The Contribution of Phonological Awareness and Receptive and Expressive English to the Reading Ability of Deaf Students with Varying Degrees of Exposure to Accurate English

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This study was planned with the knowledge that the tasks of reading require the same acquisition of skills, whether a child is hearing or deaf, monolingual, or bilingual. Reading and language research literature was reviewed. Subjects were 31 deaf students (7.9–17.9 years of age) who attended one of three U.S. programs. Performance on 15 language and literacy measures was analyzed. Results were that students who scored highest on a passage-comprehension measure also were more able (a) to provide synonyms, antonyms, and analogies of read words and phrases, (b) to read more listed words, and (c) to substitute one phoneme more correctly for another to create new words than were readers with lower scores. Two groups of students also were compared: a Longer Exposure to English Group ($n = 22$) who used Signing Exact English (SEE) for 5 years or more and a Shorter Exposure Group ($n = 8$) exposed to SEE for less than 2 years. A correlational analysis revealed that there were no significant relationships among 14 background variables with the exception of "age of identification of hearing loss," a variable then covaried in subsequent analysis of covariance. Students in the Longer Exposure Group scored higher on all measures. Significant differences were found between groups for short-term memory, receptive and expressive English, and five phonological subtests. Mini-case studies and the performance of eight students in the Longer Exposure Group who scored lowest on the comprehension measure also are discussed.

The acquisition of phonological awareness and English language knowledge is essential if children are to be able to decipher words efficiently and to understand text without assistance (Adams, 1990). This was the finding a decade ago when the U.S. Department of Education's Reading Research and Education Committee commissioned a comprehensive report of beginning reading. Expert Marilyn Adams thoroughly reviewed all aspects of phonics and early reading instruction and published her findings in a widely respected report, *Beginning Reading: Thinking and Learning About Print* (1990).

Several years later, members of the U.S. Department of Education asked the National Academy of Sciences to establish a committee of expert researchers to examine the vast and diverse research regarding reading. The committee, the National Research Council Committee of Preventing Reading Difficulties in Young Children (Snow, Burns, & Griffin, 1998), found empirical evidence that significant delays in phonological awareness and receptive and expressive (English) vocabulary were designators of potential reading problems. Soon after the Snow et al. report, Juel and Minden-Cupp (1999) published a study from the federally funded Center for the Improvement of Early Reading Achievement (CIERA) in which they found relationships between explicit phonics instruction with opportunities for guided practice and the reading comprehension progress of below-average students. Recommended were direct instruction of sound-to-letter patterns and "heavy doses of phonics at the word level for entering first graders who possess few literacy skills" (p. 3).

In 1997, Congress empowered the National Institute of Child Health and Human Development in consultation with the Secretary of Education to convene a national panel to investigate the empirical evidence regarding aspects of reading instruction. The National Reading

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  DOI: 10.1093/deafed/eng028

Panel (2000) considered approximately 100,000 studies published since 1966. For several topics, the number of studies met "rigorous research methodological standards" (p. 5) sufficient to permit a formal statistical meta-analysis. Among the results were that teaching children phonemic awareness skills significantly improved reading achievement; the ability to read and spell words was enhanced in kindergartners who received systematic beginning phonics instruction; first graders who were taught phonics systematically were significantly better able to decode, spell, and comprehend text, compared with other groups of children; synthetic phonics instruction (i.e., teaching students explicitly to convert letters into sounds and to blend sounds into recognizable words) had a significant positive effect on the reading skills of both disabled learners and those with low socioeconomic status; and vocabulary instruction correlated to reading-comprehension gains when instructional methods were appropriate to the age and ability of readers (National Reading Panel, 2000). As the first school year of the new millennium began, the International Reading Association (IRA) endorsed these findings.

The IRA endorsement is significant because the majority of deaf students are educated in public schools in the general classroom (Moores, 1999), and they are expected to comprehend textbook chapters, material from the Internet, resource books, news magazines, and written tests to the same extent as their hearing classmates. Yet most deaf students are unable to read higher than the third- or fourth-grade level (see review by Paul, 1998). Even after 30 years of educational innovations, such as the pairing of sign with spoken instructional language, the exclusive use of American Sign Language (ASL) to teach literacy skills, the use of technologically advanced assistive-listening devices, and inclusion, most deaf children do not read on grade level. In fact, it is so unexpected that profoundly deaf students will read as well as their hearing peers that they are required to read at only a fifth-grade level to be admitted to Gallaudet University, the only liberal arts university for deaf students in the world.

English Vocabulary, Deafness, and Reading

Ehri (1991, 1995) found that once beginning readers understand how sounds are mapped onto letters, they eventually can decode enough words to read independently. However, if a child does not know the meaning of the words he or she decodes, word identification and comprehension are affected. This is especially true when words have multiple meanings (Paul, 1998). Even as early as first grade, reading achievement is related to a student's ability to comprehend, express, and read English vocabulary (for reviews, see Adams, 1990; Paul, 1998; and original research by Babb, 1979; Brasel & Quigley, 1977; Geers & Moog, 1989; Harris & Beech, 1998; Kelly, 1993, 1996; LaSasso & Davey, 1987; Luetke-Stahlman, 1988; Moeller & Johnson, 1988; Moores et al., 1987; Paul, 1984, 1996; Paul & Gustafson, 1981; Paul & Quigley, 1994; Quigley, Steinkamp, Power, Montanelli, & Jones, 1978; Waters & Doehring, 1990).

The relationship between expressive English vocabulary size and reading vocabulary occurs, explained Adams (1990), because the more expressive vocabulary that is acquired, the larger will be the student's word and phrase bank of possibilities and therefore the greater the ability to guess correctly the meaning of words, figurative expressions, phrases, and sentences read in context. In addition, "good readers have the potential to become good writers" (Paul, 1998, p. 101). In fact, a correlation between vocabulary size and literacy achievement has been documented for students who are hearing, bilingual, deaf, or learning disabled (see reviews by Adams, 1990; Paul, 1998).

Below-average vocabulary skills of deaf students have been studied by numerous researchers for the past 30 years and have been found to result in low reading-achievement scores (Allen, 1986; Kelly, 1995; Paul, 1984, 1996). Research conducted in the 1970s with hearing children typically assessed vocabulary size using the Peabody Picture Vocabulary Test (PPVT; Dunn & Dunn, 1997). In this receptive vocabulary measure, an adult assesses routine vocabulary by asking a student to point to one of four pictures representing nouns, verbs, or prepositions.

However, Nagy, Herman, and Anderson (1985) concluded that the test "substantially underestimates" the amount and kind of English required to predict age-appropriate text comprehension.

