Morphographic Analysis as a Word Identification Strategy for Deaf Readers

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This review of theoretical and research literature develops a rationale for morphographic analysis as a principal component of instruction on word identification for deaf students. The word identification process is conceptualized with regard to visually accessible morphographic components of text, including definition of the variables involved in morphographic analysis. Evidence accumulated from varied sources is presented to support this rationale for another approach to reading with deaf students. The conclusion outlines implications for instructional intervention and for future research.

Word identification as an integral component of text decoding is, in turn, a critical component of comprehension. As Gough, Juel, and Griffith (1992) note: "[T]he reader is simply one who can recognize words and comprehend them." They describe how preliterate children are already skilled in using words (e.g., to follow directions, understand what is read to them), and the authors conclude that the real task in learning to read is to learn to recognize already known words in printed form. Recognition, unfortunately, is no simple task.

The megapompous technocrat's spouting of polysyllabic terminology demoralized the septuagenarian's genealogical convocation.

As should be clear after this example, the task for a reader is to scrutinize text and decipher its elements into identifiable, meaningful forms. When a printed word is recognized through association(s) in the reader's mental lexicon, its meanings become available to the reader. Subsequently, this information from the lexicon interacts with other components, including the specific context, to conclude a meaning for the text. Word identification is the term used to denote that activity in which the reader engages to move from printed forms on a page to meanings within the internal lexicon. There is evidence of substantial morphological contribution to word recognition at both the perceptual and lexical terminuses of the process. (Consider carefully how you deciphered the words from the above example.) I would like to develop morphological sensitivity within the word identification process as a foundation for early decoding instruction with deaf readers. The first section of this article conceptualizes the word identification process with regard to visually accessible morphographic components and defines the variables involved in morphographic analysis of text. The second section provides evidence to support this rationale for another approach to reading with deaf students. The final sections outline implications for instructional intervention and for future research.

Word Identification and Morphographic Analysis

Just and Carpenter (1992) conducted experiments which demonstrated that poor efficiency in one area of

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processing results not only in inadequate output from that process but degrades the proper functioning of other processes. They used the example of poor decoding and unsuccessful lexical access as causing disruption to higher order processes such as syntactic analysis of text. They also demonstrated that individuals with poor skills work harder to accomplish fundamental tasks, consuming more cognitive resources than skilled readers do. Their research reiterates the importance of word identification as the initial step in comprehension and the fact that positively affecting the word identification process could have significant overall effects on a variety of other comprehension-related processes.

Research with hearing readers has assigned much significance to phonological recoding, (i.e., the mapping of printed symbols onto already known elements of spoken language) as a primary route to lexical access especially for the beginning reader (Liberman, 1983). Specific research has documented the development of phonological awareness and the learning of graphophonemic representation as steps in the acquisition of word identification skill by hearing children (Ehri & Wilce, 1986; Frith, 1985; Hansen & Bowey, 1994). Because of the apparently obvious relationship between hearing and the development and use of phonological skills, deaf readers have been the subject of much reading-related research. They have performed the role of a natural control for determining the significance and function of phonological coding in the development of reading competence (Hanson & Lichtenstein, 1989; Waters & Doehring, 1990). Such research has shown a relationship between reading proficiency and phonological recoding even with some deaf readers. However, the process for acquiring and using apparent phonological skill has been shown to be a very complex one involving many variables. These include parameters affected directly by hearing loss and indirectly by its effects on factors of environment, instruction, and linguistic experience.

A collateral result of reading research comparing deaf and hearing readers has been expansion of knowledge, particularly regarding the contributions of linguistic and orthographic competence to decoding. Furthermore, this research has highlighted the role of vision in the development and exercise of word identification skills. My premise is that the same body of knowledge regarding the decoding process also suggests a potentially advantageous approach to word identification instruction for deaf students.

