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CHAPTER 3

Phonology and Reading: Evidence from Profoundly Deaf Readers

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Abstract

The prelingually, profoundly hearing-impaired reader of English is at an immediate disadvantage in that he or she must read an orthography that was designed to represent the phonological structure of English. Can the deaf reader become aware of this structure in the absence of significant auditory input? Evidence from studies with deaf college students will be considered. These studies indicate that successful deaf readers do appreciate the phonological structure of words and that they exploit this knowledge in reading. The finding of phonological processing by these deaf readers makes a strong case for the importance of phonological sensitivity in the acquisition of skilled reading, whether in hearing readers or deaf readers.

Résumé

Le lecteur d'anglais qui à subi une perte d'audition avant le début de sa capacité de parler a un désavantage immédiat en ce qu'il est obligé de lire une orthographie dessinée à représenter la structure phonologique de l'anglais. Est-il possible que ce lecteur sourd puisse devenir conscient de cette structure dans l'absence de signaux auditoires assez forts? On considérera l'évidence obtenu dans des études avec des étudiants universitaires sourds. Ces études indiquent que les lecteurs sourds qui

réussissent, se rendent compte de la structure phonologique des mots et qu'ils utilisent cette information pour lire et pour écrire. L'évidence des procès phonologiques chez ces lecteurs sourds recommande beaucoup l'importance de la sensibilité phonologique en l'acquisition de la lecture, soit chez ceux qui entendent bien, soit chez ceux qui sont sourds.

Zusammenfassung

Englisch-sprechende Personen, die ihr Gehör vor dem Spracherwerb verloren, sind beim Lesen benachteiligt, da die englische Orthographie phonologische Struktur darstellt. Können gehörlose Leser diese Struktur erkennen, die gesprochene Sprache charakterisiert? Experimente an gehörlosen Studenten zeigen, daß erfolgreiche Leser die phonologische Wortstruktur erkennen und dieses Wissen im Lesen und Schreiben ausnützen. Diese Resultate unterstützen die in der Forschung mit normal hörenden Kindern entwickelte Hypothese, daß phonologische Analyse wichtig für das Erlernen des Lesens ist.

Resumen

Desde su infancia, el lector de inglés severamente incapacitado para la audición se encuentra en desventaja con relación a la lectura de la ortografía utilizada para representar la estructura fonológica del inglés. Dada su incapacidad auditiva, ¿puede el lector sordo llegar a comprender aquella estructura? Para elucidar esta cuestión tomaremos en consideración datos reportados en estudios que tratan sobre estudiantes sordos de enseñanza secundaria. Estos estudios indican que los lectores sordos aventajados aprecian la estructura fonológica de las palabras, y que utilizan este conocimiento en la lectura y en la escritura. El hecho de que estos lectores sordos puedan procesar un mensaje fonológicamente prueba claramente la importancia de la sensibilidad fonológica en la adquisición de la capacidad de lectura,

tanto en el caso de las personas que oyen como de las incapacitadas para la audición.

In the normal course of events, children are fluent speakers and listeners of their native tongue, English, before they begin learning to read. In this chapter, I am concerned with a population of readers for whom this is not the case. This population is prelingually, profoundly hearing impaired. For these deaf readers, speech and lipreading are difficult to acquire and require years of instruction.

Research on reading has indicated that building on a spoken language foundation is a critical feature of reading and that in order to use an alphabetic orthography, such as English, to best advantage, the reader must go beyond the visual shape of words to apprehend their internal phonological structures (Liberman 1971, 1973). Despite their extensive experience in using the phonology in everyday speech, evidence presented elsewhere in this monograph argues that hearing children who are poor readers may have phonological deficits that underlie their reading problems. These children have difficulty in setting up phonological structures, in apprehending such structures in words, and in using a phonetic code for the storage and processing of words in working memory. The phonological deficits of these children may be fairly subtle, however, such that no difficulty in the child's speaking ability or listening comprehension may be readily apparent.