Snow and her colleagues at Harvard (e.g., Dickinson, Cote, & Smith, 1993; Snow, Tabors, Nicholson, & Kurland, 1984) confirmed the conclusion of Nagy et al., (1985). Research team members analyzed data from a large longitudinal study and discovered that the amount of time emergent readers spent engaged in analytical, decontextualized conversations with adults was a better predictor of reading achievement than were PPVT receptive vocabulary scores (Tabors, 1996). For example, Dickinson et al., (1993) found that formulating definitions in kindergarten and first grade was significantly correlated with reading-comprehension scores by the end of fourth grade. Analytical conversation was described by Luetke-Stahlman (1998) as interactive discourse in which children hear novel words and figurative phrases used in academic conversation and synthesize, analyze, compare, judge, and use other higher level thinking skills. Cummins (1984) referred to such English as *cognitive-academic language.*

Recently, Nielsen and Luetke-Stahlman (2002a) found that passage-comprehension scores across 9 years were positively affected by a deaf child's ability to define words, discern similarities and differences of word pairs, and provide multiple attributes for nouns. In addition, the researchers found that tools that evaluated the cognitive-academic language proficiency required in the general classroom were better predictors of text comprehension than was the PPVT receptive measure of single words. Example measures were the Language Processing Test (Richard & Hanner, 1995), the Clinical Evaluation of Language Foundations ([CELF]; Semel, Wiig, & Secord, 1995), and the Oral and Written Language Scales ([OWLS]; Carrow-Woolfolk, 1995).

If age-appropriate literacy is a goal, evaluation of student semantic language ability should include the evaluation of the comprehension and/or use of figurative English, which is often encountered in text (King & Quigley, 1985). Estimates of the incidence of nonliteral English in a sample of children's fiction include an average of 38 similes per book and approximately 10 instances of figurative English per 1,000 spoken words (see review by Orlando & Shulman, 1989).

Orlando and Shulman (1989) found that deaf students continued to have difficulty comprehending figurative English (e.g., multiple meanings, similes, metaphors, idioms, and proverbs) throughout the educational years. They attributed this finding to a lack of exposure to figurative English in conversation and not to cognitive dysfunction. To evaluate figurative English, Nielsen and Luetke-Stahlman (2002a) recommended subtests of the CELF test (Semel et al., 1995) and the OWLS (Carrow-Woolfolk 1995).

English Syntax, Deafness, and Reading

The importance of students' development of English grammar when the goal is to read proficiently was documented by Tunmer and Hoover (1992), who published a review of the empirical literature on the topic. In addition, Matluck and Tunmer (1979) examined the relationship of syntax to reading achievement among nonnative-speaking, elementary-aged hearing children and found that students had to attain a threshold of grammatical competence before they could progress in reading English. Cummins (1984) agreed and after extensive review of the second-language acquisition research, estimated that although it takes a student only about 2 years to acquire informal, routine language skills in a second language, it takes approximately 5–7 years to develop cognitive-academic language proficiency in that same language. Thus, if a deaf student is not exposed to grammatically accurate English until he or she enters kindergarten, he or she is not likely to develop age-appropriate English proficiency necessary for reading until the fifth grade. Recent research by Nielsen and Luetke-Stahlman (2002a) supported this estimation.

Few researchers have delineated the extent to which understanding and/or using English morphology and syntax are required for a student to read on grade level. Rubin (1988) studied hearing children and found that inflectional awareness of English was correlated with reading ability (inflections distinguish words such as *run, runs, running,* and *ran* from each other). In fact, awareness of how inflections and derivations change the meaning of English sentences (derivations mark differences in words such as *perfect, imperfect, perfectly*) was discovered to distinguish average and below-average hearing readers by second grade (see research review by Apel & Swank, 1999). In addition, at least three investigators found that poor English morphological awareness contributed to poor decoding skills because morphology is routinely used by hearing children as a word-recognition strategy by third grade (see research review by Apel & Swank, 1999). Leong (1984) also studied third graders and discerned that performance on an English syntactic-semantic task accounted for more reading variance (40%) than did phonological awareness (8%) in the mid-elementary grades. Carliste (1995) described three other studies that evidenced similar results. Menyuk (1983) found that the ability of fourth graders to identify ungrammatical sentences in speech was related significantly to reading achievement as measured by both the Stanford Achievement Test (SAT) and the Gates-MacGinitie reading test.

A profoundly deaf student's acquisition of English usually depends on how it is signed because conversation cannot be heard well enough for him or her to comprehend it and is difficult for deaf students to speechread. One way to measure the grammatical integrity of signed English is the use of a sign-to-voice syntactic ratio (Luetke-Stahlman, 1989). A sign-to-voice ratio of 80–99% has been recommended (Luetke-Stahlman, 1998) to ensure that deaf students have access to gramatically accurate English. Such access has been linked to literacy achievement (Heng, 1998; Luetke-Stahlman, 1988, 1996, 1997; Nielsen & Luetke-Stahlman, 2002a; Mitchell, 1982; Moeller & Johnson, 1988; Schick, 1990; Schick & Moeller, 1992).

One form of signing that preserves grammatical integrity is Signing Exact English (SEE) (Gustason, Zawolkow, & Pfetzing, 1973). This system was invented by a deaf English professor in conjunction with educational interpreters in the early 1970s (Gustason et al., 1973). It was designed so that a sign represents each morpheme of a word (e.g., the word *motorcycle* is represented with one sign, MOTORCYCLE; the words *broke* and *breaking* are signed with two signs each, BREAK + PAST TENSE MARKER; BREAK + ING MARKER). Using SEE, English is signed literally, just as it is spoken, so that a sentence such as "Cut it out" would be signed with the signs for CUT + IT + OUT. When SEE is used, American Sign Language (ASL) semantic concepts do not replace English, as is the case when using Pidgin Signed English (PSE) or Signed English (types of manual communication that also are referred to as "conceptual sign"). That is, "Cut it out" would be signed with the sign for STOP in Signed English or PSE.

No research is available to demonstrate the benefit of signing conceptual ASL signs instead of literal English ones when deaf students are learning to read English (Luetke-Stahlman & Nielsen, in press). Paul and Jackson (1993) found that "ASL is no more sufficient for developing English literacy skills than is Chinese" (p. 138). In 1998, Paul explained that most proponents of ASL-English bilingualism seem to believe that it is possible to learn to read and write English by using ASL to explain aspects of the English language or culture and requiring that students read or write English only. There does not seem to be much evidence to support this assumption for phonetic-based languages such as English.

Additionally, researchers have not reported that deaf students read as well as their hearing peers when enrolled in programs where ASL is used exclusively as an instructional language to teach literacy skills (Andrews, Ferguson, Roberts, & Hodges, 1997; Mahshie, 1995; Padden & Ramsey, 1997; Strong & Prinz, 1997; Prinz & Strong, 1998).

A comprehensive study of literacy, deafness, and signing was sponsored by the National Institutes of Health (NIH) in the 1980s. A team of researchers at Gallaudet University (Moores et al., 1987; Moores & Sweet, 1990) analyzed data from 130 profoundly deaf teenagers—some with deaf parents and some with hearing parents. Neither the grammatical accuracy of their English sign nor that of their teachers was reported. The participants' reading scores from a battery of language and literacy tests ranged from second or third grade to 12th grade and above. Results of a multiple-regression analysis were that four skills accounted for 64% of the variance in the reading achievement of deaf students with deaf parents ($n = 65$). These were use of English grammatical structures; the ability to identify a missing element in a picture; the ability to choose similarities, opposites, and definitions of words; and students' speech perception while using hearing aids. Researchers also analyzed data from signing students with hearing parents ($n = 65$). Five predictors accounted for 77% of the variance in their reading scores: the ability to use English grammatical structures; to choose similarities, opposites, and definitions of words; to pronounce phonemes; to sequence pictures in the correct order; and to perceive the common elements of two terms. The authors summarized these results as suggestive "that knowledge of English grammar and vocabulary, along with the ability to utilize even minimal amounts of auditory input, are highly predictive of the reading skills of deaf adolescents whose deaf parents signed to them since birth" (Moores & Sweet, 1990, p.184), whereas English grammar, vocabulary, and verbal IQ were correlated "most highly with reading" (p. 195) when deaf adolescents had hearing parents. In addition, measures of ASL did "not exhibit high correlations" (p. 195) with reading achievement.

