has also been observed that it requires very little effort for deaf signers to learn to control fingerspelling.

In conclusion, training the deaf to use fingerspelling could help them to develop the ability to segment words, just as hearing people do with alphabetic writing. By using alphabetic writing, hearing children learn to recognize that words can be segmented into letters, syllables, etc., and that these units correspond to the sounds used in spoken language. In the case of fingerspelling, it is possible that the deaf convert manual gestures into graphemes. The deaf do develop spelling skills, because they are able to use phonological and visual codes, although preferential use is made of the latter type of code for most tasks. Phonological development is not specific to auditory ability, but rather can be acquired through speechreading, fingerspelling, and cued speech.

Experiment 3: Decoding Fingerspelled Words and Mapping Them Onto the Writing System

The second experiment consisted of four matching-detection tasks, which made it possible for study participants to give a correct response without actually being able to identify a logo. For example, participants could have identified the Zuko logo simply by knowing the link between the letter Z and the fingerspelled Z. Or they may have been able to identify Chilevisión simply because of the number of letters in the logo and in the fingerspelled representation. (Other strategies may also have been used, such as relying on words' initial letters or on word lengths, in order to establish the connection between a fingerspelled word and its corresponding logo.) Because of this possibility for students to identify logos by relying on clues rather than on a complete understanding of the relationships between the fingerspelled words and the logos, a test was designed to measure the ability to transfer a fingerspelled word, originally embedded in a signed sentence, to writing. The aim of this third experiment was to understand how deeply mastery of sign language and mastery of fingerspelling are related to or could serve as mediators in a writing task, which consists of reading and identifying dactylic representations of words.

Method

Participants

The same students who took part in Experiment 2 participated in Experiment 3.

Procedure

Twenty signed sentences with one fingerspelled word inserted into each were signed by a deaf native CHSL signer and presented in a video recording. Once the sentence was completed, study participants were asked to answer, in writing, a question given by the experimenter. An example sentence consisted of the signing of the phrase *Maria's new dress is* followed by the dactylic spelling of the word *pink*. After completion of this sentence, a few seconds were allowed to pass and then the participant was asked in CHSL, *What colour was Maria's new dress?* He or she was then supposed to write the word *pink* on the response sheet. Once the response was written, the next sentence was presented. Three training runs were performed before the task was begun in order to familiarize participants with the process. Each participant sat at a desk facing the screen, and each wrote the words on a response sheet. The instructions were shown in the video, in CHSL: "Observe the sentence carefully; pay attention to the question and write your answer correctly on the response sheet."

Results

In terms of age group, the children's group in Experiment 3 gave correct responses for only 7.08 of the signed sentences on average, while the adolescents gave correct responses for 18.83 sentences on average. With respect to the main effect of the variable "reading level," the study participants with low-level reading skills responded correctly, on average, to 11.33 of the signed sentences, while those with high-level reading skills responded correctly, on average, to 14.58 of the sentences.

We performed an ANOVA in order to evaluate the differences, that is, the effects of "age group" and "reading level" on the fingerspelling task. The ANOVA results show that there were statistically significant differences with respect to age group ($F_{1.20} = 104.75$, $p < .001$) and reading level ($F_{1.22} = 8.01$, $p = .01$). The interaction between these two variables did not reach a statistically significant level ($F_{1.22} = 1.90$, $p > .05$), although the difference in reading levels among children was greater; that is to say, the children with high-level reading skills performed better

on this task than the children with low-level reading skills.

Discussion

The results of Experiments 2 and 3 provide convergent evidence that the use of fingerspelling and sign language can facilitate the development of reading and writing skills, because the differences in the fingerspelling tasks (both the recognition and identification tasks) can be explained by age and reading level.

Several studies support the notion of a relationship between the mastery of sign language and reading. Chamberlain and Mayberry (2000) evaluated ASL communication skills and discovered a positive correlation with reading. Different studies having found correlations of between .43 and .80 (Hoffmeister, 2000; Mayberry & Fischer, 1989; Moores et al., 1987; Padden & Ramsey, 2000; Strong & Prinz, 1997, 2000).

Ross (1992) studied the use of fingerspelling in skilled and novice deaf readers and found that both groups use it. Novice readers not only use fingerspelling, they explore the patterns of orthographic rules and investigate the sublexical structure of signs. We therefore believe it relevant to explore the relationship between sign language and fingerspelling ability and reading and writing ability, as we believe fingerspelling could serve as a bridge to or mediator in the development of metalinguistic skills.