If in the hearing population even subtle phonological deficits are associated with poor reading, then how is it possible for profoundly deaf individuals to read? One might suppose that deaf persons would have difficulty with reading, and, indeed, this is the case. Surveys have consistently shown that hearing impaired students lag significantly behind their normally hearing counterparts in reading achievement (Conrad 1979; Furth 1966; Trybus and Karchmer 1977). Although it is typical to state, based on these surveys, that the average hearing impaired student graduating from high school reads only at about the level of a hearing child of fifth grade, that statistic obscures the even greater reading deficiency of *profoundly* hearing impaired students, that is, those who could be considered truly deaf. For them, the statistics are even more discouraging: Profoundly deaf students graduating from high school read, on the average, only at the level of a normally hearing child of third grade (Conrad 1979; Karchmer, Milone and Wolk 1979). Remember, though, that these reading achievement scores represent only a population average. We find, for example, that measures of reading achievement for deaf students attending Gallaudet University may average seventh to tenth grade, with some students reading at above the twelfth grade level (see, for example, Hanson 1988; Hanson and Feldman 1989; Hanson, Shankweiler and Fischer 1983; Reynolds 1975).

These statistics on reading achievement levels of deaf students have been used by investigators to argue two opposing views of the relationship between phonology and reading. The assumption common to both views is that the hearing impairment of these students prevents access to English phonology. In one view, access to phonological information is believed to be crucial for reading and the generally low reading achievement levels of deaf students are believed to reflect its importance. Because these readers presumably lack access to English phonology, their acquisition of reading suffers as a consequence. The second view takes the position that access to phonological information is not important in reading. The fact that *some* deaf individuals are able to attain fairly high reading levels is taken as evidence of this. Again, the assumption is that these readers, due to their hearing impairment, lack access to phonological information. Consequently, if they succeed at reading it must be without benefit of phonology.

Neither of these positions need to be correct, however, in their interpretation of the reading achievement of deaf students. Deaf readers, despite their hearing impairment, might have access to phonology that could be used to support skilled reading. To assume that deaf readers lack access to phonology because of

their deafness confuses a sensory deficit with a cognitive one. While the term *phonological* is often used to mean acoustic/auditory, or sound, this usage reflects a common misunderstanding of the term. Phonological units of a language are not sounds, but rather a set of meaningless primitives out of which meaningful units are formed. These primitives are related to gestures articulated by the vocal tract of the speaker (see Liberman and Mattingly 1985 for a more detailed discussion).[1] In the case of English, the deaf individual could learn about the phonology of the language from the motor events involved in speech production, through experience in lipreading, or from experience with the orthography.

As a rule, deaf children in English-speaking countries receive intensive instruction in speaking and lipreading. This is true both in schools that use an oral education approach (with speech being the only means of communication used in the classroom) and in schools that use a simultaneous or total communication approach (with speech being accompanied by manual communication in the classroom). Through this speech training, prelingually, profoundly deaf individuals develop varying skill in speaking and lipreading. Although some of these individuals develop quite good speaking and lipreading skills, most do not (Conrad 1979; Smith 1975). Speech training, nevertheless, does provide the deaf individual with a means of learning English phonology.

Speech intelligibility does not necessarily indicate, however, the extent to which a deaf reader has access to phonological information. Intelligibility reflects the degree to which a deaf speaker's speech can be understood by a listener. Among the things that can affect intelligibility are phonation and prosodic information. While such features clearly add to intelligibility, they may not be relevant for an individual's internal manipulation of phonological information. In any event, it cannot simply be assumed that deafness necessarily blocks access to English phonology. This is a question for empirical investigation.

How do congenitally, profoundly deaf readers who read well manage to do it? That is the question to be addressed here. It is possible that deaf readers read English as if it were a logographic language; namely, treating printed English words as visual characters, without taking into account the correspondences between the printed letters and the phonological structure of words. Research on the reading of Japanese and Chinese, however, has suggested that for logographic languages, as for alphabetic languages, phonetic recoding of words is one component of a linguistic processing system required for the task of reading (Erickson, Mattingly, and Turvey 1977; Mann 1985; Tzeng, Hung, and Wang 1977). For example, Tzeng et al. (1977) found that the phonetic composition of printed Chinese characters influenced sentence processing for skilled readers of Chinese. These investigators concluded that even in cases where lexical access is possible without phonological mediation, a phonetic code is still required for effective processing in working memory.

