The Use of ASL to Support the Development of English and Literacy

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The purpose of this article is to review research dealing with the use of ASL in teaching English and literacy. I review some of the literature (and direct readers to additional sources) that indicates that early learning of ASL need not create concerns for future development of English structure, speech, or other cognitive skills. I also suggest ways in which ASL can contribute directly to developing more of the high-level skills needed for fluent reading and writing. The global benefit of learning ASL as a first language is that it creates a standard bilingual situation in which teachers and learners can take advantage of one language to assist in acquiring the other and in the transfer of general knowledge. As part of this discussion, I compare English and ASL as natural languages for similarities and differences.

Does American Sign Language (ASL) interfere with deaf students' acquisition of English? Consider the steps necessary to prove that it does. One would have to demonstrate that specific errors in deaf students' English could be attributed to aspects of ASL and to no other source, which means that other sources would have to be investigated and ruled out. Then, and only then, could it be determined whether sign language interference accounted for the errors that remain to be explained. When I began to approach this task from a linguist's perspective, the research plan was to (1) ana-

lyze deaf students' reading and writing errors; (2) determine which errors could be attributed to typical acquisition errors made by young hearing children; (3) determine which errors could be attributed to typical errors made by second-language learners acquiring English; (4) consider any other linguistic factors that could be contributing to learning difficulties, such as theoretical complexity or quirks of English structure; and (5) then eventually examine the structure of ASL and its possible role with respect to English acquisition.

When these objectives were pursued systematically, the results were clear and dramatic: ASL was not the source of the problem. In a 1975 review of the implications of these results, Veda Charrow and I pooled our separate lines of investigation (see also Charrow, 1975), and concluded that it might be more realistic, and successful, if procedures similar to the ones used in bilingual education programs for minority children were followed in teaching English to deaf children. Ideally, in the earliest years, deaf children should learn ASL. Once ASL is established as a means of communication, teachers can then use it as a medium of instruction for all subjects, including English, which can be taught along with speech, speechreading, and reading. Such a program would require that more teachers be fluent in ASL, which would in turn require that biases against ASL be discarded. A first step, then, would be to train more teachers of the deaf to use ASL and understand its structure, and to improve the attitudes of all persons—deaf and hearing, teacher and student—

toward ASL (Charrow and Wilbur, 1975, p. 358).[1] I present here a review of the research on cognitive abilities, performance, and structure of ASL, information that can be integrated into suggestions for ways that ASL can be used to foster English literacy in the deaf.

Deaf Students as Literacy Learners

General Background to the Problems in Reading and Writing

The overall difficulty that deaf children have learning English has been very well documented (Quigley and Kretschmer, 1982; Quigley and Paul, 1984; Wilbur, 1979, 1987). As a general observation, by age 18, deaf students do not have the linguistic competence of 10-year-old hearing children in many syntactic structures of English (Fruchter, Wilbur, & Fraser, 1984; Quigley, Montanelli, & Wilbur, 1976; Quigley, Wilbur, & Montanelli, 1974, 1976; Wilbur, 1980; Wilbur, Goodhart, & Fuller, 1989). Studies report that less than 12% of deaf students at age 16 can read at a fourth-grade reading level or higher as measured on the Metropolitan Reading Achievement Test (Furth, 1966a; Office of Demographic Studies, 1972).

By the time hearing children begin to learn to read, they already have conversational fluency in their native language and can be taught to transfer this knowledge to reading. Deaf children who have lost their hearing at an early age do not have this knowledge; thus, they do not come to the reading task with the same skills in sentence formation, vocabulary, and world knowledge as hearing children. Even though young deaf students have not yet fully developed competence in the spoken language, techniques for teaching them to read do not differ substantially from those used with hearing children. Students are taught to make letter-sound or whole word-sound associations, using whatever residual hearing and speech skills may be available. Beginning deaf readers are expected to be able to read out loud, not only as a means of teaching reading but also as a way of working on speech skills. This is true in both oral and total communication programs; in the latter, children may also sign the sentences "out loud" but the primary strategies for teaching reading focus on some form of sound recoding. Studies of deaf read-

ers show that sound recoding is used by some for reading and memory purposes, but that other strategies are also present. These other strategies include recoding to signs, to fingerspelling, and to an internal representation of the printed letters ("graphemic recoding"). Sound recoding seems to be used more by deaf people whose hearing loss is not as severe, who have better speech skills, who score higher on intelligence tests, and who have higher educational achievement (these latter both contribute to and result from better reading ability; summary of relevant studies in Hirsh-Pasek & Treiman, 1982). Sign recoding is used more frequently by native signers and individuals who do not meet the characteristics above. Most deaf people show indications of using more than one strategy. However, the benefits of these other strategies are not systematically called upon in current programs for the teaching of reading (Wilbur & Nolen, 1986b).

Deaf children who have deaf parents (less than 10% of all deaf children) who use sign language at home are an apparent exception to the generalizations about deaf children's reading ability, because they have a fully established language base prior to learning to read. These children are more similar to hearing children who must learn to read and write in a second language (Charrow and Fletcher, 1974), and their performance on such tasks tends to be better than deaf children who have hearing parents and who did not use signing from an early age (Brasel & Quigley, 1977). Deaf children with deaf parents are four times more likely to go to college than deaf children with hearing parents (Stevenson, 1964; see review of studies in Wilbur, 1987).

That these results are related to knowledge of signing and not other, perhaps socioemotional factors (e.g., deaf parents being more accepting of a deaf child), can be seen in the results of the study by Brasel and Quigley (1977), who defined four groups on the basis of the parents' educational approach: a signed English group, an ASL group, an early intensive oral group, and an average oral group with no special early training. The groups were compared on tests of English syntax (Quigley, Wilbur, Power, Montanelli, & Steinkamp, 1976) and on four subtests of the Stanford Achievement Test (Language, Paragraph Meaning, Word Meaning, and Spelling). The results of the Brasel and

Quigley study show "that the two Manual [signing: RBW] groups were significantly better than the two Oral groups on every test measure employed." Thus, the results are independent of parental deafness, as only the ASL group included deaf parents.

Many levels of processing are involved in fluent reading, among them: (1) decoding or word recognition; (2) acquiring, storing, and retrieving word meanings; (3) extracting sentence meaning from words and syntactic structures; (4) realizing what is not stated but implied (inferencing), and (5) using the structure of the text to organize, store, and recall information. The skilled writer, like the skilled reader, must be able to perform multiple tasks: (1) determine the structure of the text to be produced, (2) construct paragraphs that convey the major points, (3) construct and sequence grammatical sentences, (4) choose the correct vocabulary, (5) spell the words correctly, and (6) produce legible handwriting. All of this must be done while one is mindful of what the reader already knows and needs to know to understand the intended message.

In many respects, deaf children's problems with writing are parallel to their problems with reading and reflect the same general deficiency with English. They tend to display the same concern with the structure of individual sentences that their teachers do and approach the task of writing a paragraph or letter as a matter of stringing together "good" sentences. Their paragraphs are stilted and do not contain the connecting words that skilled writers use to allow the thoughts or events to be framed with reference to other thoughts, events, or time frames. Instead, deaf writers order their description of events in the same order that they actually happened (Wilbur & Nolen, 1986b). The resulting story structures lack complexity and creativity in terms of temporal sequence. The practice of teaching sentence by sentence certainly contributes to this problem.

What causes deaf students' problems in learning to read and write? Early research on deaf students' problems in learning English concentrated on parts of speech and word order within a sentence. Researchers counted the number of omissions, substitutions, redundancies, and word order errors (e.g., Myklebust, 1964). Since then, linguistic advances in syntax and pragmatics have provided tools for research that have added considerably to our knowledge of deaf students' problems. We can identify several sources for these errors, including the ways in which deaf children's acquisition is like hearing children's, the ways in which it differs, and identification of errors attributable to other sources, such as teaching techniques. Research indicates that, in general, problems stem from (a) inadequate language skills, compounded by reduced input due to the hearing loss; (b) inadequate teaching methods due to concerns over communication modality and lack of appreciation of the complexities of language acquisition; and (c) teacher focus on sentence structure over other aspects of language use (inferencing, paragraph structure, conversational and story structure as transmission of sequenced information; for summary, see Wilbur, 1977; for extensive bibliography, see Wilbur, 1987).

Deaf learners of English are like other young learners in their acquisition strategies. One problem that deaf students have is that they incorrectly overgeneralize strategies that they have learned for understanding basic sentences. These general strategies are based on the students' familiarity with English sentences that have a subject, verb, and direct object. From such familiarity, the students learn that the understanding of a sentence involves interpreting the first noun as the agent, the verb as the action, and the second noun as the recipient of the action, an interpretation strategy called "reading surface order" (RSO). This strategy works very well for reading many English sentences, especially the simple ones presented to very young deaf children, for example, "The truck hit the car." Unfortunately, for many structures the RSO strategy produces incorrect results, as in "The truck was hit by the car," where it is the car that does the hitting. Children relying on RSO would read it as the truck that does the hitting.

This type of language learning error is also seen in young hearing children. Common examples include incorrect overgeneralization of morphological rules such as the plural or past tense, yielding forms like "bringed," "shutted," "goed," and even "wented" in children's productions. A similar example can be found in the written language of deaf children: "*The girl helped her mother to packed the picnic basket." On the positive side, the past tense -ed added to the infinitive

"to pack" shows that the student knows the past tense rule and knows that "pack" is a verb that is eligible (sometimes) to have the past tense suffix added. The negative side is that the student does not know why infinitive verb forms do not also receive the past tense suffix. If the children knew this, the overgeneralization of past tense usage could be eliminated.

Persistence: Deaf Learners Differ From Other Young Learners

What differentiates deaf children's use of overgeneralization from hearing children's is its long-term persistence and its extension to larger syntactic domains (see, for example, the discussion of passives and relative clauses in Quigley, Smith, & Wilbur, 1974; Wilbur, 1987). In the examples discussed above, the hearing children are overgeneralizing morphological word endings to exceptional words that do not fit the regular rule, whereas the deaf children are overgeneralizing the placement of a morphological ending onto a syntactic construction: the infinitive. Why do these overgeneralizations grow and persist in deaf children? At least three factors can be identified.

Limited input. One reason is the fact that deaf students receive only limited input (all modalities combined). As a result, when they learn English syntactic rules, they learn some of the details incorrectly and do not have enough input and experience with using the structures to realize their mistakes.

The demonstration that limited input is a major factor in persistence requires consideration of specific data from conjunction, the process by which two sentences are "glued together" with "and." The easiest type of conjunction for deaf students is with sentences that do not share common elements, for example, "Kim bounced a basketball and Lee practiced tennis." However, if the two sentences share similar subjects or objects, a number of unusual omissions occur. For example, deaf students might rewrite the two sentences "John washed the car" and "Mary waxed the car" as "John washed the car and Mary waxed," where the object of the second sentence has been deleted because it is identical to the object of the first sentence (object-object deletion). Likewise, "The boy hit the girl" and "The girl hit him back" might be rewritten as "The boy hit the girl and hit him back," where the second subject has been deleted because it is identical to the first object (object-subject deletion). Critically, object-object deletion seems to disappear with age, but object-subject deletion does not; in fact, it increases (Wilbur, Quigley, & Montanelli, 1975).

Notice that these are not simply random deletions, that they occur in the second sentence of two conjoined sentences, and that this is one of the environments in which English normally puts pronouns. Suppose that deaf children are aware of the need for reducing redundancy, but instead of pronominalizing, they simply delete; that is, they overgeneralize deletion. This initial hypothesis might explain the locations of the omissions but would not explain why object-subject deletion increases in use while object-object deletion decreases.