General Discussion

The aim of the present study was to examine whether deaf students whose first language is CHSL use fingerspelling to identify words and if this ability is related to reading and spelling. Linguistic and reading development in the deaf can be achieved in three ways: (a) by taking advantage of any remaining auditory capacity to strengthen oral language, (b) by developing oral language with the help of complementary communication systems, and (c) by promoting and institutionalizing the use of sign language. The development of oral language requires a great effort in the case of people who are profoundly deaf. Sign language, in contrast, is totally accessible to such individuals, and strategies involving fingerspelling training could represent an alternative for acquiring reading skills.

For a long time, it was thought that a person's access to phonological information was exclusively auditory. Nowadays, however, many studies support the idea that phonological information can also be nurtured, acquired, and strengthened with the help of visual information (MacDougall, 1979). Fingerspelling, for example, is a visual form that reflects the graphemes that make up words, providing a means by which to gain access to the segmental information of words. It is a system of support that can reinforce orthographic representations and serve as a base for the development of rudimentary phonologic codes.

According to Ross (1992), deaf beginning readers whose main language is sign language actively seek to establish relationships between the sublexical structure of sign language words and the written form of these same words. For many generations, the deaf have learned to take advantage of this relationship when they learn to read. In the beginning stages of reading, written words have no reference in their internal lexicon. But little by little, fingerspelling reveals the significance of sequences of letters, organizing them into an accessible code that allows deaf learners to acquire alphabetic principles. Learning to fingerspell involves not only learning to associate manual alphabetic configurations with their printed forms but also learning to understand the interactions between fingerspelling and other language systems.

We have observed that, before reaching adolescence, the deaf have difficulty with sign recognition and fingerspelling recognition. These results suggest that mastering CHSL and mastering the reading of fingerspelling are complex tasks that require many years of practice and education. The difference between children and adolescents is not observed in the identification of signs, but is due fundamentally to the difficulty younger students have in identifying pseudosigns and fingerspelled pseudowords. Also, the ability to read and write dactylic code is less developed that the ability to read and write signed vocabulary. There are at least two possible explanations for this particular finding: (a) that the deaf are less exposed to the fingerspelling lexicon than to the signed lexicon, and (b) that fingerspelling is not a natural language, and the deaf acquire it as a code as they learn the orthographic rules of language.

Our results are consistent with those obtained by Padden and Hanson (1999) in that the comprehension and, above all, the writing of fingerspelled words require deaf students to have years of experience and to have reached a more mature age. The effect, however, is more clearly observed when the words to be written occur infrequently (Leybaert, 2000). Ross (1992) found that adolescent deaf readers use fingerspelling more precisely than younger deaf children. Consistent with the findings of Padden and Hanson and those of Ross, the results of our first two studies (i.e., Experiments 1 and 2) highlight the significant differences between groups of different ages and academic levels, demonstrating that adolescents perform better.

As to the role of fingerspelling in reading, we have observed how skilled readers are able to successfully perform the task of recognizing and storing fingerspelled words in order to match them later to their corresponding logos and identify dactylic words. Our results support the notion, defended by Hanson and colleagues (1984), that fingerspelling is a mediator between the printed alphabet and reading comprehension. In the present investigation we have obtained results that provide evidence that deaf individuals, once they have acquired dactylic skills, use these skills as one of the permanent means by which they gain access to the language system.

That good or at least adequate reading skills can develop, even if phonological awareness is severely deficient, has been demonstrated by both single-case (Howard & Best, 1996) and group studies. The latter show that there is considerable overlap in phonological decoding abilities of proficient and poor readers (e.g., Treiman & Hirsh-Pasek, 1983). The fact that good word recognition can occur in the context of poor phonological awareness implies that an adequate sight vocabulary can be built up simply through regular exposure to a sufficient number of words. This is not to say, however, that information about letter-sound or other orthographic-phonological relationships is not simultaneously being learned, however slowly or imperfectly. Some theorists have argued explicitly that single-word recognition requires an amalgamation of knowledge of a word's meaning, its phonology, and its orthography (Ehri, 1992a, 1992b). What we are suggesting here is that lexical and nonlexical (or phonological and orthographic) strategies are likely to have a reciprocal relationship. If so, children with an inadequate whole-word system (lexical reading strategy) may have difficulty acquiring a nonlexical reading procedure.

Fingerspelling, though it has always been present in the teaching of deaf children, has not received as much attention as other codes. Using visual-spatial configurations of the hand, fingerspelling reflects the graphemes that make up words. As a result, access is obtained to words' segmentation information. Knowledge of each segment of a word facilitates its recognition and reconstruction. Fingerspelling can act as a system of support which, though not analogous to phonology, can reinforce orthographic representations in order to provide a system of codes. As Perfetti and Sandak (2000) have shown, in the case of the deaf "more is better." Because the deaf cannot acquire access to phonological representations as hearing people do, the broadening and stimulation of multiple routes could be highly beneficial to their acquisition and development of reading and writing.

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