The deaf individuals who participated in the studies to be discussed here had backgrounds in which sign was used predominantly. That is, they generally *had* or *were* receiving instruction using sign language. Most of these individuals considered American Sign Language (ASL), to be their preferred means of communication. ASL is the common form of communication used by members of deaf communities across the United States and parts of Canada. It is a visual-gestural language that has developed independently from spoken languages and from other signed languages. For many of the subjects in the studies reported here, ASL was their first language, having been learned as a native language from deaf parents. These subjects were typically undergraduates at Gallaudet University. All were profoundly deaf. These deaf subjects, therefore, can be characterized as having higher than average reading levels and not being exposed to an exclusively oral background.

Findings on Phonetic Coding in Working Memory

Evidence reviewed elsewhere in this monograph indicates that hearing children who are poor readers have a language deficit

that is specific to the phonological domain. For example, in tests of short-term memory hearing poor readers recall fewer items overall and display less sensitivity to rhyme than hearing good readers (see, for example, Shankweiler et al. 1979). That is, on rhyming lists, the accuracy of the good readers is typically worse than on nonrhyming lists. In contrast, the accuracy of the poor readers is about the same for rhyming and nonrhyming lists. The good readers' differential performance on recall of rhyming and nonrhyming strings has been taken to mean that these readers convert the printed letters into a phonetic form and retain this phonetic information in memory. Accordingly, the finding that poor readers are not much affected by rhyming manipulations suggests that they are less able to use the phonetic information.

Is a phonetic code uniquely well-suited to the task of reading? To examine this question, we asked whether for deaf signers a different language code, one based on the structure of signs, could provide an alternative coding system for reading.

A sign of ASL is produced by a combination of the formational parameters of handshape, place of articulation, movement, and orientation (Battison 1978; Stokoe, Casterline, and Croneberg 1965). Evidence indicates that when *signs* are presented for recall in a short-term memory task, the signs are coded in terms of these formational parameters. The first line of evidence comes from studies on intrusion errors in the recall of lists of signs (Bellugi, Klima, and Siple 1975; Krakow and Hanson 1985). In the study by Bellugi, Klima, and Siple, lists of spoken words or signs were presented to hearing adults and deaf adults, respectively. The subjects were asked for immediate written recall. Intrusion errors for the hearing group were confusions of phonetically similar words. For example, a subject might write the word *boat* instead of the word presented, "vote." Errors for the deaf subjects, however, were completely different; they were confusions of the formational parameters of signs. As an example, a subject might write the word *egg* instead of the sign presented, NAME. The signs corresponding to the words *name* and *egg* differ only in terms of the movement of the hands (see fig. 1).