Vocabulary Knowledge and Word Identification

Differences in the performance of deaf versus hearing readers in vocabulary knowledge and efficiency of text processing have been documented in the literature (Furth, 1966; Quigley & Paul, 1984; Trybus & Karchmer, 1977; Waters & Doehring, 1990). Vocabulary difficulties and deficiencies, of one form or another, often have been attributed to inadequate language learning experience of deaf students (Griswold & Cummings, 1974; Quigley & Paul, 1984; Walter, 1978). According to Stanovich, West, and Cunningham (1991), deaf children do possess the appropriate "wiring" (i.e., innately directed processes) to develop the linguistic competencies that are prerequisite to literacy. However, due primarily to deficiencies in linguistic input (arising from hearing loss and ineffective compensatory strategies by adults in their environment), they reach less than adequate levels of competence in conversational English. The predictability, precision, and communicability of English grammatical conventions, word level and beyond, that can be brought by aspiring hearing readers to comprehension of English print is disrupted.

Text processing differences are another possible source of reading performance differences. As researchers have noted, really very little is known about the word recognition processes of deaf readers (Merrills, Underwood, & Wood, 1994; Paul, 1998). Presumed impediments to abstracting a phonological form through which to process words has been cited principally as an underlying cause of deaf readers' difficulties (Hanson, 1982, 1991). Others have blamed failure of word recognition as responsible for more generalized comprehension failure at the sentence and discourse levels (Marschark & Harris, 1996).

Specific problems of deaf students with vocabulary include reduced size of the vocabulary stock generally, deficiencies in certain categories of words, narrower than normal range of meanings for any given word, and failure to relate inflected and derived forms of words.

A sense of the magnitude of this problem is garnered from a very early (but clearly still valid) study by Cooper and Rosenstein (1966), which determined the "average vocabulary level of deaf eighteen-year-olds to be about the fourth grade level" (p. 976). A significant word-based factor changes the reading equation by the third or fourth grade level from "learning to read" to "reading to learn," which spotlights the reading of subject matter text that students first encounter at this level. A more basic fact is that fourth grade reading material, subject matter texts especially, require students to read more different words and more complex words.

Vocabulary knowledge is a very significant variable in successful reading generally (Gough, 1984) and also has been shown to correlate highly with reading achievement for deaf students (LaSasso & Davey, 1987; Waters & Doehring, 1990). Evidence indicates that differences in vocabulary performance are at least partially attributable to disparate knowledge of the morphological make-up of words. Differences between good and poor readers in their ability to recognize words (i.e., speed and efficiency) is even more pronounced for morphemically complex words (Nagy, Anderson, Schommer, Scott, & Stallman, 1989). The morphographic instructional focus proposed here targets both print vocabulary processing, which is a particular weakness of deaf readers, and use of the visual channel, which is typically a strength of deaf students.

Sight and Sound in Learning to Identify Words

At this point, it is necessary to distinguish between learning to read and fluent reading. This distinction is essential to comprehension of the components involved in word identification and their relation to the eventual skill and automaticity that mark the successful outcome of the learning process.

The process of fluent reading has been described in some detail elsewhere (Just & Carpenter, 1992; Perfetti, 1992). Without repeating details here, I will note points relevant to this discussion. In the early stage of learning to read, beginning readers rely heavily on letter-by-letter analysis and production of graphophonemic correspondence. This sounding out process can be observed during oral reading and is often used for assessing the level of students' mastery and integration of component word identification skills. Over time in the maturing reader, this process apparently becomes almost effortless. By approximately the age of nine, the average reader no longer routinely sounds out words. The letter-sound associations for groups of letters in larger segments of words have been committed to memory. That is, with increasing experience and word familiarity, middle steps in processing may be eliminated. Words may be instantaneously recognized visually and their cognitive associations immediately made available to higher level analytical and comprehension processing. The intermediary process of recoding to speech is no longer necessary (Gough, 1984; Stanovich et al., 1991). The end result is processing similar to how readers must always handle irregular words, those words for which graphophonemic analysis does not produce the proper pronunciation (e.g., *is, was*). Referred to commonly as "sight words," the printed forms of these irregular English words are straightforwardly committed to memory, presumably according to some aspect of their visual configurations. Bowey and Patel (1988) suggest that much early decoding is of this nature.