The problem is environments in English in which it is possible to delete the subject of the second sentence in a conjoined structure. The result is a conjoined verb phrase (e.g., the deletion of the second occurrence of "the elephant" in "The elephant crushed the roots and ate them"). The general rule for English is that the subject of the second sentence may be deleted if it is identical to the subject of the first sentence. The deaf students who use object-subject deletion are deleting the second subject when it is identical to the first object. Together with object-object deletion, their generalization may be "delete a noun phrase in the second sentence if it occurs in the first sentence." With subjects, this generalization sometimes gives correct forms (conjoined verb phrases) as well as the incorrect forms. Increasing mastery and use of conjoined verb phrases then reinforces deletion of subjects. In contrast, objects are never deleted in English-object deletion is never correct. Eventually, a new generalization is formulated-"delete the subject in the second sentence if it occurs in the first sentence." This generalization produces correct verb phrases and incorrect object-subject deletion, accounting for the failure of object-subject deletion to disappear over time. Because there is no parallel situation for objects, the loss of object-object deletion is predictable. This situation suggests that deaf students' problems with English syntax reflect their attempts at coping with increasing, but still limited, data. An explanation based solely on overgeneralization fails to address the differential behavior of the two erroneous rules. From this example

one can see that limited input is a major factor hindering full development of English skills in deaf children.

Structures are taught in isolation. Another factor contributing to the persistence of overgeneralizations is that deaf students are frequently taught in isolated sentences, which does not provide adequate information for them to learn all the situations in which a structure is used and all the constraints on its usage. In a specific test of this hypothesis, Nolen and Wilbur (1985) found that for some difficult structures, such as relative clauses, deaf students' comprehension was much better when the structure was presented in a meaningful context than when it was presented in an isolated sentence.[2]

Context interacts with syntax in such a way as to allow certain syntactic structures and prohibit others. Consider the two related sentences: "The car hit the truck" and "the truck was hit by the car." The difference in meaning or function is not at all obvious without the benefit of context. An appropriate response to "What hit the truck?" may be either "The car hit the truck" or "The truck was hit by the car." However, it is inappropriate to respond to "What did the car hit?" with "The truck was hit by the car" (without special intonation) because of the conflict of contextual focus (what is foregrounded and what is backgrounded). Context reflects shared knowledge between sender and receiver, expectations of both based on world knowledge, conversational content, and linguistic structure, and the effects of these on choice of syntactic structure. In the discussion of ASL structure to be presented later in this article, it will be seen that knowledge of how ASL handles these contextual differences could be useful in rectifying deaf students' lack of knowledge in this area.

Several of the syntactic structures that deaf students have difficulty with seem to form a group in that they are involved in separating old from new information, which is a function of previous contextual history. Repeated reference to previously presented information may become redundant; hence, English uses pronominalization, definite determiners ("the"), deletion in conjoined structures, or relative clauses ("The boy who[m] I told you about").

For deaf students, English pronoun usage is easier within a single sentence than across two sentences in sequence (Wilbur, Montanelli, & Quigley, 1976). The problem with sentences in sequence is that the first one introduces new information ("This is my friend John"), which immediately after presentation is considered old information. Thus, the second sentence, if it refers back to the first, must use a pronoun ("He goes to school with me"). Pronoun usage is further complicated by the lack of a fixed rule in English. A pronoun should be used to avoid redundancy when information is referred to several times in succession, but ambiguity of reference must be avoided so if more than one male individual has been previously mentioned, the use of "'he/him/his" can be problematic (note that the ASL pronoun system does not have this problem). Only practice in extended contextual situations can develop a mature sense of when the pronoun is permitted and when the noun or proper name must be mentioned again.

The same general tendency to reduce redundancy is apparent in the deletions that produce conjoined structures, and, likewise, deaf students' confusion is similarly reflected in their errors (Wilbur, Quigley, & Montanelli, 1975). Deaf students' difficulty with determiners is also an old versus new problem. It is not the placement of determiners before nouns that is problematic, but rather correctly distinguishing situations for when to use definite (old) and indefinite (new) determiners (Wilbur, 1977). Determiner usage constraints, and the other pragmatic constraints, must be applied to each individual conversational task, making the acquisition of such constraints a complicated task. Limited input and interactional experience merely compound the problem.

Only certain structures are taught. Still another contributing factor to difficulties deaf children have learning English is related to teaching; choices must be made concerning which structures to teach because it is impossible to teach everything all at once. In any given year, a particular structure may or may not be covered (this is also true for vocabulary). Given input limitations, deaf students can only be expected to know a structure if it has already been taught. Theoretical syntactic and semantic complexity is a better predictor of the order observed in deaf learners than learning predictions based on hearing children's order of acquisition, in part because as teachers decide what to teach first, they intuitively feel certain structures are more

difficult than others, and their intuitions reflect linguistic complexity (for example, that "something" is simpler than "anything"; Wilbur & Goodhart, 1985; Wilbur, Goodhart, & Montandon, 1983; for an overview of factors affecting hearing children's acquisition, see Bloom, 1993; Fletcher & Garman, 1986; Slobin, 1985; and for discussion of the contribution of frequency of occurrence, see Pinker, 1993). Deaf students are much more affected by what is presented in class because they lack extensive contextual and interactional experiences.

We have seen then that deaf learners experience difficulty in the acquisition of English and literacy skills not because of interference from sign language structure, but as a result of several factors. They approach the learning process much like young hearing children, generalizing their linguistic observations to novel structures and contexts. However, unlike young hearing learners, deaf learners' overgeneralizations persist, which can itself be attributed to greatly reduced language input and interactional experiences.

Deaf Students' Coding and Memory Skills Related to Reading

Cognitive Abilities

The ability to read fluently depends on cognitive skills, such as information coding, storage, and retrieval. Here I review research related to hearing and deaf readers, highlighting both similarities and differences. It has long been known that hearing people use some form of phonological coding in certain reading and memory tasks. For example, when hearing people are deprived of an opportunity to use semantic information in the recall of word lists, they tend to make mistakes based on the phonological properties of the words they hear or see (Conrad, 1962; Wickelgren, 1965). Bellugi and Siple (1974) have demonstrated that phonological/formational properties of signs produce similar errors in deaf memory. Furthermore, Sachs (1967) reported that hearing people discard the specific syntax of a sentence very shortly after it is seen or heard, because once the meaning has been extracted, the syntax is no longer useful for memory. For hearing people, then, one can expect that longer-term memory for sentences will be coded on a semantic basis and not on the form (syntax) of the sentence (Bransford, Barclay, & Franks, 1972; Bransford & Franks, 1971; Crowder, 1972; Franks & Bransford, 1972; LaBerge, 1972; Norman, 1972; Paris & Carter, 1973). Moulton and Beasley (1975) report similar results for deaf individuals, showing that they take advantage of the semantics of stimulus items whenever possible, but that they use sign-based coding when semantics cannot be of assistance.

Further studies have shown that many deaf people have a choice of coding English either by phonological, visual, or sign-based means; that oral training methods do not guarantee phonological coding strategies; and that nonsigning deaf people who do not use phonological coding strategies do not give clear evidence of reliance on any one of the other possible strategies (Conrad, 1970, 1971, 1972, 1973; Locke & Locke, 1971). However, the lack of clear strategies does not indicate that the use of other memory strategies is necessarily impaired. When deaf students are given instructions (for example, to use fingerspelling during rehearsal, or different rehearsal strategies), their performance improves to nearly 100% (Belmont, Karchmer, & Pilkonis, 1976; Karchmer & Belmont, 1976). Also, when performance is compared on tasks involving English words and nonverbal information such as pictures, it is clear that the problem is specific to the linguistic task (English words) and not to memory in general (Karchmer & Belmont, 1976). It is critical then that one keep in mind that memory strategies must be learned, so that reports of what deaf persons do in experimental situations are not taken as indicators that they cannot be taught more effective approaches.

Furth (1966b) demonstrated that the general cognitive ability of deaf people is not greatly different from that of hearing people in nonlinguistic tasks. Perhaps deaf children do not develop the ability to apply their nonlinguistic cognitive skills to linguistic tasks? This suggestion is clearly not true for those deaf children who learn ASL as a first language, given the fact that these children easily acquire ASL (Lillo-Martin, 1994; Newport & Meier, 1985; Petitto, 1993). In a study directly addressing this suggestion for deaf children who do not know ASL, Wilbur (1982) investigated linguistic but nonsyntactic generalizations made by deaf students. The task required the students to recognize En-

glish constraints on allowable words. For example, *blick* could be a word of English whereas *bnick* cannot be because of the initial consonant cluster *bn* (compare with Russian, which allows clusters *zd* and *gd*). These constraints, unlike spelling rules and grammatical rules, are not taught to either deaf or hearing children in school; hence, any knowledge that deaf children have of these constraints must have been extracted entirely on their own using their cognitive processing ability applied to English.

The deaf students' scores are quantitatively below those of the hearing children at the first, third, and fifth grade levels, but the error patterns are not qualitatively different. That is, violations of word structure constraints that are easy for the hearing children to identify are also easy for the deaf students, and those that are hard for the hearing children are also hard for the deaf children. These data support the conclusion that deaf students' difficulty in learning the proper rules for the more complex syntactic patterns of English is not attributable to a disturbance of general linguistic or cognitive processing, but rather to difficulty in learning the specific rules of English. This conclusion is strengthened by the fact that by seventh grade, the deaf and hearing students performed equally well on this nonsyntactic task despite the huge gap in syntactic performance of hearing and deaf students (Wilbur, 1982).

Letter–Sound Associations and Phonological Coding

Research on hearing children indicates that children who learn letter-sound associations, and then use these associations in reading (by sounding out the word), experience superior reading achievement (Chall, 1967). Consequently, reading materials intended for hearing children rely heavily on the phonological properties of the words to serve as recognition cues to the beginning reader. Smith (1986) argues that the skills necessary to develop fluent reading should be considered in two stages, the declarative stage, wherein skills are learned (e.g., letter-sound associations used by beginning readers), and the procedural stage, wherein the learned skills are exploited for fluent and automatic reading. Thus, two questions can be asked: (1) Is phonological coding necessary for reading; that is, do hearing read-

ers exploit phonological coding for fluent reading? (2) What is the relevance of phonological coding for deaf readers?

Perfetti (this volume) suggests that phonological structure potentially underlies all writing systems: "Phonology is so pervasive a part of word reading across all writing systems that it is plausible to hypothesize a Universal Phonological Principle (UPP), by which reading routinely includes activation of spoken language units in all writing systems." But is it the case that all writing systems are inherently phonologically based such that all reading involves activation of spoken language units? And, if so, must we conclude that phonological coding is necessary to the development of fluent reading?

Perfetti cites as partial support for the pervasiveness of phonology in writing the fact that Chinese characters frequently contain a "radical" that provides an indication of the pronunciation class of the word that the character represents. However, this does not mean that one must be able to pronounce the language in order to be able to read (making a distinction here between what people do in experimental or nonautomatic reading situations and what they do in fluent reading situations). The Chinese writing system (with others, such as hieroglyphics, cuneiform, and the glyphs used on rocks and pottery in the American Southwest; Cunkle, 1993) is "logographic," meaning that each character represents a separate morpheme (unit of meaning). Each character represents a whole word rather than the individual sounds associated with the word's pronunciation. Because each word has its own symbol, these systems have the disadvantage of being slow to learn; the estimate is that people must learn about 5,000 characters just to read a Chinese newspaper and twice that for a college text. However, the literacy level in China is very high, reflecting the fact that learning this written system is nonetheless routine. The great advantage of logographic systems is that someone does not have to know how to pronounce the language in order be able to read it. This makes it possible for people who speak mutually unintelligible dialects of Chinese (e.g., Mandarin and Cantonese) to read the same newspapers and to communicate with each other by writing even though they cannot carry on a spoken conversation (hence the

language policy of the Chinese government to teach all students Mandarin in school). Thus, the fact that some written Chinese characters may contain phonological "radicals" reflecting pronunciation class does not bear directly on the question of whether spoken language units are activated during the reading process for Chinese readers.