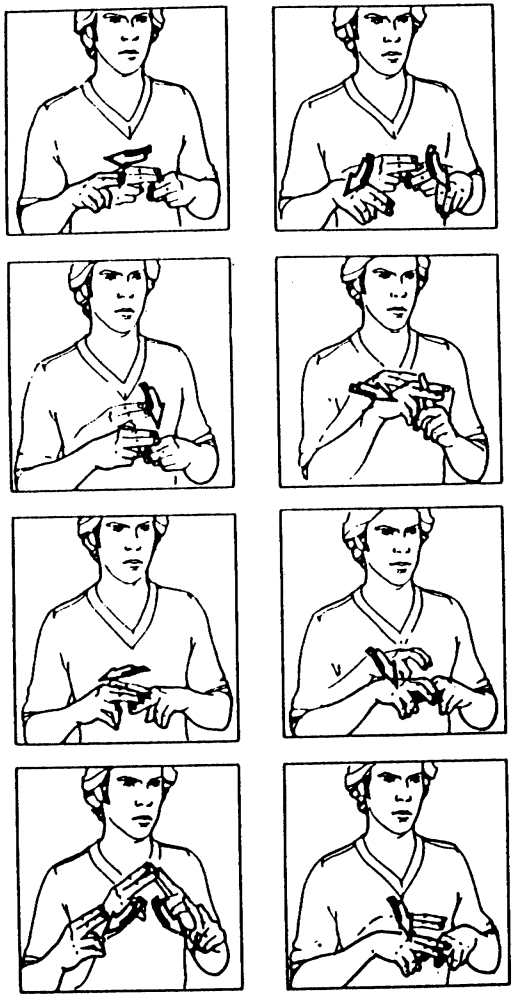

Fig. 1. Formationally similar signs. Shown left to right from the top are KNIFE, EGG, NAME, PLUG, TRAIN, CHAIR, TENT, SALT. (From Hanson 1982, 574.)

In addition, there is evidence that lists of formationally similar signs can produce performance decrements in serial recall tasks (Hanson 1982; Poizner, Bellugi, and Tweney 1981). For example, shown in figure 1 is a set of formationally similar signs that I used in one such study (Hanson 1982). Shown here are, left to right from the top, the signs for KNIFE, EGG, NAME, PLUG, TRAIN, CHAIR, TENT, and SALT. On each trial in that experiment, deaf college students were shown five of the signs from this set and were asked to remember the five signs in order. Results of that experiment indicated that fewer signs were recalled from lists made up of signs from this formationally similar set than from lists made up of signs from a formationally unrelated (control) set.

Despite such evidence that sign coding can thus mediate short-term recall of *signs*, evidence from other research does not support the notion that a sign code can serve as a viable code in the service of skilled adult reading. In another condition of that study (Hanson 1982), I tested deaf college students in a short-term recall task of *printed* words. There were three types of word lists of interest here: rhyming words, orthographically similar words, and words whose signs were formationally similar. The words in the rhyming set were *two, blue, who, chew, shoe, through, jew,* and *you.* The words in the orthographically similar set were visually similar. The words in this set were *bear, meat, head, year, learn, peace, break,* and *dream.* While argument could be taken with the degree of visual similarity of the words in this list, it is at least true that these words are more similar visually than were the words in the rhyming list. The words in this visually similar set served as a control to ensure that any potential rhyme effects could not be attributed to the visual similarity of the printed words. The words in the formationally similar set were words whose corresponding signs were formationally similar. These were the words *knife, name, plug, train, chair, tent,* and *salt,* whose corresponding signs are shown in figure 1. Each of these sets was paired with a control set of words. Of interest in this experiment were any differences in ability to recall an experimental and control set.

The pattern of results in the experiment clearly indicates the use of phonetic coding by the deaf subjects. Whereas these subjects recalled 65.4 percent of the lists in the control condition, they recalled only 47.6 percent of the lists in the phonetically similar (rhyming) condition. There was, however, no decrement on the visually similar lists, indicating that the decrement on the rhyming lists was due to phonetic, not visual, similarity.

Interestingly, I found no evidence that the deaf college students I tested were using sign coding. Their performance on lists of words having formationally similar signs and on the control lists was comparable (52.9 percent of the control lists recalled vs. 51.4 percent of the formationally similar lists recalled). Converging evidence from later research supports this finding that the better deaf readers do not use sign coding in their recall or reading of printed English words (Lichtenstein 1985; Treiman and Hirsh-Pasek 1983). More than 100 years ago, Burnet (1854) argued that sign coding would be a ponderous strategy for the deaf readers, and, thus, limited in its use to the poorer readers. By finding that the better deaf readers do not use sign coding when processing printed English words, current research on the cognitive processing of deaf readers is consistent with Burnet's speculations.