Thus, phonological recoding is not the process by which fluent readers decode most words. Indeed, it is the effect of this practiced effort over time that results in the automaticity of orthographic processing. This was the reason for emphasizing the critical distinction between learning to read and fluent reading. Until recently, descriptions of the behaviors of fluent readers and novice readers were intertwined in the reading literature as if they were merely age-varied versions of an identical process. Hence, any observed performance variables were presumed to be involved in and necessary to the ultimate competence of any fluent reader (i.e., sounding out was something that good readers had to do). Perhaps it is possible to be more flexible about what is absolutely *necessary* in *learning* to read.

At the printed page terminus of the decoding process, when one scans a word into the deciphering mechanism, a reader attends to the graphic content of words (i.e., the letters). Further examination of the constituents of printed English reveals that much more than letter information is actually available to the reader.

English has been described as employing a “deep alphabetic” system (Moats, 1998). That is, the orthography of the language reflects not only phonemic but syllabic, morphemic, and orthographic aspects of the language as well. For example the printed word *reading* decomposes phonologically into direct letter-sound correspondences for *-r* and *-d,* more variable correspondence between the *-ea* spelling and the long *-e* sound, and so on. At the same time, the printed code also decomposes into two syllables that, coincidentally, also represent its two morphemic constituents: a base word, the verb *read,* and an inflectional suffix, *-ing,* that adds the meaning of *ongoing* to the meaning of the verb. It should be clear from this example that some translation is required to accomplish the letter-sound associations (e.g., graphophonemic correspondence) necessary to arrive at meaningful segments that can be processed toward comprehension of a text. In contrast, the structure (i.e., orthographic configuration) of a printed morpheme that is essentially meaningful can be perceived directly when a reader encounters text. Identification of a morpheme is coincidental with identification of its meaning. Throughout this article, *morphograph* will be used to designate the graphic representation of a morpheme.

Orthographic regularities, the eventual stimuli for word identification, express spelling and morphological constraints on the occurrence and order of letters, base words, and affixes. All of this input is visually available to perception as processing begins. Morphographic information is again consequential at the lexical terminus of the process where both phonological and orthographic (including morphemic) stimuli can enervate access. Internal to the lexicon, the organization also reflects morphological composition of elements (Marslen-Wilson, Komisarjevsky, Waksler, & Older, 1994). These aspects of morphographic processing will be discussed in more detail later. The point here is that current processing theory appears to allow for important roles in word identification for both phonologically based and visually based components. Instructional emphasis specifically on the role of phonological recoding may be unhelpful to many readers, including deaf students, whose perceptual, attentional, or cognitive skills do not accommodate this traditional approach to word analysis. Unfortunately, the visual component of the process outlined in the theoretical reading literature has not as yet translated significantly into general instructional practice.

Patterns and requisites in developing and using morphographic skills are central to this article. However, morphographic processing has not been extensively researched, particularly in relation to deaf subjects. Because of this deficiency, I will examine research providing pertinent evidence of visual processing or, more specifically, orthographic processing for proof that deaf readers use morphographic strategies in word identification.