One direct investigation of phonological encoding by Chinese readers was conducted by Chu and Loritz (1976), who report that they do in fact engage in some degree of phonological recoding when presented with Chinese characters. However, Tzeng and Wang (1983) also report strong visual/logographic coding effects in Chinese readers of Chinese characters and further that these logographic effects transfer to the treatment of English alphabetic words when English is learned after reading fluency has been achieved in Chinese. Smith (1986) notes that these apparent contradictions can be resolved by not expecting a reader to use the same abilities or strategies for all levels of task difficulty and provides extensive discussion of strategy change and flexibility with good, medium, and poor hearing and deaf readers (he presents data from Pattison, 1983). Smith (1986, p. 493) concludes that phonemic awareness is a "crucial concomitant" for reading an alphabetic system but that it is not clear why this is true, as there appears to be no clear link between phonological awareness and information processing. Further, the phonemic awareness that is helpful to beginning readers can be a hindrance to fluent reading at later ages. Instead, he suggests that phonemic awareness is linked to success in reading by a more imprecise notion, linguistic maturity.

The second issue, whether the phonological coding observed in hearing readers is critical to the reading process or is the result of the fact that hearing people speak before they read and are taught to read based on the speech they already know, is also critical. One assumption behind the "phonological coding is necessary to reading" line of reasoning is that children can take advantage of letter-sound relationships, that is, match letters with possible spoken segments (phonemes) of the language. There is clear evidence, however, that hearing children's awareness of segments is a late developing and reading-influenced skill. Language games

provide one assessment of children's facility with phonological structure. Bagemihl (1989) and Pierrehumbert and Nair (1995) argue forcefully that subsyllabic (smaller than a syllable) constituents, such as individual segments (phonemes), do not participate in children's language games; indeed, Pierrehumbert and Nair extend this to phonological theory in general, claiming that such subsyllabic constituents do not exist. Yip (1982, 1994) further argues that subsyllabic constituents are not referenced by the phonological processes of spoken Chinese and are therefore unnecessary at the phonological level; she concludes that mora (weight units), syllable, and foot (batched sequences of syllables) are the only prosodic units given by Universal Grammar. Bagemihl concludes from the wide distribution of language game types that manipulate or reverse syllables as compared to those that explicitly manipulate segments (e.g., Pig Latin requires separation of the first sound from the rest of the syllable): "It seems that the presence of an alphabetic writing system is necessary for the establishment of some metalinguistic awareness of the notion of 'segment'" (1989, p. 485f). That is, the narrower distribution of language games that manipulate segments is restricted to (a subset of) languages that have alphabetic (segmental) writing systems. Thus, he suggests that becoming aware of an alphabet also involves becoming aware of individual segments within syllables. Smith (1986) states this relationship even more explicitly: "Children's awareness of units in their speech and their ability to identify and exploit corresponding units in print are two mutually supportive developments: morphophonological awareness aids reading, and reading aids morphophonological awareness" (p. 479).

Herein lies the key to the success of early fingerspelling in the development of literacy as described by Padden and Hanson (1999). Deaf children who know ASL are provided access to fingerspelling before or in conjunction with print and spelling and are able to connect fingerspelling segments (handshapes) to printed segments (letters). However, the absence of an alphabetic writing system, and hence the absence of awareness of individual phonemes, is no detriment to literacy, as reflected by the Chinese situation. Recent research on brain development further suggests that

the critical feature of initial input is that it is consistent, adequate, and interactive, not whether it is auditory or visual (Thelen & Smith, 1994). That is, infants must have adequate amounts of consistent interaction with the environment, including language, to develop properly, but there appears to be no bias toward auditory as opposed to visual input. Again, the parallel course of acquisition for ASL as well as spoken languages (Lillo-Martin, 1994; Newport & Meier, 1985; Wilbur & Jones, 1974) and the superior achievement in many domains of deaf children who have deaf parents also support the conclusion that higher level cognitive processes and intellectual abilities depend on information input, not speech input. If the input to the child does not carry information in a useable format, there is no information transmission.

There is one further reason to question the importance of phonological coding to deaf readers. In a memory study of orally trained deaf adults who used ASL as their primary means of daily communication (six of the eight individuals had deaf parents as well), Bernstein-Ratner and Wilbur (1984) reported a strong effect of graphemic errors (visually based on orthography, e.g., confusing "four" with "sour") and no significant differences among errors based on sign, phonological, or miscellaneous foils (Bernstein-Ratner & Wilbur, 1984). In the discussion of their results, they note that Mark, Shankweiler, Liberman, and Fowler (1977) report that hearing beginning readers who use phonological coding strategies were better readers than those who relied on graphemic coding. Bernstein-Ratner and Wilbur suggest that this is true because phonological coding capitalizes on the primary communication mode of speech in hearing children, which of course graphemic coding does not do. "Rather than conclude that phonological coding per se is the most efficient mediator of memory and reading, we would like to suggest that the most efficacious coding strategy will be the one which is congruent with the primary communication mode. The problem in demonstrating that this is so is the apparent absence of a population which has been taught to read using a code other than spoken phonology" (Bernstein-Ratner & Wilbur, 1984, p. 61). That is, in the United States, deaf children are still taught to read using speech- and letter-sound asso-

ciations, even when other techniques are also used. It is important then to remember that the results reported on experimental studies of these readers are the outcomes of this tradition and are not in themselves evidence for the way reading should necessarily be taught.

Deaf Students' Speech and Overall Performance

Development of Speech Skills

There is no evidence to support the belief that use of sign language interferes with development of speech abilities. In his summary of studies of deaf children with early oral preschool compared to those without, Moores (1971) reported that none of the studies indicated any difference in oral skills (speech and speechreading). Vernon and Koh (1970) compared deaf children of hearing parents with early intensive oral training to deaf children of deaf parents with no preschool (i.e., ASL users). Again, no differences in oral skills were found, but the students with deaf parents were superior in reading and general achievement. Several other studies compared deaf children of deaf parents to deaf children of hearing parents. Four of these studies included relevant results (Meadow, 1966; Quigley & Frisina, 1961; Stevenson, 1964; Stuckless & Birch, 1966; for a description of these, see Bonvillian, Charrow, & Nelson, 1973; Moores, 1971, 1974). Deaf children of deaf parents are superior on some or all of the English skills and general measures of ability. Three of these studies reported no difference between the two groups on measures of speech production, but the fourth reported that the deaf children of hearing parents are better. One of the studies also reported that the deaf children of deaf parents are better on measures of speechreading ability, whereas the other three reported no differences between the two groups. A study of children using Swedish Sign (Ahlstrom, 1972) reported that "speech was not adversely affected by knowledge of signs" (Power, 1974). What is striking about these studies is the lack of any direct evidence that the use of signing is detrimental to the development of speech skills. If such an interference relation-

ship existed, one would expect to see it reported in study after study. Its absence is thus noteworthy.

Overall Socioeducational Performance

Studies overwhelmingly report better overall achievement for deaf students of deaf parents, compared to deaf students of hearing parents who presumably do not know ASL, although there are differences on some measures, and, in some cases, no differences at all. Moores (1974) summarized several such studies. Stevenson (1964) reported higher educational achievement for the deaf students of deaf parents in 90% of the comparisons, with 38% of the students with deaf parents going on to college, compared to only 9% of the students with hearing parents. Stuckless and Birch (1966) reported superior reading, speechreading, and written language for the deaf students of deaf parents, with no differences noted in speech or psychosocial development. Meadow (1966) reported higher self-image and academic achievement (arithmetic, reading, and overall) in deaf children of deaf parents. In addition, teachers' ratings of the students favored the deaf students of deaf parents on maturity, responsibility, independence, sociability, appropriate gender role, popularity, appropriate responses to situations, fingerspelling ability, written language, signing ability, absence of communicative frustration, and willingness to communicate with strangers. No difference was noted in speech or speechreading.

Vernon and Koh (1970) also reported that deaf students of deaf parents were superior in reading, vocabulary, and written language. No differences were found in speech, speechreading, or psychosocial adjustment. Quigley and Frisina (1961) reported higher vocabulary levels for the deaf students of deaf parents, no differences in speechreading or educational achievement, and better speech for the deaf students of hearing parents. Furthermore, Vernon and Koh compared the academic achievement of deaf students of deaf parents with early ASL to that of deaf students of hearing parents with early intensive oral training. They reported that the students of deaf parents were ahead in all areas and had superior reading skills. No differences were found in speech or speechreading.

The above studies have established, to the satisfaction of more than a generation of researchers, that knowledge of ASL is invaluable in the education of deaf children. A quick look at the successful deaf individuals in my professional field reveals that they either have deaf parents (indeed, in some cases large deaf families) or they have hearing parents who began signing with them, however awkwardly, when they were diagnosed as deaf as children. Poor parental signing skills are easily overcome by providing deaf children with interactional opportunities with ASL-fluent members of the Deaf community (deaf clubs, deaf schools, deaf athletics, etc.). The best general discussion of these conclusions is contained in Johnson, Liddell, & Erting (1989; readily available from Gallaudet University), in which they outline a model program for the education of deaf children with ASL as a central focus and family support provided by Deaf community interaction (among other sources). Crucially, they set a clear goal for deaf education: access to age-appropriate curriculum. Are, for example, third-grade deaf children able to demonstrate competency in the standard third-grade curriculum in math, history, science, and whatever else is typical for third grade? Anything less is unacceptable.

ASL as a Basis for English Literacy

Consider then the benefits that all deaf children would receive from early exposure to ASL. One would be the fully developed language base that deaf children of deaf parents are already getting. A fully developed language base provides normal cognitive development within the critical language acquisition period (Newport & Meier 1985; Petitto 1993; Lillo-Martin 1994; review of older work in Wilbur, 1987). Teacher-child and parent-child communication is vastly improved and the limited input problem for reading and writing English is eliminated. Instead, ASL-signing deaf children become another bilingual minority learning English (Charrow & Wilbur, 1975). It is already known that deaf children approach learning English as though it were a foreign language. Charrow and Fletcher (1974) gave the Test of English as a Foreign Language (TOEFL) to deaf high-school students of college-entrance age. Although the deaf subjects did not perform as well as foreign college entrants, in general their

results more closely resembled those of foreign students than those of native speakers of English. From the perspective of treating deaf children like other second-language learners, it is reasonable to expect grade-level performance, and it is recognized that some of that performance may be demonstrated in the first, rather than the second, language. Hakuta (1986) has demonstrated that there is no problem with transfer of curricula material learned in one language to eventual use in the other language.

Advantages of Having a Fully Developed First Language

From a linguistic perspective, knowledge of ASL as a first language is beneficial because it taps normal capacities at the appropriate stage of development. As Lillo-Martin (1993, 1994) discusses, when children have a first language (ASL or other language), their linguistic competence is constrained by Universal Grammar. That is, the normal language acquisition process has taken place within the confines of what all natural languages have in common (related discussion in Newport & Meier, 1985; Petitto, 1993; Pinker, 1993, inter alia). As a result of this first-language acquisition process, there is reduced need for emphasis on teaching particular syntactic structures in the second language (see also discussion of knowledge transfer in Hakuta, 1986). Given a first language, learners of a second language have some idea of what to expect, making the acquisition of the second language a task with reduced complexity.