The finding that the better readers were using phonetic coding is reminiscent of the results reported by Conrad (1979) in a very large-scale study of deaf and hearing impaired students in England and Wales. Conrad tested these students in a short-term memory task of rhyming and nonrhyming lists of printed letters. Comparing their performance on this memory task with measured reading ability, Conrad found that the better readers in his deaf population recalled fewer rhyming than nonrhyming lists. Thus, the better readers were using phonetic coding.

My study with deaf signers (Hanson 1982) took Conrad's findings one step further. Conrad's subjects were from schools that generally subscribed to an oral philosophy of education. As a result, phonetic coding was the only language form available to the subjects. In my study, the deaf subjects had sign language readily available to them. In fact, all of my deaf subjects had deaf parents and reported ASL to be their first language. Yet, these signers, as skilled deaf readers, used phonetic coding in that memory task, indicating the importance of phonetic coding in short-term retention of printed material.

Sensitivity to the Phonological Structure of English Words

Additional evidence that deaf readers can access phonological information about English words is provided by studies of individual word reading. For example, one experimental paradigm that has been shown to produce phonological effects with hearing readers uses a lexical decision task in which two letter strings are shown to the subjects on every trial, one string above the other (Meyer, Schvaneveldt, and Ruddy 1974). The subjects must decide whether or not *both* of the letter strings on a trial are real English words.

In a series of three experiments, we used this paradigm with deaf college students (Hanson and Fowler 1987). There were two types of word pairs of particular interest. As shown in table 1, the first was pairs in which the two words rhymed. These rhyming words were spelled alike except for the first letter. The second type of word pair of interest was pairs in which the two

TABLE 1. Rhyming and nonrhyming pairs and their matched controls

Rhyming Pairs	Nonrhyming Pairs
save-wave	*have-cave*
fast-past	*last-east*
Rhyming Controls	**Nonrhyming Controls**
save-past	*have-east*
fast-wave	*last-cave*

Source of data: From Hanson and Fowler 1987, Experiment 2.

words were spelled alike except for the first letter, but the pairs did *not* rhyme. It is apparent that the rhyming and nonrhyming pairs were equally similar orthographically, differing only in the phonological similarity of the two members of a pair. We tested whether there was any difference in the response times to the rhyming and nonrhyming pairs. Since, however, response times to words vary with word familiarity and orthographic regularity, it was not possible in this study to simply compare the responses to the rhyming and nonrhyming pairs. To eliminate familiarity and regularity as confounding factors, two control conditions were used. Word pairs in the control conditions used the same words as in the rhyming and nonrhyming pairs, but were repairings of these words. Thus, the control pairs for the rhyme condition were the same words as in the rhyme condition, just paired now with different words. For example, in the rhyme condition, the words *save-wave* and *fast-past* were paired together, while in the rhyme control *save-past* were paired together and *fast-wave* were paired together. Similarly, the control pairs for the nonrhyme condition were the same words as in the nonrhyme condition, just paired with different words. By comparing each word in the rhyme and nonrhyme condition with itself in a control condition, any effects of word frequency and regularity were eliminated.

The predictions for this experiment are shown in table 2. If readers in this task did not access phonological information, then there should have been no effect due to the phonological relationships between words in a pair. That is, if the readers were using solely orthographic information, then the first equation shown here would hold; namely, that the difference be-

TABLE 2. Predictions in the Hanson and Fowler 1987 Study

If ORTHOGRAPHIC CODING, then:
Control − Rhyming = Control − Nonrhyming
If PHONOLOGICAL CODING, then:
Control − Rhyming ≠ Control − Nonrhyming

tween response times to rhyming pairs and the rhyme controls would equal the difference between response times to nonrhyming pairs and their controls. Thus, response times would be the same whether or not the words of a pair rhymed.

If, however, readers *were* accessing phonological information, then there *would* be a difference in response times as a function of phonological relationships between words in a pair. Access to phonological information would be indicated if the second equation held; namely, that the two differences in response times would not be equal. In that event, the response times would be affected by the rhyming manipulation.