Additional empirical support of the relationship between English grammatical proficiency and reading when students are deaf includes recently published research by Harris and Beech (1998) and Lichtenstein (1998). The correlation of English vocabulary, figurative English, and grammar to reading comprehension also was discussed in detail in reviews of the hearing, bilingual, and deaf research literature by Kelly (1996), Marschark and Harris (1996), Paul (1998), Paul and Jackson (1993), and Quigley and Paul (1984).

Acquisition of Phonological Awareness

In addition to knowledge of English vocabulary and grammar, students who learn to read and write in English have to master an alphabetic script. The development of understanding and use of sound-to-print and print-to-sound associations in decoding new words was researched thoroughly by Linnea Ehri (1980, 1991, 1995), who described several stages of learning to recognize words. These include the progress made by preschoolers and kindergartners who, if provided opportunities to experience print, build an understanding of the orthography of words and begin to orchestrate this knowledge in conjunction with their knowledge of the linguistic English properties of words (Adams, 1990; Ehri, 1980). Deaf children are particularly challenged in this regard, because many cannot hear the words and phrases of spoken English, let alone the individual phonemes that comprise words. Yet Adams (1990) explained that all children who learn to read and write in English *must* learn how the sounds of spoken English map onto letters and letter sequences within words. Beginning readers typically develop an awareness of "parts" and "wholes" at the word level, then at the syllable level, and finally at the phoneme level (i.e., phonemic awareness).

Phonemic awareness is the term given to segmenting, blending, deleting, and substituting sounds in words. Research has indicated that the two most important skills for beginning readers are segmenting and blending (Jorm & Share, 1983; Share, Jorm, MacLean, & Mattews, 1984). Segmenting is the ability to divide a word into its separate sounds, and blending is the ability to combine individual sounds sequentially, thus creating a word.

Fox and Routh (1984) as reported in Copeland, Winsor, and Osborn (1994) found that the reading skills of kindergarten children who were taught combined skills of segmenting and blending "on tasks analogous to reading" (p. 32) were superior to those of children who were taught only segmenting or only blending. Williams (1979) found support for the training of segmenting and blending of phonemes in text for 7- to 12-year-old children with special needs. In addition, Copeland et al. (1994) discerned that phonological training that involved these skills in conjunction with sound-to-print manipulation was more effective than that including only oral blending and segmenting practice.

By the middle to end of first grade, a student who is engaged in age-appropriate reading tasks usually is able to decode common sound-letter patterns. As children continue to learn to read additional words, they refine their understanding of how the sounds of spoken words are mapped onto letters and move their attention to the orthography of letter combinations or word "chunks" to unlock written words (Juel, 1988; Juel, Griffith, & Gough, 1986; Juel & Minden-Cupp, 1999). That is, progressing first-grade readers do not sound out every letter of a new word to figure out how to pronounce it. Instead, they read groups of familiar letter combinations or "chunks" to discern novel combinations of letters. To simulate this stage of development, consider that to read an unfamiliar name of a medication, an adult would not "sound out" each letter (e.g., /r/, /e/, /s/, /t/, /o/, /r/, /i/, /l/ but instead will read parts of the word in sequence to decode the word: /rest/, /or/, /il/). Two decades ago, Quenin (1982) observed "chunking" in profoundly deaf readers. More recently, Transler, Leybaert, & Gombert (1999) confirmed this finding. Children develop word-comprehension ability while reading by combining phonological awareness with short-term memory and the skills of "word identification, classification, sequencing, and association" (Paul, 1998; p. 199).

Phonological Awareness and Deafness

Whether they are deaf or hearing, monolingual or bilingual, normally developing or experiencing cognitive or learning disabilities, beginning readers must learn how sounds of the spoken language are represented by letters or letter sequences within words. Ling (1976) argued that although deaf children do not have complete access to auditory information, they seem to be able to use some cues obtained from the sounds that they hear and speechread combined with the speech articulation training that they have received to discover the relationship between the sound of speech and English orthography. This information allows them to read individual words. Therefore, the development of phonological awareness may be delayed when children are deaf but it resembles that of their hearing peers (Hanson, 1991; Hanson & Fowler, 1987; Miller, 1997). However, Dodd (1974) cautioned that the phonological awareness of deaf students is likely to be underspecified because deaf students often can't hear the phonetic distinctions that hearing children can. Much of the available research regarding phonological awareness and deafness is described in Nielsen and Luetke-Stahlman (2002b).

Cued Speech and Phonological Awareness

Research regarding phonological awareness, reading, and deafness prompted some educators to pair English speech sounds with manual cues so that the phonology of the language was more visually accessible to students who could not hear some or all of spoken English. One such system is Cued Speech, invented by Cornett (1967) as an aid in the development of speech articulation of deaf students. Cornett intended that Cued Speech be used in conjunction with spoken language.

The system consists of the use of eight handshapes that each represent three different sounds. The three sounds appear different when speechread, although the handshape for them is the same. A particular handshape placed in one of four vowel locations on or near the face signals a consonant-vowel pair. For example, the sound /ba/ is spoken and shown by placing the handshape for the /b/ sound in the position were the short /a/ sound is "located." To produce diphthongs (e.g., *oy* as in *boy*), two different vowel locations are executed. (For a more detailed description of Cued Speech, see Luetke-Stahlman, 1998). Whereas only 30% of syllables or words are accessible to deaf students via speechreading alone, 80–90% are available when Cued Speech manual cues are added (see reviews by LaSasso & Metzger, 1998; Quenin, 1992).

Wandel (1989) confirmed that Cued Speech assisted in the acquisition of phonological awareness. Her research evidenced that there was no difference in the reading scores of hearing and profoundly deaf students exposed to cueing as assessed by the SAT. A year later, Alegria, Lechat, & Leybaert (1990) found that Cued Speech assisted deaf students in decoding unknown words while reading. Further, the ability of deaf students to decode was related to their comprehension of the cues and not a factor of their hearing ability.

Leybaert and Charlier (1996) also studied the benefit of Cued Speech. They found that deafness per se did not preclude the development of phonological representation. That is, French deaf subjects exposed to Cued Speech both at home and in school relied on phonological awareness to the same extent as hearing peers when rhyming, remembering, and spelling tasks were analyzed. Leybaert confirmed in e-mail to Luetke-Stahlman that the subjects could not hear speech with the use of hearing aids or other assistive listening devices (March 1999).