In several publications, VanPatten (1995, 1996) has argued that for successful language acquisition, learners need access to input that is communicatively or meaningfully oriented and comprehensible in nature. He notes three corollaries to this observation: (1) the learner must interact with the input to maximize language acquisition; (2) the input must not only be comprehensible, it must be comprehended with ease; and (3) the degree and quality of language acquisition is partially determined by degree and quality of input received. Deaf children of deaf parents are clearly provided with the necessities for successful acquisition of English, and this is reflected in their academic and professional accomplishments.

Learning to read requires an already developed language base. As deaf children are traditionally taught, they are asked to learn English language structure, speech, and reading at the same time. The problem is that students cannot understand what they are being told until they have mastered English well enough to understand the teacher's instructions. This vicious cycle is broken when the children come to school with a fully established ASL language base; then a normal situation is encountered for teaching English as a second language (ESL). Properly trained teachers of the deaf should have substantial expertise in ESL methods, and speech-language pathologists and audiologists working to develop speech and listening skills should have conversational fluency in ASL in order to be able to work with the children.

Consider what hearing children are expected to be able to do with the language base before learning to read (reading readiness). They are supposed to have a reasonably well-developed vocabulary; otherwise, they will not recognize a written word even if they sound it out. They are supposed to be able to handle sentences of some complexity; even though the construction of beginning readers limits the number of words per sentence, actual syntactic structure is not properly regulated (Quigley, Wilbur, Power, et al., 1976; Wilbur & Nolen, 1986b). Finally, they are supposed to be able to draw on their conversational skills and their knowledge of story structure to draw inferences and conclusions so that they can "read between the lines." With ASL as a fully developed language base, deaf children could be expected to meet reading readiness milestones as well. Although they might not be able to recognize words that they sound out, they might be able to do the equivalent with fingerspelling (again, see Padden & Hanson, 1999). Certainly, they should be able to understand those words when signed, and this is precisely where knowledge of ASL makes a difference.

Stuckless (1981) noted that deaf children exposed only to a graphic form of English are working with a clear and complete code but still need to have an established language base in order to derive meaning from it. Similarly, Hirsh-Pasek and Treiman (1982) note that deaf children rarely possess a strong language base that is compatible with the alphabetic writing system and that recoding in the absence of extensive articulatory

or fingerspelled vocabularies is unprofitable. They suggest that teachers working with signing deaf children can increase the child's fingerspelled lexicon, but that explicit instruction in using fingerspelling as a coding strategy related to print may be necessary because children may not discover it without assistance. In this manner, the process of learning to deal with printed material is separate from the task of learning a language in the first place. As long as the two goals are collapsed, progress toward both will continue to be hindered.

When teachers and students are able to turn their attention to the development of reading skills, other reading issues and options also become relevant. For example, Clarke, Rogers, and Booth (1982) point out that "[t]here is no compelling evidence that any one reasonable method of teaching reading will yield results that are significantly better than any other reasonable method (p. 59)." Hirsh-Pasek and Treiman (1982) caution that the studies involving memory tasks with lists of single words may not be generalizable to the reading of sentences and larger units, and that studies using fairly realistic reading tasks have also failed to find articulatory recoding among congenitally hearing-impaired subjects. Ewoldt (1982) further warns: "[T]he reading of isolated sentences is also foreign to real reading. It is more difficult than reading a whole story, in which semantic build-up helps the reader not only to identify words but also to handle difficult or unusual syntax" (p. 85). Finally, Chall (1967) warns that teaching methods are difficult to define in practice.

The suggestions for a research-based reading program for beginning readers from The Texas Reading Initiative report (www.just4kids.org/html/bri.html) may be very useful here. I include their 12 Essential Components in order to prevent these valuable ideas from eventually being lost somewhere in cyberspace. The only adaptation that needs to be made for deaf readers is to replace "oral/spoken" with "conversational," which covers both speech and signing, and to include "fingerspelling" with "sounds":

1. Opportunities to expand use and appreciation of oral language,

2. Opportunities to expand use and appreciation of printed language,

3. Opportunities to hear good stories and informational books read aloud daily,

4. Opportunities to understand and manipulate the building blocks of spoken language,

5. Opportunities to learn about and manipulate the building blocks of written language,

6. Opportunities to learn the relationship between sounds and letters,

7. Opportunities to learn decoding strategies,

8. Opportunities to write and relate writing to spelling and reading,

9. Opportunities to practice accurate and fluent reading in decodable stories,

10. Opportunities to read and comprehend wide assortment of books and other texts,

11. Opportunities to develop new vocabulary through wide reading and vocabulary instruction, and

12. Opportunities to learn and apply comprehension strategies as they reflect upon and think critically about what they read.

Note the use of the key word "opportunities." One of the most significant advantages of working with deaf children who already have a well-developed first language base is that many opportunities for learning can be found outside of the traditional classroom situation. For example, a trip to the zoo becomes more than just an opportunity to learn the names of animals; with extensive communication provided through ASL, teacher and students can have a discussion about which animals are more interesting to write stories about and why. Children can make up short stories and tell them in ASL, enjoying the experience without the frustration of English structure, spelling, and writing. When the children do finally write the stories, the task is different, but typical for bilingual children: translating into another language. For children who do not know ASL, writing the story is not a translation task and requires attention to factors other than just the structure of English. For example, the notion of a story grammar has to be developed. However, children who can use ASL will have already learned many things about normal story grammar structure, such as creating the setting, introducing participants, and so forth.

ASL as a Natural Language

ASL is a naturally evolved complex language that varies significantly from English (Stokoe, 1960). Like many

other languages (e.g., Russian, Spanish), it has a flexible word order, preferring that sentence elements reflect discourse roles (topic, focus) rather than the grammatical relations (subject, object) that English prefers (Wilbur, 1997). Another difference between ASL and English is that ASL has fixed phrasal stress; that is, it does not allow stress to shift to different words in a sentence in order to focus on different items (Wilbur, 1997). Instead, ASL takes advantage of its more flexible word order to ensure that the desired focus will receive stress only in sentence-final position. Languages that allow phrasal stress shift, like English and Russian, are referred to as [+plastic], whereas languages like ASL and Catalan are [-plastic]; [plastic] is a typological feature that reflects how a language brings stress prominence and information focus together (Vallduví, 1991).

An illustration of the differences between the two types of languages may be helpful here. English allows the following sentences, each one with a different stressed item but all with the same word order:

1a. Selena saw Marita put the book on the TABLE. (not the SHELF)

1b. Selena saw Marita put the BOOK on the table. (not the MANUSCRIPT)

1c. Selena saw MARITA put the book on the table. (not ADONI)

1d. SELENA saw Marita put the book on the table. (it was not KIM)

Such stress movement cannot be done in languages like ASL with fixed phrasal stress. Instead, the word order must be changed so that the item to be stressed is situated in the place that is reserved for focused items; in ASL and many other languages, this position is at the end of a sentence (Wilbur, 1994b, 1995b, 1996). ASL has a very common structure that translates into English in two ways, either as in (1a–d) or as the *wh*-cleft as in (2); signs are glossed in small capitals:

2a. SELENA SEE MARITA PUT BOOK WHERE, TABLE
"The place where Selena saw Marita put the book was the table."

2b. SELENA SEE MARITA PUT-ON-TABLE WHAT, BOOK
"What Selena saw Marita put on the table was the book."

2c. SELENA SEE BOOK PUT-ON-TABLE WHO, MARITA
"The person who Selena saw put the book on the table was Marita."

2d. SEE MARITA BOOK PUT-ON-TABLE WHO, SELENA
"It was Selena who saw Marita put the book on the table."

The ASL structure can be generalized easily to create further structures that are considered exceptionally complex in English:

2e. SELENA SEE MARITA DO++, BOOK PUT-ON-TABLE
"What Selena saw Marita do was put the book on the table."

2f. SELENA DO++, SEE MARITA BOOK PUT-ON-TABLE
"What Selena did was see Marita put the book on the table."

2g. SELENA SEE MARITA DO++ WITH BOOK, PUT-ON-TABLE
"What Selena saw Marita do with the book was put it on the table."

The basic form of this construction in ASL is "old information + *wh*-word, new information," with the old information clause marked by a brow raise (Wilbur, 1996). Brow raises and other nonmanual markers are integral components of the ASL intonation system, performing many of the same functions in the signed modality that pitch performs in the spoken modality (Baker & Padden, 1978; Battison, 1974; Frishberg, 1978; Siple, 1978; Wilbur, 1991, 1994a, 1994c, 1995a, 1999a; Wilbur & Patschke, 1999). These differences in prosodic structure and intonational marking are primary contributors to significant differences in syntactic structure between ASL and English (Wilbur, 1999b, 1999c). The prosodic, intonational, and syntactic structures evolved together to provide natural language capability in the signed modality (Allen, Wilbur, & Schick, 1991; Wilbur, 1997, 1999a; Wilbur & Allen. 1991).

The nonmanual markers comprise a number of independent channels: head; body position; eyebrow and forehead; eyeblink and eye gaze; nose; and mouth, tongue, and cheek (Wilbur, 1994b). Nonmanual cues provide morphemic information on lexical items, or indicate the ends of phrases (boundary markers) or their extent (domain markers). The nonmanual signals made on the face can be roughly divided into two groups, lower and upper. The lower portion of the face is used to provide adverbial and adjectival information. The mouth, tongue, and cheeks provide meaningful mark-

ers that associate with specific lexical items or phrases (Liddell, 1978, 1980; Wilbur, 1999b) and the nose can be used for discourse marking purposes (Wood, 1996). Readers are referred to introductory textbooks on ASL, such as Baker and Cokely (1980) and Valli and Lucas (1992), for overviews.

The nonmanuals supplied by the upper part of the face and the head (eyebrows, head nods, tilts, and shakes, eyegaze; Wilbur, 1991) occur with higher syntactic constituents (clauses, sentences), even if such constituents contain only a single sign (e.g., a topicalized noun). Liddell (1978, 1980) noted the larger scope of upper face/head nonmanuals when he discussed the nonmanual marking "q" for yes/no questions, as in (3):

$$\overline{\rule{0pt}{1em}\hspace{10em} q \hspace{3em}}$$
$$\overline{\rule{0pt}{1em}\hspace{8em} mm \hspace{5em}}$$

3. Man fish[I:continuous] "Is the man fishing with relaxation and enjoyment?"

This single example illustrates inflectional modification on the predicate sign itself (continuous), lower mouth adverbial modification of the predicate ("mm"), and upper face, head, and body marking for the entire question ("q," lean forward, head forward, brows raised), all on only two sequential lexical items. Information corresponding to English intonation is provided throughout the ASL clause from beginning to end by the upper face and head and differs in production from what hearing people might also do with their face and head (Veinberg & Wilbur, 1990).

In Wilbur (1999b), I discuss various nonmanuals and how and why they may be layered; by "layered" I mean simultaneously produced without interfering with the perception and production of the signs themselves or with other co-occurring nonmanuals. It is the presence of this layering in ASL, and its absence in signed English, that makes the prosodic difference between natural language and artificial system, respectively. Similarly, spatial arrangement in ASL can convey syntactic, semantic, and morphological information. If a verb is inflected for its arguments by showing starting and ending locations, then the nouns or pronouns do not need to be separately signed. Aspectual

information carried in English by adverbs and prepositions phrases can be conveyed in ASL by modifying the verb's temporal and rhythmic characteristics. Information is layered, and thus ASL does not need separate signs for many of the concepts that English has separate words for. In this respect, the fact that ASL is a naturally evolved language in the visual/manual modality can be fully appreciated: More information is conveyed simultaneously than in comparable English renditions. Students who know ASL first are then fully prepared with an understanding of complex conversational strategies and information flow. Development of abilities to read and write the equivalents in English can take advantage of what the children already know. Standard bilingual and ESL teaching techniques include comparison and contrast of the ways that different languages accomplish the same goals (in this case, conveying organized information in proper sentences and paragraph form).