For the deaf college students we tested, there *was* an effect of the phonological relationship between the words in a pair. Shown in table 3 are the response times from one experiment of that study (Experiment 2). Response times were faster for the rhyming pairs than for the matched controls. In contrast, response times were slower on the nonrhyming pairs than on the matched controls. Since the rhyming and nonrhyming pairs were equally similar orthographically, this significant difference in response times for the rhyming and nonrhyming pairs was not due to orthographic influences. As a consequence, the difference in response times to the rhyming and nonrhyming pairs could be unambiguously attributed to the discrepant phonological structures. Thus, these good deaf readers, like hearing readers, accessed phonological information when reading the words.

Most impressive is the finding that the deaf subjects in that study were not only accessing phonological information, but were doing so in a highly speeded task. It might be supposed that deaf readers would be able to access phonological information only in situations in which they have time to laboriously

TABLE 3. The Response Time (RT) Difference for the Rhyming and Nonrhyming Pairs and Their Matched Controls for Deaf College Students

Control − Rhyming (52 msec) ≠ Control − Nonrhyming (-15 msec)

Source of data: From Hanson and Fowler 1987, Experiment 2.

recover learned pronunciations. In this research, however, we found that they accessed phonological information quite rapidly, suggesting that accessing such information is a fundamental property of reading for these skilled readers.

In more recent work, we have found other evidence that skilled deaf readers are sensitive to the phonological stucture of words. For example, deaf college students, when asked to think of words that rhyme with a specific target word have been found to be able to do so (Hanson and McGarr 1989). In addition, we have found that deaf college students are able to apply principles of grapheme-phoneme correspondence in generating the correct pronunciation of letter strings not previously encountered—a skill underlying the acquisition of new words. In this latter task (Hanson 1989), I tested these students on their reading of orthographically possible nonwords; that is, pseudowords. The critical test was between pseudowords such as *flaim* that were homophonous with an actual English word (*flame*) and control pseudowords. These controls were orthographically matched pseudowords that were not homophonous with an actual English word (e.g., *proom*). Examples of stimuli from the task are shown in table 4.

In two experiments using different lists of pseudowords, a paper and pencil task tested whether subjects could identify which of several pseudowords were homophonous with English words. The actual instructions to subjects were that they were to indicate whether or not each of the "nonsense words" was

TABLE 4. Examples of Pseudohomophones and Control Pseudowords

English Word	Pseudohomophone	Control
flame	flaim	proom
dog	daug	grine
spoon	spune	fosh
tall	taul	brate
home	hoam	spail
blue	bloo	nole
noon	nune	fune

Source: Selection of stimulus items from Hanson 1989, based on Mcdonald 1988.

pronounced like a real English word. In both experiments, deaf college students were able to correctly make this judgment with better than chance accuracy, although they were not as accurate as the hearing subjects. As an additional aspect of this pseudohomophone task, subjects in one of the two experiments were asked to indicate *which* English word they thought a pseudoword was pronounced like, if they had indicated that they thought it was pronounced like one. In this second task, deaf subjects were usually able to supply the correct English word.

Studies on individual word reading thus indicate that it is possible for deaf readers to have access to English phonology. This does not mean that such access is easy for these readers. Nor does it mean that all or even most deaf readers are able to use this information. The point, rather, is that hearing loss alone does not preclude access to phonology. In addition, it is important to note that the better deaf readers generally take advantage of this phonological information.

Why Phonological Coding?

In sum, the evidence, which has been summarized here, indicates that it is possible for deaf readers to use phonology. The use of phonological information tends to be characteristic of deaf good readers, whether they are beginning readers (Hanson, Liberman, and Shankweiler 1984), high school students (Conrad, 1979; McDermott 1984), or college students (Hanson 1982; Hanson and Fowler 1987; Lichtenstein 1985). Why would the better deaf readers use this type of linguistic information when reading? One possibility has to do with the structural properties of particular languages. In English, where word order is relatively fixed, grammatical structuring is essentially sequential. A phonological code may be an efficient medium for retaining the sequential information that is represented in English.