Purpose of the Study and Research Questions

A review of the literature resulted in the verification that both phonological awareness and English-language knowledge are related to the reading proficiency of both hearing and deaf students. However, the relationship between phonological awareness abilities of deaf children who were exposed to grammatically accurate English and their ability to read and comprehend passages has not been investigated using tests standardized on hearing peers nor has the influence of background characteristics and program variables been considered in such research. Therefore, this study was designed to address the following questions:

1. Given a battery of tests standardized on hearing children, which English language, phonological awareness, and reading skills are most correlated

with deaf students' ability to read and comprehend passages?
2. Do the background and program variables of students correlate to their passage-comprehension scores?
3. Do the background and program variables of students exposed to grammatically accurate English for 5 or more years (i.e., the Longer Exposure to English Group) differ from those of students exposed to grammatically accurate English for 2 years or less (i.e., the Shorter Exposure to English Group)?
4. Do students in the Longer Exposure to English Group score significantly higher than those in the Shorter Exposure to English Group on measures of English language ability, phonological awareness, and reading?

Methods

Subjects

Students who participated in this study had a profound, unaided hearing loss (91 dB or greater; cannot hear speech without amplification; Flexer, 1999). They also had normal intelligence, no handicapping condition that interfered with learning, hearing parents, and parental permission. None used cochlear implants. To address the first two research questions, 31 students aged 7–17 years were identified in three deaf-education programs that matched these characteristics: a residential and day-school program for deaf children located in the northeastern part of the United States, a day-school program for deaf students located in the northwestern region of the country, and a program housed in numerous public schools served by itinerant teachers in the south-central region of the country. All of the programs strictly adhered to the production rules of the SEE system.

To address the third and fourth research questions, students in a Longer Exposure to English Group were compared with those in a Shorter Exposure to English Group. The students in the Longer Exposure Group were exposed to SEE for 5 or more years; those in the Shorter Exposure Group were enrolled in the same programs for 2 years or less. These divisions were based on the assumption that students who had access to English vocabulary and grammar (i.e., morphology and syntax) for a longer period of time would demonstrate better English language development than would those who had access to it for a shorter time and would therefore be better readers. Students in all programs were represented in the Longer Exposure Group; students in two programs were represented in the Shorter Exposure to English Group.

Procedure

School administrators identified students for the study and secured parental permission for participation. To check the grammatical accuracy of teachers' signing in English, language samples were videotaped as teachers taught students in their classrooms. These were sent to the first author of this article, who calculated sign-to-voice ratios for 25–50 utterances per teacher. A graduate student in deaf education also independently calculated ratios for approximately one third of the samples. Interrater reliability was figured. Coding discrepancies were discussed, and the first author's coding was used when agreement could not be reached.

Teachers supplied demographic data from student folders pertaining to date of birth, gender, ethnicity, age of diagnosis of hearing loss, and so forth. They also rated the socioeconomic (SES) status of their students using the subjective categories of "poor," "low-middle," "mid-middle," and "high-middle" class. They also rated parents' ability to sign, given four subjective categories of "no signing ability," "beginner," "intermediate," and "advanced." Finally, teachers subjectively rated each student's speech intelligibility using a rating score of 1–4 (4 being highly understandable). Frequencies and percentiles of background data were figured by the first author.

To find a measure of phonological awareness that would identify differences between subjects, two standardized tests were administered. Given the Test of Phonological Awareness (Torgesen & Bryant, 1994), almost all students were able to match the beginning phoneme of a target word to another word beginning with the same sound. On the same measure, most were able to match the final phonemes of target words without an error. Five subtests of the Phonological Awareness Test (PAT; Robertson and Sattler, 1997) were administered to measure the substitution, segmenting, and blending of phonemes. Also administered were measures of receptive, expressive, and written English (i.e., OWLS; Carrow-Woolfolk, 1995) and reading (i.e., Woodcock Reading Mastery Test [WRM]; Woodcock, 1998). The WRM-Visual-Auditory Learning subtest, which required the association of unfamiliar visual symbols with words, was given to measure short-term memory.

A program professional administered the battery of 15 subtests to students individually and figured percentile or percentage scores. Percentage scores were figured for the PAT because the ages of some of the subjects were greater than those provided to figure percentile scores. Assessment materials were then sent to the authors and rechecked before they were entered into a computer database. Information about the programs in which the students were enrolled was gathered from program administrators, who were asked several questions about language and literacy program policies.

Analysis and Results

In this section, findings related to background and program characteristics of interest are presented, followed by the results of analyses organized by research question.

Background Characteristics

The 31 subjects for the study included 9 students enrolled in public-school general education classrooms who received itinerant services and 22 students who received instruction in contained deaf education programs. In the total sample, 77% were white and 23% minority; 52% were boys and 48% girls. Most parents were rated as intermediate signers (52%), followed by those rated as beginner signers (29%), advanced signers (13%), and parents who did not sign (7%). Given four rankings of SES, most parents were rated as low-middle class (39%), followed by middle-middle class (36%). There was an equal number of families rated as living in poverty as there was rated upper-middle class (13%).

Program Characteristics

Students for this study were enrolled in three geographically diverse deaf education programs committed to the use of the SEE sign system. They are referred to as Programs I, II, and III throughout this article. Personal communication with program administrators confirmed that grammatically accurate spoken and signed English use was expected in each program. Regular training sessions were scheduled to practice specific structures and to reinforce the rationale for signing in this manner. For two programs, administrators regularly transcribed teacher language samples and figured sign-to-voice ratios annually.

Sign-to-voice ratios for this study were figured for the teachers primarily working with the students in the three programs. Interrater reliability was 95%. The mean of the grammatical percentages of 13 staff members in Program I was 92% (with a range of 86–99%); the mean of the ratios of four staff members in Program II was 85% (with a range of 80–95%); and the mean of the five teachers in Program III was 80% (with a range of 76–95%).

Seventy-one percent of students who participated in the study were educated in a contained classroom and taught by a teacher of the deaf. Twenty-four percent were educated in a public-school classroom taught by a general education teacher and seen regularly by a teacher of the deaf. An analysis of covariance (ANCOVA) was run to investigate the passage comprehension of students ($n = 9$) who were enrolled in public-school general education classrooms and received itinerant services, as compared with those ($n = 22$) who received instruction in contained deaf education programs. The variable of "age of identification of hearing loss" served as the covariate in the analysis (the reasons for which are explained below). Results were that there was no significant difference in passage-comprehension abilities of the two groups of students controlling for age of identification of hearing loss.

Information gathered about the programs also revealed that an indeterminable number of students from one program may have received instruction from paraprofessionals about sound-symbol associations during the earlier years of their elementary education.

To analyze the possible effect of having received phonological training, student (n = 9) percentile scores from the WRM-Passage Comprehension subtest were compared with those of students who did not receive such training (n = 22) using an ANCOVA procedure. Again, the variable of "age of identification of hearing loss" served as a covariate. Results were that those who might have received phonological training comprehended passages significantly better than those who had not received training (p { .0001, see Table 1.) The group mean on the WRM-Passage Comprehension of those who might have received phonological training was 46.5 (of a possible 68); the mean of those who had not received training was 7.1. These students were in both the Longer Exposure to English Group and the Shorter Exposure group (see *Results Organized by Research Question*).