Why I Really Mean ASL, Not Signed English

There are many situations in the daily lives of deaf children, especially those who have hearing parents, when communication in a form of signed English (SE) between adult and child is acceptable and adequate for information transfer. Those situations arise when, and only when, the child has acquired a sufficient knowledge of English for the signed English to be meaningfully interpreted. It is clear from the research and the success of deaf children of deaf parents who use ASL that one can reasonably expect to reach this point sooner and more efficiently with ASL as the first, early established language. Brasel and Quigley (1977) suggest a slight advantage to performance on tests of English syntax for those children whose parents used SE with them instead of ASL; however, there were no other advantages in favor of the SE group. Thus, when English syntax is the focus of educational attention, SE usage may have an appropriate place as an effective educational tool. (For a review of the history of the debate surrounding signed English as an educational tool back to 1834, see Lane, 1992.) This does not mean that SE should be used with very young deaf children, as it is quite clear that many stages of language acquisition

precede specific concern with syntactic structures (lexical development, lexical categorization such as transitive vs. intransitive verbs, concepts of aspect and time, morphological marking, among many others; see Atkinson, 1992; Lust, Hermon, & Kornfilt, 1994; Lust, Suñer, & Whitman 1994; Radford, 1990), and there are many cognitive and socioemotional things that children must develop during the early years in addition to language (see relevant discussions in Bloom, 1993; Fletcher & Garman, 1986; Slobin, 1985).

Concerning the disadvantages of early use of signed English, it is clear that natural languages have certain linguistic characteristics in common, including those features that linguists refer to as Universal Grammar. I have argued that "layering" is one such characteristic (Wilbur, 1999b). Could it be argued that signed English is just a coding for English, and certainly English is a natural language, so why should signed English be problematic? Good question.

Two criterial features for defining a natural language are that (1) it has a community of users and (2) it can be learned by babies from birth. It must be a perfect fit with the perception and production characteristics of the human user, and over time, natural languages evolve to fit the modality in which they are produced and perceived. Obviously, spoken languages are designed to be communicative with ease by people who speak and hear. Similarly, signed languages are evolved to provide easy communication for people who sign and see. It is only when spoken languages and signed languages are compared for commonalities, despite their modality differences, that these linguistic design features become obvious.

What SE lacks is adaptation to its modality, which would allow it to take advantage of simultaneity rather than sequentiality. It has not developed an intonational and rhythmic system that is designed to be seen by the eyes and produced by the hands and face. Let me explain first why this evolution has not taken place and then describe briefly what that leaves for the structure of signed English. The sociolinguistic reasoning for the absence of prosodic and linguistic evolution of signed English to natural language status is as follows.

The various forms of SE are artificially created systems for communication in pedagogical situations.

They are designed as a code to mimic the lexicon, morphology, and syntax of English. It is in essence recreated as it is learned by each learner and it is learned with the overriding constraint that it should follow English word order. Thus, syntactic structure is not available for adaptation for modality purposes; that is, flexible word order could not develop under the circumstances that now surround SE usage. However this fact by itself is not a problem as there is no principled reason why a signed language could not have the word order of English if by "syntax" we mean merely the basic word order.

More critically, SE is supposed to follow English morphology, which makes the morphological domain also off-limits for modification for modality purposes. The lexical vocabulary of ASL and SE overlap approximately 90% (Wilbur, 1987). These signs do not provide an exact match with English because certain information is carried in ASL not by separate signs, but by derivational and inflectional morphological modifications (e.g., aspect, verb agreement, classifier constructions) that are marked on basic signs by making spatial or temporal adjustments to the sign movement (Klima & Bellugi, 1979). English morphology involves affixes that are added to the stems (plural, past tense, progressive, comparative, superlative, possessive) and freestanding grammatical words (future, prepositions, infinitival "to," and determiners). Because ASL uses other grammatical methods such as spatial arrangement in place of several types of prepositional phrases, signs for many function words and morphemes (e.g., at, to, the, -ing) that are not needed in ASL were invented for SE. These are translated into SE as separate signs, each requiring independent articulation in sequence; the result is that SE sentences have substantially more signs per sentence than ASL. Therefore, SE takes at least 50% longer to produce the same set of propositions than the two natural languages, spoken English and ASL, which are roughly comparable (Bellugi & Fischer, 1972).

The constraint that SE should follow English morphology encourages sequentiality and prevents layering mechanisms from arising. If SE should match English, any child who invents SE (such as those reported by Gee & Mounty, 1991; Supalla, 1991) involving the

types of manual or nonmanual mechanisms that we have discussed for ASL will be under pressure to normalize to the proper English sequence of signs. For example, Supalla (1991) reports that despite pure signed English input and modeling containing no spatially modified verbs or pronouns (and no known contamination by ASL signers), 10-year-old deaf students produced signing in which 80% of the verbs and 86% of the pronouns were spatially modified. The total absence of these devices in the teacher's signing suggests that these innovative spatial modifications will be increasingly treated as unacceptable errors until they are completely eliminated from the students' signing and are replaced by the proper SE forms (sequentially suffixed in the case of the verbs, simultaneously initialized handshapes in the case of the pronouns). Under these circumstances, grammaticization of nonmanuals or manual sign modifications for functions like verb agreement cannot evolve. Furthermore, when adults (usually hearing) learn to sign English, they are already fluent in English and find it convenient to follow English principles, making innovations by this older population less likely. In essence, then, the dominance of English sequentiality of words and morphemes in this communication situation suppresses layering adaptations of signed English.

Wilbur and Petersen (1998) studied two groups of fluent SE users, one that also knows ASL (adult children of deaf parents) and one that does not (teachers, parents, audiologists, speech-language pathologists). In this study, the signers who know ASL were relatively diligent in using ASL nonmanual markers to convey information while producing SE (with or without speech); that is, they extended layering from ASL to SE. The signers who do not know ASL used minimal and occasionally incorrect nonmanual marking while signing SE. For example, some of their SE productions of yes/no questions had correct ASL brow raise on them, whereas other productions were inappropriately marked with brow lowering. Fully 81% of the yes/no questions produced by these signers were not correctly marked by ASL standards. Other nonmanuals (blinks, negative headshakes) clearly differed between the two groups even though both groups were supposed to be producing the same SE content. The signers who knew ASL were able to transfer nonmanuals to SE because

SE has no specified nonmanuals of its own. As a group, the signers who did not know ASL but who are nonetheless fluent users of SE were not homogeneous in their use of nonmanuals because no such system has developed for SE. If this is true for the general population of SE signers who do not know ASL, then it is clear that children are not presented with a consistent adult model of SE in the settings in which it is used.

Finally, the observation that there are systematic cues for intonation in signed languages provides insight into the universal structure of natural languages (Wilbur, 1991, 1997, in press). One may infer that intonational information is a necessary component of the human linguistic and cognitive systems, and that at the prosodic level, the central processing mechanisms of the brain is indifferent to the modality in which such information is received by the peripheral mechanisms (ear or eye), so long as the information is present and appropriate to the linguistic content and communicative situation. There are clear differences between naturally evolved languages prosodically suited to their modality by appropriate layering (ASL and English) and artificial systems like signed English that take structure from one modality (spoken English) and attempt to convey it in another modality (signed English) without regard to modifications that might be appropriate for the production modality.

The Problem With Speaking and Signing at the Same Time

I am arguing that ASL should be used as the initial language of communication and instruction for deaf children and English as a second language. That second language has a signed form (SE), a spoken form, and a written form. I have identified problems with SE and indicated why I do not think it should be the first method of communication and language instruction. However, I want to make it clear that I think there is a role for SE and that it is separate from signing and speaking at the same time. Signed English can be used to assist deaf children as they struggle to understand the differences between ASL and English. It can be used to concentrate on English syntax and morphology and on its written form (reading and writing).

Speaking and signing at the same time is another

matter altogether. First, it should be clear from the above description of ASL that it is impossible to sign ASL and speak English at the same time. There are cognitive, linguistic, and motoric reasons for the presence of English-based signing and the absence of ASL-based signing when speaking English. For example, in English, analytical causatives "causer cause causee event" can occur with animate or inanimate causers, as in "Susan forced Paul to rewrite the report" and "The earthquake made the buildings shake," respectively. In ASL, animate causers take the same word order as English, but inanimate causers require a different structure, as in BUILDINGS SHAKE WHY, EARTHQUAKE (the same wh-cleft structure illustrated in example 2 above; Wilbur, 1994a). Furthermore, the wh-clause BUILDINGS SHAKE WHY is accompanied by a required brow raise, followed by a pause and possibly a blink, and earthquake is typically marked with a head nod (Wilbur, 1994b, 1994c, 1995b). To produce spoken English with ASL, one would have to say "The earthquake" while signing BUILDINGS SHAKE WHY, and say "made the buildings shake" while signing EARTHQUAKE. Aside from such linguistic and motoric mismatches, the information flow that must be tracked cognitively for effective discourse structure is also mismatched, with the causer preceding the resulting event in English and the resulting event preceding the causer in ASL.

Second, simultaneous communication (SC) was designed as an instructional communication method for deaf students. The rationale was that continued exposure to speech while signing would decrease the need for separate speech training. Questions have arisen about the quality of speech that serves as input to deaf children in SC situations. Wilbur and Petersen (1998) reported that in the production of simultaneous communication, speech duration increased as compared to producing speech alone. The rates of speech observed in both conditions confirm those reported by Hyde and Power (1991) for Australasian Signed English. Similarly, Whitehead, Schiavetti, Whitehead, and Metz (1995) and Schiavetti, Whitehead, Metz, Whitehead, and Mignerey (1996) report increased duration measures for various characteristics of speech accompanied by signing, most notably vowel duration and voice onset time (VOT). Taken together, these data indicate that signers have slower speaking rates when

accompanied by signing than with speech alone. The speech is not only slower; it is distorted. As part of the original design of the Wilbur and Petersen study, the speech with and without accompanying signs was also recorded on audiotapes so that the speech could be presented to "blind" duration-measurers who would not know if the speakers were signing or not. It proved impossible to carry out this portion of the experimental design, as even naive listeners were instantly able to identify from the speech when the subjects were also signing. It is important to understand that this does not mean that the speech was unintelligible. As Whitehead et al. and Schiavetti et al. document, speech produced in SC does not violate the English phonological rules that provide necessary cues for morpheme intelligibility, namely the marking of voicing (VOT and vowel duration). Voicing distinctions are critical to separating English consonants and hence English words.

For example, the difference between the two words *bill* and *pill* is the voicing of the initial consonant (carried by VOT); the difference between *bid* and *bit* is a matter of the voicing of the final consonant, the first cue for which is the duration of the vowel that precedes it (longer before voiced consonants). Instead, what slower speaking rate in simultaneous communication creates is a perception of decreased naturalness. A recent study by Schiavetti, Whitehead, Whitehead, and Metz (1998) includes ratings of perceived naturalness in addition to their acoustic measures. They report "significant differences in temporal measures and naturalness ratings between the speech and simultaneous communication conditions." Furthermore, their regression analysis indicated a significant correlation between the measures of temporal duration (which included word, sentence, and interword interval durations) and the ratings of perceived naturalness. Slower, elongated speech such as that produced in SC sounds less natural than speech produced alone, with intelligibility in need of further investigation.