Deaf individuals have specific difficulty in the recall of temporally sequential information (Hanson 1988). Studies have consistently found that the measured memory span of deaf individuals is shorter than that of hearing persons (see, for example, Bellugi, Klima, and Siple 1975; Blair 1957; Belmont and Karchmer 1978; Conrad 1979; Hanson 1982; Kyle 1980; Pintner and Paterson 1917; Wallace and Corballis 1973). It is important to note that this finding of a short span applies not only to the English materials (e.g., lists of words, letters, or digits), but also applies to studies that have measured serial recall of *signs*. Fairly typical results were found in the Bellugi, Klima, and Siple (1975) study, in which deaf adults' correct serial recall of signs reached an asymptote with a list length of four signs, while the hearing subjects reached asymptote with lists of six words. Thus, the differences in memory span found in deaf individuals appear to be due not simply to unfamiliarity with the English material; rather, they appear to be related to cognitive processes involved in short-term memory for linguistic materials, in general.

Ability to maintain a sequence of words in short-term memory is related to the use of phonological coding. That is, studies with orally trained subjects (Conrad 1979), native signers of ASL (Hanson 1982), and subjects mixed in terms of their educational and linguistic backgrounds (Lichtenstein 1985), have all found strong correlations between the magnitude of the rhyme effect for deaf subjects and measured memory span. In these studies, the larger the rhyme effect for a deaf subject, the larger that subject's memory span. In contrast, no correlation between use of manual coding and measured memory span has been established (Lichtenstein 1985).

Given this relationship between serial recall ability and phonological coding, we have suggested that one reason the skilled deaf reader uses phonological coding may have to do with the critical syntactic role played by sequential structuring in English (Hanson 1982; Lake 1980; Lichtenstien 1985). This analysis suggests that an issue to be faced by teachers is how to educate deaf students to process a highly temporally structured language such as English.

Deaf Readers and Phonology

It is notable that the subjects in the studies discussed were not generally from oral backgrounds. In some cases, subjects were expressly selected because they were *native signers of ASL*. Yet, even these subjects, if skilled readers, were found to be using phonological information in the reading of English, rather than referring to ASL.

A discussion of phonological sensitivity in deaf readers always leads to the question of how this sensitivity is acquired. It is likely that congenitally, profoundly deaf readers acquire phonology from a combination of three sources: experience with the orthography through reading, experience in speaking, and experience in lipreading. In many of the studies discussed here, there was evidence of phonological processing for deaf subjects whose speech was not intelligible. That even these subjects use phonological coding suggests that deaf individuals' ability to use phonological information when reading is not well reflected in the intelligibility ratings of their speech. Further research is needed to determine the type of language instruction capable of promoting access to the speech skills most relevant to reading.

When this chapter was first planned, it was titled "Is reading different for deaf individuals?" The answer appears to be both yes and no. Clearly the answer is yes in the sense that deaf readers will bring to the task of reading very different sets of language experiences than the hearing child. These differences will require special instruction. But, the answer is also no. The evidence indicates that skilled deaf readers use their knowledge of the structure of English when reading. Although sign coding, in theory, might be used as an alternative to phonological coding for deaf signers, the research using various short-term memory and reading tasks has found little evidence that words are processed with reference to sign by the better deaf readers. Rather, the better deaf readers, like the better hearing readers, have learned to abstract phonological information from the orthography, despite congenital and profound hearing impairment.

The finding of phonological processing by deaf readers, particularly deaf readers skilled in ASL, makes a strong case for the importance of phonological sensitivity in the acquisition of skilled reading, whether the reader is hearing or deaf. For deaf readers, the acquisition and use of phonological information is extremely difficult. They would be expected to use alternatives such as visual (orthographic) or sign strategy, if such were effective. Yet, the evidence indicates that the successful deaf readers do not rely on these alternatives.

NOTES

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1. The term *phonology* need not be limited to use with spoken language. In the case of American Sign Language, for example, the term phonology has been used to describe the linguistic primitives related to the visible gestures by the hands, face, and body of the signer. In the present chapter, however, phonology will be restricted in reference only to features related to spoken languages.

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