Results Organized by Research Question

Research Question 1: Given a battery of tests standardized on hearing children, which English language, phonological awareness, and reading skills are most correlated with deaf students' ability to read and comprehend passages? The total number of students whose passage-comprehension scores were analyzed by Pearson correlations for the comparisons varied somewhat (n = 27–31) due to a few missing scores on some of the subtests.

Using Marasciulo's (1971) categories for examining strength of the correlation, several variables were "very strongly" correlated with students' WRM-Passage Comprehension subtest percentile score. These were performance on two reading subtests, the WRM-Word Comprehension (r = .970; p = .0001) and Word Identification (r = .832, p = .0001) subtests and the PAT-Substitution [of phonemes] without Manipulation subtest (r = .826, p = .0001). That is, students who scored high on the passage-comprehension subtest also scored significantly higher on three subtests as compared with other measures: they could provide synonyms, antonyms, and analogies of read words and phrases; read more listed words; and substitute one phoneme for another to create new words without using blocks to represent sounds.

"Strongly" correlated with students' comprehension ability was performance on two of the PAT subtests, Blending Phonemes (r = .723, p = .0001) and Syllables (r = .720, p = .0001), as well as the OWLS written language subtest (r = .702, p = .0001) and one WRM-Letter Identification subtest (r = .700, p = .0001).

"Moderately" correlated with students' comprehension ability was performance on two PAT subtests, Syllable Segmentation (r = .66, p = .0002) and Phoneme Segmentation (r = .648, p = .0003; the OWLS expressive English subtest (r = .557, p = .0011); and two additional PAT subtests, Substitution with Manipulation (r = .532, p = .0043), and Segmentation of Sentences (r = .42, p = .029*)*. "Weakly" correlated with students' comprehension ability was performance on the OWLS receptive English subtest, Listening Comprehension (r = .387, p = .034).

Research Question 2: Do the background and program variables of the students correlate to their passage-comprehension scores? Results of a correlational analysis showed no significant correlation between passage comprehension and age, gender, ethnicity, SES, parent signing ability, educational placement, unaided and aided pure-tone average (PTA), speech intelligibility, use of a frequency modulation (FM) listening device, or age at time of testing—with the exception of the variable of "age of identification of hearing" (p = .083). This was not because some children were identified *later* than others but because the age of identification of hearing loss was unknown for some students. Thus, a conservative analysis procedure was adopted because (a) the variable of "age of identification of hearing loss" was unknown for some of the students, (b) significant differences were found in some cases between the age of identification of hearing loss and other variables, and

Table 1 Means adjusted (for deafness identified before 2 years of age) and standard deviations for students in the Phonological Awareness (PA) possibly facilitated or PA not directly facilitated groups

Dependent variable	PA facilitated, n = 9	PA not facilitated, n = 22	p Value from ANCOVA
Passage comprehension	45.3	7.7	.0001

Note. ANCOVA = analysis of covariance.

(c) it was unknown whether students in the Shorter Exposure to English Group had an advantage or a disadvantage in opportunity to develop English language abilities, compared with those students in the Longer Exposure to English Group. To ensure that knowledge of age of identification did not contribute inappropriately to any result reported as significant, the variable of age of identification of hearing loss was covaried when ANCOVAs were computed.

Research Question 3: Do background and program variables of students exposed to grammatically accurate English for 5 or more years (i.e., Longer Exposure to English Group) differ from those of students exposed to grammatically accurate English for 2 years or less (i.e., Shorter Exposure to English Group)? Percentages for each background characteristic were figured and appear in Table 2. For example, students in the Longer Exposure to English Group (n = 22) were on average 11.6 years old (range 7.7–17.7 years). Students in the Shorter Exposure to English Group (n = 9) were on average 12.5 years of age (range: 9.0–15.2 years). ANCOVA procedures resulted in a finding of no significant differences between groups.

Research Question 4: Did students in the Longer Exposure to English Group score significantly higher than those in the Shorter Exposure to English Group on subtests of English language ability, phonological awareness, and reading? An ANCOVA was computed to investigate whether there were differences between the scores of the two groups on any of the language, phonological awareness, or reading subtests. As explained in *Program Characteristics,* the variable of age of identification of hearing loss served as a covariate.

Results were that students in the Longer Exposure Group scored higher on all 15 subtests than did those in the Shorter Exposure Group. Differences were significant for about half of the subtests: the WRM-Visual-Auditory Learning subtest (p = .089), which served as a short-term memory gauge; the OWLS receptive (p = .026) and expressive (p = .003) English language subtests; and three PAT subtests: segmenting sentences into words (p = .006), substituting phonemes using blocks to represent sounds (p = .002) and without blocks (p = .087), blending syllables into words (p = .056), and blending phonemes into words (p = .048). Adjusted means for the battery are listed in Table 3.

Group mean scores did not differ on any of the reading subtests (see Table 4), on the OWLS subtests (see Table 5), or on three of the PAT scores (see Table 3). However, the scores of students in the Longer Exposure group were always higher (for example, see Table 6). Four students in the Longer Exposure Group scored above age level on the passage-compression subtest.

Highest performers. Three subjects scored above average, compared with hearing norms. All had profound hearing losses that were identified before the age of 2 years, wore binaural aids, used an FM system at school, and had parents rated as intermediate signers. The students had variable speech intelligibility (2–4 ratings). All had usable hearing in the mild range (i.e., 25, 30, 32, 43 dB), although Flexer (1999) cautioned that the educational disadvantages of such losses are not minimal. Expressive English abilities were well within the average range (50th, 81st, and 84th percentiles), and all scored well on the short-term memory measure. The phonological manipulation subtest scores were within the 60–90 percentile range for segmenting phonemes, 60–100 percentile range for substituting phonemes without manipulatives, and 40–90 percentile range for blending phonemes.

Lowest performers. Data from eight students in the Longer Exposure Group who scored the lowest (.01–2.0 percentile) on the WRM-Passage Comprehension measure are presented in Table 7. Figures in this table require some explanation. According to Woodcock (1998), the percentile rank table used to interpret WRM subtest scores includes extended percentile ranks. If a subject's percentile rank is .01, for example, this indicates not only that the score is below the first percentile (1.0 or 1 percentile) but also that during the standardization testing, only one child of 1,000 achieved a score this low or lower. Thus, the Table 7 figures are not analogous to those obtained when converting decimals to percentages.