The source of these speech production modifications was not signer fluency (see similar findings in Whitehead et al., 1995; Schiavetti et al., 1996). Rather, the observed modality interaction is likely the result of the prosodic structural mismatches between spoken and signed English. Theoretically, simultaneous speaking and signing contains the same number of words in

each modality, as they are both coding English. However, the number of syllables in the two modalities, and the concomitant metrical pattern, are extremely unlikely to match (Wilbur, 1990a, 1990b, 1993; Wilbur & Petersen, 1997; Wilbur & Schick, 1987). There are numerous mismatches in the number of forms produced because SE frequently requires a separate sign for spoken English suffixes (e.g., -s); hence, a single-syllable word in spoken English (e.g., *cats*) may be two separate signs in SE (e.g., CAT + Plural). Every sign is given full metrical timing (e.g., comparable sign duration) regardless of whether its corresponding English translation is a lexical item or suffixal morpheme (Wilbur & Nolen, 1986a). Hence, the single spoken syllable for *cats* is matched by two full sign productions. Furthermore, spoken English has many words that have two or more syllables, but SE, which gets its basic vocabulary from ASL, contains mostly monosyllabic signs (Coulter, 1982; Wilbur, 1990b). For example, the English word meaning "eliminate" has four spoken syllables but only one signed syllable (cf. discussion of signed syllables in Wilbur, 1990b). Thus, in simultaneous signing and speaking, the number of syllables being produced is usually different in the two modalities.

One implication of the Wilbur and Petersen (1998) study is that there may be a learning sequence toward the development of optimal signer fluency for SC productions: ASL first, SE alone second, and SE combined with speech last. The acquisition of ASL first would provide several benefits. Signers would develop fluency in signing as a motor skill, with an established production prosody against which progress could be measured. There would be fewer problems of interference from the translation of English into ASL, as most modern ASL courses avoid instructional strategies that involve such translation wherever possible. Signers would learn the use of nonmanual marking and develop a grammatical sense of licensed omissions with contextual support. When signers progress to SE alone, they must acquire word-to-sign translation skills and fluency in this new motoric format. Practicing these new skills without the interference of speech effects is likely to be more efficient. Finally, when SE and speech are combined, signers must acquire additional motor fluency to synchronize the two channels. It is at this point that knowledge of ASL will allow signers to make ap-

propriate decisions concerning permissible sign omissions and enable them to provide compensating nonmanual marking and other devices to ensure effective message transmission. Clearly, the linguistic, cognitive, and motoric complexity of simultaneous production of speech and signing is continually underestimated. Yet it is not at all clear what educational functions can be optimally served by SC as opposed to separating signing (ASL or SE) from speech. Until such functions are identified, a straightforward bilingual approach would use ASL for establishing communication and fostering general education, SE as part of the program to teach English contrastively with ASL, and speech separately as a skill to be acquired for future use with hearing people and voice-operated software.

Summary of the Benefits of ASL

The research reviewed here provides strong support for the use of ASL as a medium of communication before a child enters school and continuing into the classroom to develop cognition, socialization, and an age-appropriate knowledge base, as well as providing a basis for learning English and English literacy. Consider the various ways in which knowledge of ASL can be helpful in improving acquisition of English and literacy proficiency with deaf children.

Conversational use of ASL models important features of ASL discourse, and discourse in general (Wilbur, 1990c, Wilbur & Petitto, 1983). As we have seen, ASL requires more obvious attention to the focus of the sentence in order to place that focus at the end of a sentence. This structural requirement in turn requires the signer to separate old and new information, placing the discourse old information prior to the new. Deaf students' difficulty with determiner usage (a/the), pronoun usage, and the stiltedness of their paragraphs is precisely that they do not understand when and how to push old information to the background and how to bring new information to the foreground. The mechanisms for accomplishing these tasks in ASL are clear and consistent, so that children who know ASL come to the task of learning the English counterpart constructions with a strong base of understanding of the differences in meaning that need to be encoded in English syntax. That is, they would already know how to

separate old from new information and have a sense of how conversational flow affects individual sentence structure. The task then becomes one of presenting these children with a situation in the form of "if this is what you mean in ASL, here's how you express it in English." When phrased this way, the task is not confounded by the necessity to also teach the notions of old and new; in short, we now have a typical bilingual learning environment.

Prosodic structure (intonation, stress placement) provides cues to the listener as to where sentences end and new ones begin, as well as providing cues as to whether the speaker intends to continue, plans to yield the floor, expects a response from the addressee, or expresses other conversational controlling functions. These functions are only partially represented in the written form of English, through the use of punctuation and novelty uses of capitals, italics, bold, and graphic symbols (!@$%#). In ASL, sentence boundaries, signer intentions, and conversational controllers are all provided by cues other than the signs themselves. Various nonmanual cues provide overt information about phrasing and syntactic constituency. The difference between a string of words and a real sentence is the "sentence glue" that binds the words into phrases and the phrases into sentences. In ASL, eyeblinks, head nods, and brows raised or lowered all signal the ends of clauses and sentences. The height of the hands signals whether the signer intends to continue, yield, or interrupt someone else (Wilbur & Petitto, 1983). Focus, contrast, emphasis, and other more subtle functions, such as uncertainty, specificity, and inclusion/exclusion, are carried by the face, head, and body (Wilbur & Patschke, 1998). Deaf children who learn ASL first are prepared with full conversational fluency before they begin the task of learning to use English fluently. Full conversational fluency includes the signer's responsibility to ensure that the addressee can follow the topic, who is doing what to whom, and how much certainty the signer places in the truth of the assertions. All these things are coded in normal English usage, but are not part of the standard English lessons provided for deaf students. Again, the task of acquiring English is already simplified when learners have a first language that has prepared them with notions of conversational structure.

Along the same lines, ASL provides clear cues to which noun phrase is the subject/agent and which is the object/undergoer. For many verbs, formation is adjusted so that the verb production starts at a location representing the subject and moves to a location representing the object (see Meir, 1998, for a complete linguistic discussion). In addition, eye gaze and head tilt are also used as subject and object markers (Bahan, 1996). Information about subject and object in English is carried strictly by word order, subject before the verb and object after. Students with knowledge of ASL will find this aspect of English syntax fairly easy to acquire. More important, they will then be prepared to deal with exceptional constructions, such as the passive where the agent is not the subject, because one can explain to them how the two structures (active and passive) differ in the placement of the agent. The use of nonmanuals and spatial modifications of sign formations is one of the reasons why ASL does not need separate signs for many of the concepts that (spoken/signed) English has separate words for. In this respect, the fact that ASL is a naturally evolved language in the visual/manual modality can be fully appreciated-more information is conveyed simultaneously than in comparable English renditions.

As shown in the section on the development of speech skills in deaf learners, early acquisition of ASL does not affect the development of speech production or speechreading skills. Deaf children who have deaf parents who use ASL as the primary means of communication perform at a level comparable to orally trained deaf children from hearing households with respect to speech skills. Deaf children of deaf parents, like other deaf children, routinely receive speech skill training in school. ASL does not compete or interfere with this training; clearly, it produces speech results as effective as oral-only training. In addition, deaf children who know ASL have the further advantages of superior performance on measures of cognitive, linguistic, and social skills.

Finally, there is the fact that ASL has no written form. This is also not a major concern, as more languages do not have written forms than do; many languages are written with the International Phonetic Alphabet (IPA) for use only by linguists and missionaries. Consider the functions that writing serves: long-distance (not face-to-face) communication and preser-

vation of documents for future use. For ASL, these functions are easily served by videotape. The history, stories, biographies, theatrical performances, poetry, and other linguistic expressions of Deaf culture in ASL are preserved in video recordings (and earlier, on film) dating back to the beginning of the twentieth century. Early knowledge of ASL allows deaf students access to their history and culture, which in turn engenders pride in who they are. Through a bilingual, bicultural approach, one should see elimination of what Johnson, Liddell, and Erting (1989) call "the cycle of low expectations," which they suggest is the primary cause of the failure of deaf education in the United States.

If the adults in the deaf child's environment do not know ASL, how can the child develop ASL fluency? Parents trigger the language acquisition process, but they do not control its ultimate outcome. Instead, children acquire the language of their peers. In a monolingual English situation, this same phenomenon is easily seen with dialectal differences: Children of New Yorker dialect parents will acquire the local dialect wherever they grow up. For example, the earlier in their lives they move to Indiana, the more Hoosier they will sound, even though the parents may never lose their New York accent. Children of immigrant parents regularly face the same situation. If the parents speak language X and move to the United States, the younger the children are, the more like native speakers of English they will sound. The earlier the child is placed in contact with ASL, the better the child will learn it. Strategies for accomplishing this contact include opportunities for the child to play with other signing children (deaf or hearing), signing babysitters, regular visits to the local Deaf clubs or schools, and other interactions with members of the Deaf community. Johnson, Liddell, and Erting (1989) provide a number of additional suggestions, many modeled after the successful programs for the Deaf in Sweden. The critical factor is that the child must be placed in an appropriate language learning environment. If the parents never become fluent in ASL and can only just manage in signed English, so be it. The focus should not be on what the parents can or cannot do. Rather, the focus should be on the child's education, which requires communication in a natural language, on which all advanced learning is built. Early knowledge of ASL is a critical part of the solution, not part of the problem.

Notes

1. We emphasized the concept of deaf children as a linguistic minority, whose linguistic and cultural rights should be respected, rather than the older view of deaf children as flawed and somehow incomplete children, who must be made to look and act like hearing children. Prelingually deaf children, after all, are not aware of a "handicap," since they do not know what "normal hearing" is. Only when they are required to look, perform, behave, and achieve like hearing children do they begin to see themselves as "not normal"—as opposed to merely deaf (see extensive discussion of this topic in Padden and Humphries, 1988). It is my hope in reiterating those results here that a responsible approach to deaf education will finally come to pass.

2. But not all structures were similarly enhanced by context; see Wilbur and Nolen (1986b) for details.

References

Ahlstrom, K. (1972). On evaluation of the effects of schooling. In *Proceedings of the International Congress on Education of the Deaf.* Stockholm: Sveriges Laraforbund.

Allen, G. D., Wilbur, R. B. & Schick, B. S. (1991). Aspects of rhythm in American Sign Language. *Sign Language Studies, 72,* 297–320.

Atkinson, M. (1992). *Children's syntax.* Oxford: Basil Blackwell.

Bagemihl, B. (1989). The crossing constraint and 'backwards languages'. *Natural Language and Linguistic Theory, 7,* 481–549.

Bahan, B. J. (1996). *Non-manual realization of agreement in ASL.* Doctoral dissertation, Boston University.

Baker, C., & Cokely, D. (1980). *American Sign Language: A teacher's resource text on grammar and culture.* Silver Spring, MD: T. J. Publishers.

Baker, C., & Padden, C. (1978). Focusing on the nonmanual components of American Sign Language. In P. Siple (Ed.), *Understanding language through sign language research* (pp. 27–57). New York: Academic Press.

Battison, R. (1974). Phonological deletion in American Sign Language. *Sign Language Studies, 5,* 1–19.

Bellugi, U., & Fischer, S. (1972). A comparison of sign language and spoken language: Rate and grammatical mechanisms. *Cognition, 1,* 173–200.

Bellugi, U., &Siple, P. (1974). Remembering with and without words. In F. Bresson (Ed.), *Current problems in psycholinguistics.* Paris: Centre National de la Recerche Scientifique.

Belmont, J., Karchmer, M., & Pilkonis, P. (1976). Instructed rehearsal strategies' influence on deaf memory processing. *Journal of Speech and Hearing Research, 19,* 36–47.

Bernstein-Ratner, N. E., & Wilbur, R. B. (1984). Another look at memory strategies in deaf signers. *Journal of Visual Verbal Languaging, 4,* 55–63.