All eight of the lowest performing Longer Exposure Group students were enrolled in Programs II and III. Ages of the three girls and five boys ranged from 9.1 to 17.6 years. All were profoundly deaf when unaided but their aided hearing acuity varied considerably (from 30 to 78 dB or "mild" to "severe" losses; Flexer, 1999). The

Table 2 Percentages for background characteristics of participating students (means provided where appropriate)

Group	Age (years)	Unaided R PTA (dB)	Unaided L PTA (dB)	Aided average (dB)	Hearing & cochlear implant use	FM rating	Speech intelligibility	Speech min/week
Shorter exposure	9.0–15.2 (*M*=12.5)	*M* = 94, Range = 68–105	*M* = 98, Range = 95–100	*M* = 65, Range = 45–110	1 student with zero hearing aids, 2 students with one hearing aid, 3 students with two hearing aids, and 3 students with one hearing aid and one cochlear implant	Yes = 44%, No = 56%	*M* = 2.6, Range = 1–4	*M* =70
Longer exposure	7.7–17.7 (*M* = 11.6)	*M*= 94, Range = 63–117	*M* = 96, Range = 53–120	*M* = 49, Range = 27–78	3 students with zero hearing aids, 3 students with one hearing aid, 15 students with two hearing aids, and 1 student with cochlear implant	Yes = 56%, No = 45%	*M* = 2.4, Range = 1–4	*M* = 71

Note. FM = frequency modulation; LPTA = left-ear pure tone average; RPTA = right-ear pure tone average.

Table 3 Adjusted (for deafness identified before 2 years of age) means for students in the longer exposure to English group compared with students in the shorter exposure to English group

Dependent variable	Longer exposure to English group ($n = 22$)	Shorter exposure to English group ($n = 9$)	p Value from ANCOVA
Visual-Auditory subtest	68.4	43.3	.089
Letter Identification	25.1	25.6	.97
Word Identification	15.4	13.6	.848
Word Comprehension	19.5	14.8	.670
Passage Comprehension	20.9	13.0	.471
OWLS-Listening Comprehension (Receptive)	28.8	1.8	.003
OWLS-Oral Expressive	35.4	0.6	.026
OWLS-Written	27.0	22.0	.673
Segment sentences into words	9.3	5.9	.006
Segment syllables into phonemes	7.1	5.9	.374
Sound changed using blocks	7.8	3.1	.002
Sound changed without blocks	4.7	1.8	.087
Blend syllables	5.0	2.2	.056
Blend phonemes	3.8	1.4	.048

Note. OWLS = Oral and Written Language Scales.

Table 4 Rounded group mean percentile scores for the Woodcock Reading Mastery subtests

Group	Visual-auditory (percentile)	Letter ID (percentile)	Word ID (percentile)	Word comprehension (percentile)	Passage comprehension (percentile)
Shorter exposure	44	23	12	11	8
Longer exposure	78	34	16	29	30

median speech intelligibility rating was 2 (of a possible 4) but one subject was rated 4, or "highly understandable." The OWLS receptive scores of four of the students were within the below-average range; four were within the average range (although one of those, 80th percentile, was almost above average). All but one of the eight students scored lower on the expressive subtest than on the receptive subtest. Again, four of these scores were within the below-average range, and a fifth score was very low average. The three remaining scores were within the average range.

The phonological awareness ability of the lowest performing subjects with regard to their ability to segment phonemes was less than 50% for five of the seven students (one student was not tested). Scores for substituting phonemes without manipulating blocks was less than 30% for all who were administered the subtest. Students' ability to blend phonemes was less than 50% for all but one student (see Table 7).

Mini-case studies. Information was compiled on four students in a case-study format to provide additional discussion opportunity (see Table 8). Two students were picked who scored high on the WRM-Passage Comprehension subtest, and two were picked who scored low. Two students were in the Longer Exposure to English Group (Students A and B) and two were in the Shorter Exposure to English Group (Students C and D).

Students A and C (Longer-High and Shorter-High) scored well on the WRM-Passage Comprehension subtest (89th percentile and 55th percentile, respectively) and relatively well on the other subtests. Students B and D (Longer-Low and Shorter-Low) showed little comprehension of WRM passages even at the sentence level (percentile scores were .1 percentile and .01 percentile, respectively) and scored relatively low on the other subtests as well.

Students A and C were judged to be similar in several ways. Both were boys, used English at home and school, and had parents who were intermediate SEE

Table 5 Group mean percentile scores for the Oral and Written Language Scales

Group	Receptive English Listening Comprehension (percentile)	Expressive English Oral Expression (percentile)	Written Expression[a] (percentile)
Shorter exposure	44	3	16
Longer exposure	35	28	29

[a]According to the test manual, <25 is a weakness.

Table 6 Group mean percentage correct for the Phonological Awareness Test

	Segmenting sentences	Segmenting syllables	Segmenting phonemes	Substitute with manipulation	Substitute without manipulation	Blending syllables	Blending phonemes
Shorter exposure	55%	53%	20%	28%	12%	17%	12%
Longer exposure	95%	74%	45%	80%	50%	53%	39%

signers. Student A had always been enrolled in his current SEE program. Student C was in the SEE program for preschool, spent several years in a program in which English was not signed (and in which PSE-ASL was used), then reenrolled in the SEE program. At the time of the study, both students attended the same program, one in which some phonological training inconsistently occurred in earlier grades. Both students also were identified to have a hearing loss before the age of 2 years, wore binaural hearing aids, were taught by a teacher of the deaf and not a general education teacher, and had 75 min per week of speech instruction in a group.

Students A and C differed in several ways as well. Student A was rated to be of a higher SES status and had a mild aided (PTA; 32 dB)—a misleading label, according to Flexer (1999), "as the child can miss 25–40% of language spoken to him, depending on the noise level in the room and his distance from the speaker" (p. 44). In contrast, Student C, who had a severe aided PTA (85 db), was not able to hear speech even while wearing an assistive listening device. Student A did not use an FM system; Student C did. Teachers rated the speech intelligibility of Student A as 2 of a possible 4, with 4 being very understandable speech. Student C was rated as 3.

Student A (Longer-High) scored higher than Student C (Shorter-High) on every measure. Although Student A was 7.7 years old, he was reading at the 9.7-year age equivalent (AE). His passage-comprehension score (89th percentile) was 34 percentile points higher than that of Student C (Shorter-High; 55th percentile), although he was 2 years younger. Student C was 9.3 years old and reading at the 11.9-year AE level, as indicated by tables in the test manual (Woodcock, 1998). Thus, both "high" readers performed above grade level in their ability to comprehend text when hearing norms were referenced.

With regard to English language abilities, the scores of the two above-average readers differed observably from each other on all three English language subtests. Differences favored Student A (Longer-High), who scored within the 39th percentile on the receptive English subtest, within the 84th percentile on the expressive English subtest, and within the 88th percentile on the written subtest. Student C (Shorter-High) scored within the 12th, 13th, and 50th percentile, respectively. Student A also was better able to segment phonemes, blend phonemes, and substitute phonemes without manipulation (60%, 50%, 100%) than was Student C (30%, 40%, 70%).