Bloom, P. (Ed.). (1993). *Language acquisition: Core readings.* Cambridge, MA: MIT Press.

Bonvillian, J. D., Charrow, V. R., & Nelson, K. E. (1973). Psy-

cholinguistic and educational implications of deafness. *Human Development, 16,* 321–345.

Bransford, J., & Franks, J. (1971). The abstraction of linguistic ideas. *Cognitive Psychology 2,* 331–350.

Bransford, J., Barclay, J., & Franks, J. (1972). Sentence memory: A constructive versus interpretive approach. *Cognitive Psychology, 3,* 193–209.

Brasel, K., & Quigley, S. P. (1977). The influence of certain language and communication environments on the development of language in deaf individuals. *Journal of Speech and Hearing Research, 20,* 95–107.

Chall, J. (1967). *Learning how to read: The great debate.* New York: McGraw-Hill.

Charrow, V. R. (1975). A psycholinguistic analysis of "Deaf English." *Sign Language Studies, 7,* 139–150.

Charrow, V. R., & Fletcher, J. D. (1974). English as the second language of deaf children. *Developmental Psychology, 10,* 463–470.

Charrow, V. R., & Wilbur, R. B. (1975). The deaf child as a linguistic minority. *Theory into Practice, 14* (5), 353–359. Reprinted in S. Wilcox (Ed.). (1989). American deaf culture. An anthology (pp. 103–155). Silver Spring, MD: Linstok Press.

Chu, M., & Loritz, D. (1976). Phonological encoding of Chinese ideographs in short-term memory. *Language Learning, 27.*

Clarke, B. R., Rogers, W. T., & Booth, J. A. (1982). How hearing-impaired children learn to read: Theoretical and practical issues. *Volta Review, 84,* 57–70.

Conrad, R. (1962). An association between memory errors and errors due to acoustic masking of speech. *Nature, 193,* 1314–1315.

Conrad, R. (1970). Short-term memory processes in the deaf. *British Journal of Psychology, 61,* 179–195.

Conrad, R. (1971). The effect of vocalizing on comprehension in the profoundly deaf. *British Journal of Psychology, 62,* 147–150.

Conrad, R. (1972). Speech and reading. In J. Kavanagh & I. Mattingly (Eds.), *Language by eye and by ear: The relationships between speech and reading.* Cambridge, MA: MIT Press.

Conrad, R. (1973). Some correlates of speech coding in the short-term memory of the deaf. *Journal of Speech and Hearing Research, 16,* 375–384.

Coulter, G. (1982). *On the nature of ASL as a monosyllabic language.* San Diego, CA: LSA.

Crowder, R. (1972). Visual and auditory memory. In J. Kavanagh & I. Mattingly (Eds.), *Language by eye and by ear: The relationships between speech and reading.* Cambridge, MA: MIT Press.

Cunkle, J. R. (1993). *Talking pots: Deciphering the symbols of a prehistoric people.* Phoenix, AZ: Golden West.

Ewoldt, C. (1982). Diagnostic approaches and procedures and the reading process. *Volta Review 84,* 83–94.

Fletcher, P., & Garman, M. (1986). *Language acquisition: Studies in first language development.* 2nd ed. Cambridge: Cambridge University Press.

Franks, J., & Bransford, J. (1972). The acquisition of abstract ideas. *Journal of Verbal Learning and Verbal Behavior, 11,* 311–315.

Frishberg, N. (1978). The case of the missing length. *Communication and Cognition, 11,* 57–67.

Fruchter, A., Wilbur, R. B., & Fraser, B. (1984). Comprehension of idioms by hearing-impaired students. *Volta Review, 86,* 7–18.

Furth, H. (1966a). A comparison of reading test norms of deaf and hearing children. *American Annals of the Deaf, 111,* 461–462.

Furth, H. (1966b). *Thinking without language.* London: Collier-Macmillan.

Gee, J. P., & Mounty, J. (1991). Nativization, variability, and style shifting in the sign language development of deaf children of hearing parents. In P. Siple and S. Fischer (Eds.), *Theoretical issues in sign language research. Vol. 2: Psychology* (pp. 65–83). Chicago: University of Chicago Press.

Hakuta, K. (1986). *Mirrors of language: The debate on bilingualism.* New York: Basic Books.

Hirsh-Pasek, K., & Treiman, R. (1982). Recoding in silent reading: Can the deaf child translate print into a more manageable form? *Volta Review, 84,* 71–82.

Hyde, M., & Power, D. (1991). Teachers' use of simultaneous communication: Effects on the signed and spoken components. *American Annals of the Deaf, 136,* 381–387.

Johnson, R. E., Liddell, S. K., & Erting, C. J. (1989). *Unlocking the curriculum: Principles for achieving access in Deaf education.* (Available from Gallaudet Research Institute, Gallaudet University, Washington, D.C.)

Karchmer, M., & Belmont, J. (1976). *On assessing and improving deaf performance in the cognitive laboratory.* Paper presented at the American Speech and Hearing Association Convention, Houston, TX.

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

LaBerge, D. (1972). Beyond auditory coding. In J. Kavanagh & I. Mattingly (Eds.), *Language by eye and by ear: The relationships between speech and reading.* Cambridge, MA: MIT Press.

Lane, H. (1992). *The mask of benevolence: Disabling the deaf community.* New York: Alfred A. Knopf.

Liddell, S. K. (1978). Non-manual signals and relative clauses in American Sign Language. In P. Siple (Ed.), *Understanding language through sign language research* (pp. 59–90). New York: Academic.

Liddell, S. K. (1980). *American Sign Language syntax.* The Hague: Mouton.

Lillo-Martin, D. (1993). Deaf readers and universal grammar. In M. Marschark & D. Clark (Eds.), *Psychological perspectives on deafness* (pp. 311–337). Edison, NJ: Lawrence Erlbaum.

Lillo-Martin, D. (1994). Setting the null argument parameters: Evidence from American Sign Language and other languages. In B. Lust, G. Hermon, & J. Kornfilt (Eds.), *Binding, dependencies, and learnability* (pp. 301–318) Hillsdale, NJ: Lawrence Erlbaum.

Locke, J., & Locke, V. (1971). Deaf children's phonetic, visual, and dactylic coding in a grapheme recall task. *Journal of Experimental Psychology, 89,* 142–146.

Lust, B., Hermon, G., & Kornfilt, J. (Eds.). (1994). *Binding, dependencies, and learnability.* Hillsdale, NJ: Lawrence Erlbaum.

Lust, B., Suñer, M., & Whitman, J. (Eds.). (1994). *Heads, projections, and learnability.* Hillsdale, NJ: Lawrence Erlbaum.

Mark, L. S., Shankweiler, D., Liberman, I. Y., & Fowler, C. A. (1977). *Phonetic recoding and reading difficulty in beginning*

readers. Haskins Laboratories, Status Report on Speech Research SR-49, 71–85.

Meadow, K. (1966). *The effects of early manual communication and family climate on the deaf child's early development.* Doctoral dissertation, University of California, Berkeley.

Meir, I. (1998). Syntactic-semantic interaction in Israeli Sign Language verbs. *Sign Language and Linguistics, 1,* 3–33.

Moores, D. (1971). *Recent research on manual communication.* Minneapolis: University of Minnesota, Research, Development, and Demonstration Center in Education of the Handicapped.

Moores, D. (1974). *Educating the deaf: Psychology, principles, and practices.* Boston: Houghton-Mifflin.

Moulton, R., & Beasley, D. (1975). Verbal coding strategies used by hearing-impaired individuals. *Journal of Speech and Hearing Research, 18,* 559–570.

Myklebust, H. (1964). *The psychology of deafness.* New York: Grune and Stratton.

Newport, E., & Meier, R. (1985). The acquisition of American Sign Language. In D. I. Slobin (Ed.), *The crosslinguistic study of language acquisition. Vol.1: The data* (pp. 881–938). Hillsdale, NJ: Lawrence Erlbaum.

Nolen, S. B., & Wilbur, R. B. (1985). The effects of context on deaf students' comprehension of difficult sentences. *American Annals of the Deaf, 130,* 231–235.

Norman, D. (1972). The role of memory in the understanding of language. In J. Kavanagh & I. Mattingly (Eds.), *Language by eye and by ear: The relationships between speech and reading.* Cambridge, MA: MIT Press.

Office of Demographic Studies. (1972). *Academic achievement test results of a national testing program for hearing impaired students: United States.* Washington, DC: Gallaudet College.

Padden, C., & Hanson, V. (1999). Search for the missing link: The development of skilled reading in Deaf children. In H. Lane & K. Emmorey (Eds.), *The signs of language revisited: An anthology to honor Ursula Bellugi and Edward Klima.* Hillsdale, NJ: Lawrence Erlbaum.

Padden, C., & Humphries, T. (1988). *Deaf in America: Voices from a culture.* Cambridge, MA: Harvard University Press.

Paris, S., & Carter, A. (1973). Semantic and constructive aspects of sentence memory in children. *Developmental Psychology, 9,* 109–113.

Pattison, H. M. (1983). *Reading and writing in hearing-impaired children.* Doctoral dissertation, University of Reading.

Petitto, L .A. (1993). Modularity and constraints in early lexical acquisition: Evidence from children's early language and gesture. In P. Bloom (Ed.), L*anguage acquisition* (pp. 95–126). Cambridge: MIT Press.

Pierrehumbert, J., & Nair, R. (1995). Word games and syllable structure. *Language and Speech, 38,* 77–114.

Pinker, S. (1993). Rules of language. In P. Bloom (Ed.), *Language acquisition* (pp. 472–484). Reprint of Pinker, S. (1991). Rules of language. *Science, 253,* 530–535.

Power, D. (1974). Language development in deaf children: The use of manual supplement in oral education. *Australian Teacher of the Deaf, 15.*

Quigley, S. P., & Frisina, R. (1961). *Institutionalization and psychoeducational development in deaf children.* Washington, DC: Council on Exceptional Children.

Quigley, S. P., & Kretschmer, R. E. (1982). *The education of deaf children.* Baltimore, MD: University Park Press.

Quigley, S. P., & Paul, P. (1984). *Language and deafness.* San Diego, CA: College-Hill Press.

Quigley, S. P., Montanelli, D. S., & Wilbur, R. B. (1976). Some aspects of the verb system in the language of deaf students. *Journal of Speech and Hearing Research, 19* (3), 536–550.

Quigley, S. P., Smith, N. L., & Wilbur, R. B. (1974). Comprehension of relativized structures by deaf students. *Journal of Speech and Hearing Research, 17,* 325–341. Portion reprinted in Ventry and Schiavetti (Eds.) (1985). *Evaluating research in speech pathology and audiology.* New York: Wiley.

Quigley, S. P., Wilbur, R. B., & Montanelli, D. S. (1974). Question formation in the language of deaf students. J*ournal of Speech and Hearing Research, 17* (4), 699–713.

Quigley, S. P., Wilbur, R. B., & Montanelli, D. S. (1976). Complement structures in the language of deaf students. *Journal of Speech and Hearing Research, 19* (3), 448–457.

Quigley, S. P., Wilbur, R. B., Power, D. J., Montanelli, D. S., & Steinkamp, M. W. (1976). *Syntactic structures in the language of deaf children.* Urbana, IL: Institute for Child Behavior and Development.

Radford, A. (1990). *Syntactic theory and the acquisition of English.* Oxford: Basil Blackwell.

Sachs, J. (1967). Recognition memory for syntactic and semantic aspects of connected discourse. *Perception and Psychophysics, 2,* 437–442.

Schiavetti, N., Whitehead, R. L., Metz, D. E., Whitehead, B. H., & Mignerey, M. (1996). Voice onset time in speech produced during simultaneous communication. *Journal of Speech and Hearing Research, 39,* 565–572.

Schiavetti, N., Whitehead, R. L., Whitehead, B. H., & Metz, D. E. (1998). Effect of fingerspelling task on temporal characteristics and perceived naturalness of speech in simultaneous communication. *Journal of Speech, Language, and Hearing Research, 41,* 5–17.

Siple, P. (1978). Visual constraints for sign language communication. *Sign Language Studies, 19,* 95–110.

Slobin, D. I. (Ed.). (1985). *The crosslinguistic study of language acquisition.* Hillsdale, NJ: Lawrence Erlbaum.

Smith, P. (1986). The development of reading: The acquisition of a cognitive skill. In P. Fletcher & M. Garman (Eds.), *Language acquisition* (pp. 475–493). Cambridge: Cambridge University Press.

Stevenson, E. (1964). A study of the educational achievement of deaf children of deaf parents. *California News, 80,* 143.

Stokoe, W. C., Jr. (1960). Sign language structures: An outline of the visual communication systems of the American deaf. *Studies in Linguistics, Occasional Papers, 8.*

Stuckless, R. (1981). Real-time graphic displays and language development for the hearing-impaired. *American Annals of the Deaf, 83,* 291–230.

Stuckless, R., & Birch, J. (1966). The influence of early manual communication on the linguistic development of deaf children. *American Annals of the Deaf, 106,* 436–480.

Supalla, S. J. (1991). Manually coded English: The modality question in signed language development. In P. Siple and S. Fischer (Eds.), *Theoretical issues in sign language research.*

Vol. 2: Psychology (pp. 85–109). Chicago: University of Chicago Press.

Thelen, E., & Smith, L. B. (1994). *A dynamic systems approach to the development of cognition and action.* Cambridge, MA: MIT Press.

Tzeng, O. J. L., & Wang, W. S-Y. (1983). The first two R's. *American Scientist, 71*, 238–243, 479, 493.

Vallduví, E. (1991). The role of plasticity in the association of focus and prominence. In Y. No and M. Libucha (Eds.), *ESCOL '90: Proceedings of the Seventh Eastern States Conference on Linguistics* (pp. 295–306). Columbus, OH: Ohio State University Press.

Valli, C., & Lucas, C. (1992). *Linguistics of American Sign Language: A resource text for ASL users.* Washington, DC: Gallaudet.

VanPatten, B. (1995). Cognitive aspects of input processing in second language acquisition. In P. Hashemipour, R. Maldonado, & M. van Naerssen (Eds.), *Studies in language learning and Spanish linguistics: In honor of Tracy D. Terrell.* New York: McGraw-Hill.

VanPatten, B. (1996). *Input processing and grammar instruction: Theory and research.* Norwood, NJ: Ablex.

Veinberg, S. C., & Wilbur, R. B. (1990). A linguistic analysis of the negative headshake in American Sign Language. *Sign Language Studies, 68*, 217–244.

Vernon, M., & Koh, S. D. (1970). Early manual communication and deaf children's achievement. *American Annals of the Deaf, 115*, 527–536.

Whitehead, R. L., Schiavetti, N., Whitehead, B. H., & Metz, D. E. (1995). Temporal characteristics of speech in simultaneous communication. *Journal of Speech and Hearing Research, 38*, 1014–1024.

Wickelgren, W. (1965). Distinctive features and errors in short-term memory for English vowels. *Journal of the Acoustic Society of America, 38*, 583–588.

Wilbur, R. B. (1977). An explanation of deaf children's difficulty with certain syntactic structures of English. *Volta Review, 79*, 85–92.

Wilbur, R. B. (1979). *American Sign Language and sign systems: Research and applications.* Baltimore, MD: University Park Press.

Wilbur, R. B. (1980). Syntax guidelines. In J. Shulman & N. Decker (Eds.), *Readable English for hearing-impaired students: Multi-level guidelines for linguistically controlled reading materials.* Boston, MA: The Caption Center, WGBH Educational Foundation.

Wilbur, R. B. (1982). The development of morpheme structure constraints in deaf children. *Volta Review, 84*, 7–16.

Wilbur, R. B. (1987). *American Sign Language: Linguistic and applied dimensions.* San Diego, CA: College-Hill Press.

Wilbur, R. B. (1990a) An experimental investigation of stressed sign production. *International Journal of Sign Linguistics, 1*, 41–59.

Wilbur, R. B. (1990b). A comparison of signs in American Sign Language and signed English sentences. *International Journal of Sign Linguistics, 1*, 81–105.

Wilbur, R. B. (1990c). Metaphors in American Sign Language and English. In W. H. Edmondson and F. Karlsson (Eds.), *SLR '87: International Symposium on Sign Language Research.* Lappeenranta, Finland, July 15–19, 1987 [International Studies on Sign Language and Communication of the Deaf, Vol. 10] (pp. 163–170). Hamburg: SIGNUM-Verlag.

Wilbur, R. B. (1990d) Why syllables? What the notion means for ASL research. In S. D. Fischer and P. Siple (Eds.), *Theoretical issues in sign language research: Vol. 1. Linguistics* (pp. 81–108). Chicago, IL: University of Chicago Press.

Wilbur, R. B. (1991). Intonation and focus in American Sign Language. In Y. No and M. Libucha (Eds.), *ESCOL '90: Eastern States Conference on Linguistics* (pp. 320–331). Columbus, OH: Ohio State University Press.

Wilbur, R. B. (1993). Segments and syllables in ASL phonology. In G. R. Coulter (Ed.), *Current issues in ASL phonology (Phonetics and phonology, Vol. 3)* (pp. 135–168). New York: Academic Press.

Wilbur, R. B. (1994a). Arguments for sentential subjects in ASL. In I. Ahlgren, B. Bergman, & M. Brennan (Eds.), *Perspectives on sign language structure: Proceedings of the Fifth Symposium on Sign Language Research* (pp. 215–235). Durham, England: ISLA.

Wilbur, R. B. (1994b). Eyeblinks and ASL phrase structure. *Sign Language Studies, 84*, 221–240.

Wilbur, R. B. (1994c). Foregrounding structures in ASL. *Journal of Pragmatics, 22*, 647–672.

Wilbur, R. B. (1995a). What the morphology of operators looks like: A formal analysis of ASL brow-raise. In L. Gabriele, D. Hardison, & R. Westmoreland (Eds.), *FLSM VI: Formal Linguistics Society of Mid-America: Vol. 2. Syntax II and semantics/pragmatics* (pp. 67–78). Bloomington, IN: Indiana University Linguistics Club Publications.

Wilbur, R. B. (1995b). Why so-called "rhetorical questions" (RHQs) are neither rhetorical nor questions. In H. Bos & T. Schermer (Eds.), *Sign language research 1994: Fourth European congress on sign language research.* Munich [International Studies on Sign Language and Communication of the Deaf, Vol. 29] (pp. 149–169). Hamburg: SIGNUM.

Wilbur, R. B. (1996). Evidence for function and structure of wh-clefts in ASL. In W. H. Edmondson & R. B. Wilbur (Eds.), *International review of sign linguistics* (pp. 209–256). Hillsdale, NJ: Lawrence Erlbaum.

Wilbur, R. B. (1997). A prosodic/pragmatic explanation for word order variation in ASL with typological implications. In K. Lee, E. Sweetser, & M. Verspoor (Eds.), *Lexical and syntactic constructions and the construction of meaning* (Vol. 1, pp. 89–104). Philadelphia: John Benjamins.

Wilbur, R. B. (1999a) A functional journey with a formal ending: What do brow raises do in American Sign Language? In M. Darnell, E. Moravscik, M. Noonan, F. Newmeyer, & K. Wheatly (Eds.), *Functionalism and formalism, Vol. 2: Case studies* (pp. 295–313). Amsterdam: John Benjamins.

Wilbur, R. (1999b). Phonological and prosodic layering of nonmanuals in American Sign Language. In H. Lane & K. Emmorey (Eds.), *Festschrift for Ursula Bellugi and Edward Klima.* Hillsdale, NJ: Lawrence Erlbaum.

Wilbur, R. B. (1999c). Typological similarities between American Sign Language and Spanish. *Actas de VI simposio internacional de comunicacion social (Santiago de Cuba), 1*, 438–443.

Wilbur, R. B. (in press.). Stress in ASL: Empirical evidence and linguistic issues. *Language and Speech, 42.*

Wilbur, R. B., & Allen, G. D. (1991). Perceptual evidence against internal structure in ASL syllables. *Language and Speech, 34,* 27–46.

Wilbur, R. B., & Goodhart, W. C. (1985). Comprehension of indefinite pronouns and quantifiers by hearing-impaired students. *Applied Psycholinguistics, 6,* 417–434.

Wilbur, R. B., Goodhart, W. C., & Fuller, D. R. (1989). Comprehension of English modals by hearing-impaired students. *Volta Review, 91,* 5–18.

Wilbur, R. B., Goodhart, W. C., & Montandon, E. (1983). Comprehension of nine syntactic structures by hearing-impaired students. *Volta Review, 85,* 328–345.

Wilbur, R. B., & Jones, M. L. (1974). Some aspects of the bilingual/bimodal acquisition of sign language and English by three hearing children of deaf parents. In M. W. LaGaly, R. A. Fox, & A. Bruck (Eds.), *Tenth Regional Meeting of the Chicago Linguistic Society* (pp. 742–749). Chicago: Chicago Linguistic Society.

Wilbur, R. B., Montanelli, D. S., & Quigley, S. P. (1976). Pronominalization in the language of deaf students. *Journal of Speech and Hearing Research, 19,* 120–140.

Wilbur, R. B., & Nolen, S. B. (1986a). Duration of syllables in ASL. *Language and Speech, 29,* 263–280.

Wilbur, R. B., & Nolen, S. B. (1986b). Reading and writing. In J. V. Van Cleve (Ed.), *Gallaudet encyclopedia of deaf people and deafness* (pp. 146–151). New York: McGraw-Hill.

Wilbur, R. B., & Patschke, C. (1998). Body leans and marking contrast in ASL. *Journal of Pragmatics, 30,* 275–303.

Wilbur, R. B, & Patschke, C. (1999). Syntactic correlates of brow raise in ASL. *Sign Language and Linguistics.*

Wilbur, R. B., & Petersen, L. (1997). Backwards signing and ASL syllable structure. *Language and Speech, 40,* 63–90.

Wilbur, R. B., & Petersen, L. (1998). Modality interactions of speech and signing in simultaneous communication. *Journal of Speech, Language and Hearing Research, 41,* 200–212.

Wilbur, R. B., & Petitto, L. (1983). Discourse structure of American Sign Language conversations; or, how to know a conversation when you see one. *Discourse Processes, 6,* 225–241.

Wilbur, R. B., Quigley, S. P., & Montanelli, D. S. (1975). Conjoined structures in the language of deaf students. *Journal of Speech and Hearing Research, 18,* 319–335.

Wilbur, R. B., & Schick, B. S. (1987). The effects of linguistic stress on ASL signs. *Language and Speech, 30* (4), 301–323.

Wood, S. K. (1996). *Nose wrinkles in ASL: A discourse particle for co-construction.* Paper presented to the American Association for Applied Linguistics, Chicago, IL.

Yip, M. (1982). Reduplication and C-V skeleta in Chinese secret languages. *Linguistic Inquiry, 13,* 637–661.

Yip, M. (1994). Isolated uses of prosodic categories. In J. Cole and C. Kisseberth (Eds.), *Perspectives in phonology* (pp. 293–311). Stanford, CA: Center for the Study of Language and Information.