With regard to the students with "low" passage-comprehension scores, both Student B (Longer-Low) and Student D (Shorter-Low) scored below average on the WRM-Passage Comprehension subtest (.1, .01 percentile, respectively). Their raw scores were equal to the reading ability of 5-year-old nonreaders, although they were 10.8 and 9.3 years old, respectively. Students B and D were also both Caucasian and used English at home

Table 7 Background information for students in the Longer Exposure Group who scored lowest on the Passage Comprehension subtest

Age	Gender	SES	Aided PTA (dB)	FM system use	Parent signing ability	Ethnicity	Reading comprehension percentile	OWLS Receptive percentile	OWLS Expressive percentile	Segment phonemes percentage correct	Substitute without manipulation percentage correct	Blend phonemes percentage correct	Speech intelligibility #/4
9.4	M	mid-mid	55	Yes	Interm. ASL	White	.01	0.2	.01	70%	0%	20%	1/4
11.3	F	mid-mid	45	Yes	Begin. ASL	Hispanic	1.0	1.0	.01	30%	0%	20%	1/4
17.6	M	upper-mid	30	No	Adv. English	White	0.1	27.0	19.0	Did not take test	Did not take test	Did not take test	4/4
13.6	F	low-mid	55	Yes	Begin. English	Hispanic	2.0	2.0	.01	70%	20%	0%	2/4
9.8	F	poverty	65	No	Begin. English	White	1.0	9.0	3.0	20%	30%	50%	3/4
10.8	M	low-mid	78	Yes	Interm. English	White	0.1	58.0	41.0	10%	0%	10%	2/4
9.1	M	low-mid	65	Yes	Interm. English	White	0.1	80.0	42.0	0%	0%	0%	2/4
9.10	M	mid-mid	45	Yes	Interm.	White	0.1	70.0	72.0	20%	0%	3%	2/4

Note. ASL = American Sign Language; FM = frequency modulation; OWLS = Oral and Written Language Scales; PTA = pure tone average; SES = socioeconomic status.

Table 8 Background characteristics and scores of four students

Subtest and background variables	High Passage Comprehension score: Longer exposure Student A	High Passage Comprehension score: Shorter exposure Student C	Low Passage Comprehension score: Longer exposure Student B	Low Passage Comprehension score: Shorter exposure Student D
Age	7.7	9.3	10.8	9.3
Pass. Comp. grade equivalent	4.2	5.9	kindergarten	kindergarten
Pass. Comp. age equivalent	9.7	11.9	5–0	5–0
Pass. Comp. percentile	89	41	.1	.01
Gender	male	male	male	female
Home language	English	English	English	English
Ethnicity	Asian	Caucasian	Caucasian	Caucasian
SES	mid-middle	low-middle	low-middle	mid-middle
Parent signing ability	intermediate	intermediate	intermediate	beginner
Main teacher	teacher of the deaf	teacher of the deaf	general education	general education
Age of identification	<2 years	<2 years	<2 years	unknown
Unaided PTA	profound	profound	profound	profound
Aided PTA	32 dB	85 dB	78 dB	45 dB
Time in speech/week	75 min	75 min	75 min	60 min
FM Use	No	Yes	Yes	No
OWLS-Receptive English percentile	39	12	58	1
OWLS-Expressive English percentile	84	13	41	.1
OWLS-Written English percentile	88	50	10	25
Segmenting phonemes	60%	30%	10%	0%
Blending phonemes	50%	40%	10%	0 %
Subst. phonemes with manipulation	100%	70%	10%	0 %
Subst. phonemes without manipulation	100%	70%	0%	0%
WRM Word Identification percentile	83	63	2	.3
WRM Word Comprehension percentile	89	55	.1	.01
WRM Passage Comprehension percentile	92	41	.1	.0

Note. FM = frequency modulation; OWLS = Oral and Written Language Scales; Pass. Comp. = Passage Comprehension; PTA = pure-tone average; SES = socioeconomic status; WRM = Woodcock Reading Mastery Test.

and school. They were taught in the same program (which differed from the one in which the "high" students were enrolled). Both were served by itinerant teachers.

Students B and D differed in several ways as well. Student B (Longer-Low) was a boy, had a parent who was an intermediate SEE signer (Student D's parent was judged to be a beginner), was identified as deaf before the age of 2 years (the age of identification of Student D was unknown), wore two hearing aids (Student D wore one), and used an FM system (Student D did not). Student B had an average aided-hearing acuity of 78 dB as compared with Student D's acuity of 45 dB. A 78 DB loss is considered "severe," and a 45-dB loss is considered to be "moderate" (Flexer, 1999, p. 44).

Student B (Longer-Low) scored observably higher than Student D (Shorter-Low) on all three OWLS subtests: within the 58th percentile on the receptive, within the 41st percentile on the expressive, and within the 10th percentile on the written subtests. Student D scored within the 1, .1, and 25th percentiles, respectively. However, neither student scored well on the phonological awareness subtests. Their abilities to segment phonemes, blend phonemes, and substitute phonemes without manipulation were 10%, 10%, 10% and 0%, 0%, 0% (Students B and D, respectively).

Student B had always been enrolled in the same deaf-education program, whereas Student D began her education in an oral program and remained there for several years before receiving interpreted instruction in SEE.

Discussion

This study was planned with the knowledge that independent word recognition and comprehending at multiple levels of text difficulty—the tasks of reading—require the same acquisition of skills, whether a child is hearing or deaf, monolingual or bilingual. Society does not provide deaf students or adults with a special type of text to read because they cannot hear some or all of the sounds of speech. Rather, deaf students must learn to read as their hearing peers do, albeit perhaps using some different strategies. Therefore, it is not surprising that in general, the results of this study parallel those found in many past empirical projects and those emphasized in recent nationally funded, comprehensive efforts.

Results of this study found that the ability of deaf students to read and comprehend passages "very strongly" (Marasciulo, 1971) correlated with their ability to comprehend words, to identify words, and to substitute one phoneme for another with and without the use of blocks to represent sounds. The ability of deaf students to read was "strongly" correlated with their ability to blend phonemes and syllables, to segment sentences into words, and to express themselves in written English. "Moderate" correlations included segmenting words into syllables and phonemes, making substitutions using manipulatives, and segmenting sentences. Research in support of each of these is discussed below.

Word Comprehension

Proficient deaf readers could provide more synonyms, antonyms, and analogies than could deaf readers who read poorly. Many previous researchers found that reading achievement correlated with word comprehension (Adams, 1990; Allen, 1986; Ehri, 1980; Juel & Minden-Cupp, 1999; LaSasso & Davey, 1987; Nielsen & Luetke-Stahlman, 2002a; Paul, 1984, 1996; Quigley et al., 1978). The skills are facilitated by the design of the SEE system, in which synonyms are cued by initial-letter signs (e.g., the words TREE, FOREST, JUNGLE, ORCHARD, and WOODS are signed similarly but differ in the use of the signed handshapes T, F, J, O, and W).

Word Identification

Better deaf readers could read more words than deaf readers who read poorly. Past studies also found that word identification correlated with reading achievement (Adams, 1990; Conrad, 1979; Gibbs, 1989; Hanson, 1989; Hanson & Fowler, 1987; Hanson, Liberman, & Shankweiler, 1984; Lichtenstein, 1998; Marschark, 1993; Orlando & Shulman, 1989; Paul, 1998; Pressley, 1998; Quenin, 1982; Tzeng, 1993).

Phoneme Manipulation

Better deaf readers could manipulate phonemes more proficiently than deaf readers who read poorly. Because the connection between phonological awareness and reading achievement has been supported in the research literature by Adams (1990) and others (Bebko, 1998; Bus & van IJzendoorn, 1999; Campbell, 1992; Conrad, 1970; Copeland et al., 1994; Fleetwood & Metzger, 1998; Griffith, 1991; Hanson, 1989; Harris & Beech, 1998; Jorm & Share, 1983; King & Quigley, 1985; Kelly, 1996; Leybaert & Algeria, 1995; Leybaert & Charlier, 1996; Lichtenstein, 1998; Locke & Locke, 1971; Marschark, 1993; Mayer & Wells, 1996; Nielsen & Luetke-Stahlman, 2002a; Paul, 1998; Paul & Jackson, 1993; Sallop, 1973; Schaper & Reitsma, 1993; Share et al., 1984; Williams, 1979; Yopp, 1988), it is not at all surprising that in our study, scores on the PAT correlated to reading achievement. In addition, nine students who may have had inconsistent phonological instruction read significantly better than subjects who did not have phonological instruction.

In addition, we found that the Test of Phonological Awareness (Torgesen & Bryant, 1994) on which children were required to identify the beginning and ending sounds of words did not differentiate students. All students did well on it. However, differences *were* found when more involved measures of phonological awareness were assessed using the PAT (Robertson & Sattler, 1997) that involved phonological manipulation, the construct that previous research findings predicted would matter.

When students in a Longer Exposure to English Group were compared with those in a Shorter Exposure Group, word identification and word comprehension did not significantly differ. Instead, significantly different comparisons were those of (a) short-term memory, (b) receptive and expressive English language abilities, and (c) the three PAT subtest scores. However, discussion of these results should be tempered by a reminder that there were only a small number of students in the

Shorter Exposure Group and that exposure to SEE does not provide phonological information.

Short-Term Memory Abilities

Students in the Longer Exposure Group had a mean Visual Auditory Learning score, used in this study as a measure of short-term memory, that fell within the 68th percentile, as compared with those in the other group, who had a mean within the 44th percentile. These scores are both within normal limits and yet differentiated the two groups of subjects. Because there is no obvious relationship between the use of SEE and short-term memory, this finding warrants further study.

Receptive and Expressive English Language Abilities

Students in the Longer Exposure Group had significantly better receptive and expressive English language abilities than did those in the Shorter Exposure Group. This is a logical finding, assumed to be due to the length of the time that students were immersed in grammatically accurate English language via SEE. Given the relationship between English grammar and reading achievement repeatedly documented in the research literature (Apel & Swank, 1999; Babb, 1979; Brasel & Quigley, 1977; Carliste, 1995; Leong, 1984; Nielsen & Luetke-Stahlman, 2002a; Rubin, 1988), it is logical that deaf students with better cognitive-academic English abilities would be better readers (Heng, 1998; Luetke-Stahlman, 1988, 1989, 1996, 1997; Mitchell, 1982; Moeller & Johnson, 1988; Nielsen & Luetke-Stahlman, 2002a; Schick, 1990; Schick & Moeller, 1992).

However, those interested in assisting deaf students to read on grade level also must consider the eight students who were the lowest readers in the Longer Exposure Group. These students were enrolled in a program with the lowest teacher sign-to-voice SEE sign ratios and had not received phonological training in the past. The road to proficient reading is not simply paved with SEE, although access to accurate grammar appears a necessary but not sufficient condition.

Many of the low readers in the Longer Exposure group also had low receptive and expressive English language abilities. This finding suggests that future research might investigate the value of cognitive-academic English proficiency, not just grammatically correct English (Dickinson et al., 1993; Nagy et al., 1985; Nielsen & Luetke-Stahlman, 2002a; Snow et al., 1984; and Tabors, 1996).

Reading Subtest Abilities

Although the reading percentile scores were higher for the Longer Exposure Group, there were no significant differences on any of the reading subtest scores between the two groups of students, and all but four of the students scored below age level. This finding might be explained by the documented difficulty that deaf children have shown historically with regard to breadth and depth of word identification and comprehension skills (Allen, 1986; Kelly, 1995; LaSasso & Davey, 1987; Paul, 1984, 1996; Quigley et al., 1978), which the designers of the SEE sign system had hoped to eradicate. Reading difficulty also might have been affected because 29% of the parents were rated as demonstrating only beginning sign ability, although some of the lowest scoring Longer Exposure Group subjects had parents rated as intermediate (4 sets of parents) or advanced (1 set of parents).

Because most students were able to identify the letters of the alphabet, there was not a significant difference demonstrated between the two groups for this subtest. There was also no significant difference demonstrated for the Word Attack subtest, possibly because the measure required the decoding of nonsense words using phonetic and structural cues and thus required excellent articulation skills. In terms of comprehension, most of the students who participated in this study understood text at a level that was *below* the level expected in comparison with their hearing peers. The discrepancy between chronological age and reading age equivalent for students in the Longer Exposure to English Group was about 3 years; for those in the Shorter Exposure Group, it was about 7 years. Both are unacceptable if deaf students are to learn the same material required of their hearing classmates. The mean of the passage-comprehension scores for the Longer Exposure Group equated to 8 years, or mid-second-grade level (which is essentially the ability to comprehend simple chapter books), although some of the oldest children in this group were middle-school and high-school aged.

The characteristics of the four students who scored above the norms for their hearing peers might be worthy of consideration. The prediction based on prior research findings (discussed earlier) was that the three highest readers *would* be able to manipulate phonemes, whereas the eight lowest readers (in the Longer Exposure Group) would not be able to do so. This prediction is possible because research has shown that skilled readers have phonological awareness *and* proficiency in English and *not* because the SEE system provides phonological information. All of the lowest readers scored below 50% on the tasks of segmenting, blending, and substituting phonemes without manipulating blocks—a finding that we hope will not escape those interested in assisting more deaf students in reading on grade level. Immersion in grammatically accurate English for 5 or more years is not enough to offset the need for phonological training when reading proficiency is a goal (Adams, 1990; Jorm & Share, 1983; Share et al., 1984; Snow et al., 1998)—no matter whether a student is deaf or hearing (Paul, 1998). Case study data helped to explain the importance of both expressive English skills and the ability to manipulate phonemes.

Limitations

This study might have controlled for reading instruction. Perhaps results would have been clearer if a greater number of students had participated. This said, researchers will especially appreciate the difficulty of locating 31 students with detailed background and assessment information of the type used here.

Conclusion

Results of this study indicate that deaf students who read better than other deaf students can provide synonyms, antonyms, and analogies of read words and phrases; read more listed words; and manipulate phonemes. They have better receptive and expressive English abilities than do deaf students who read less well. Further, it appears that exposing a deaf student to a grammatically accurate sign system for at least 5 years does not guarantee age-appropriate reading, writing, and spelling skills. Instead, results of this study indicated that better deaf readers possessed both cognitive-academic English proficiency and phonological awareness skills. Because exposure to SEE does not provide the latter, we recommend the inclusion of Cued Speech or Visual Phonics in programs where reading proficiency is a goal. Further research is warranted to investigate whether these are the abilities that when targeted for intervention will assist beginning and below-average deaf readers to attain the literacy abilities of their hearing peers. Tremendous promise for the 21st century lies in the rich foundation of literacy research amassed during the 20th century. Deaf students should not be excluded from its benefit.

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Received June 20, 2002; revisions received January 3, 2003; accepted January 20, 2003