A Morphographic Model for Word Identification

Morphology is the study of the structure of words and rules concerning their usage. Included are processes for combining and arranging meaningful segments into longer, more complex words. A morpheme is the smallest unit of meaning in a language. English morphology includes root forms, along with forms and rules by which affixing may expand the utility of roots to encode nuances of meaning and to serve grammatical needs within sentences. Root morphemes may be free or bound forms. Free morphemes can stand alone as basic words (e.g., *build*). Bound roots, to function as words, must be completed by addition of some other morpheme (e.g., pre + *dict* or *dict* + ion). Some morphemes have both a free and a bound variant (e.g., *scrib-*, *script*). In addition, an understanding of inflectional and derivational morphological processes is essential to acquiring and using a large vocabulary. Potential readers require knowledge that English employs affixing of inflectional morphemes to mark specific classes of words with syntactic information as required by context (e.g., verbs + *ed* for past tense or nouns + *s* for plural). Similarly, affixed derivational morphemes create related word forms to function as different parts of speech (e.g., the verb, *establish,* and the noun, *establish* + *ment*). In English, inflections are almost always suffixed (i.e., added to the end of a root or base word stem). Derivational forms may be either suffixes or prefixes (i.e., forms like *re-* or *bio-* added to the beginning of stems). Of course, roots and affixes are constantly combined in new ways to create new words for new ideas. Information about morphology is useful both expressively and receptively, to produce clear and precise conversation as well as to accurately interpret printed language.

The proposed morphographic approach to word identification refers to Frith's (1985) model for learning to decipher the printed code of English. She identified three stages in the normally functioning child's reading development that are characterized by the decoding strategies used to accomplish word identification. These stages describe features of text to which readers attend, as well as the skills readers acquire that change the interdependence among visually based and phonologically based strategies over time. The first stage, *logographic,* is fundamentally visual but not very analytical (otherwise known as visual cue reading according to Ehri, 1992). Words are identified in rote fashion apparently with attention to the gross graphic configuration of a word or to some outstanding graphic element of it in conjunction with strong links to context (e.g., the golden arches M for *McDonald's*). Visual skills, meaningful exposure to print and world knowledge, contribute to development at this stage. In contrast, the second *alphabetic* stage is very analytical in that students identify, element by element, the nature of English's alphabetic system for representing spoken words through rules of graphophonemic correspondence (phonetic cue reading in Ehri, 1992). Segmental skills, particularly phonemic representation, along with visual discrimination, appear to be key at this "sounding out" stage. In the final stage, skilled readers analyze words into larger *orthographic* units, which are precisely defined by the nature and configuration of their letter and morphemic content. Here, facility with spelling conventions (letter groupings) and word structure constitute the basis for processing (cipher sight word reading in Ehri, 1992).

For readers of English who may have difficulty accessing phonology in word identification, an alternative avenue, one for visually analyzing print into meaningful segments, would be beneficial. A morphographic analytical approach can capitalize on the speed associated with direct visual scanning to meaning, which is characteristic of logographic processing (Frith, stage 1), in conjunction with the specificity of component analysis (segmental identification and order), which is characteristic of alphabetic processing (stage 2). The cumulative result of this combination of visual and segmental processing would approximate word-specific orthographic processing (stage 3). Ehri (1992) further describes the mature process: "The process differs from phonological recoding in that word specific connections rather than translation rules are used to read words. As a result, the words are accessed directly in memory from their printed forms rather than indirectly from pronunciations, and information about the spellings of specific words is retained in memory and amalgamated with information about pronunciations and meanings" (p. 108).

In the morphographic version of this developmental model, emphasis on morphographic elements replaces emphasis on phonemic elements as the focal constituent for analyzing print. Morphographs include print representations of base words, roots and affixes such as *open, -struc,* and *-ize.* In this model, the initial logographic stage is of particular importance. Sight word identification is the principle means for acquiring recognition of base vocabulary, as it likely always has been for those deaf students who cannot recode to speech. Morphographic analysis comes into play just as soon as students encounter multimorpheme words (even at the beginnings of early sight word reading (e.g., *pieces, says, laughing*). Under this model, the morphographic segments targeted for deciphering practice (stage 2) are meaning-based from the start, not tied to intermediate spoken forms. Deaf readers thus circumvent both the necessity of acquiring mastery of the phonemic system of English and the later difficulties usually experienced (by most readers) in learning to apply graphophonemic correspondence to read English. In Frith's model, readers at the third stage begin to focus on orthographic processing of words. Under the morphographic model there really is no third stage because printed segments tied directly to meaning have been the focus all along. Developmental progression under this model involves moving to ever more abstract or linguistically distant forms, that is, from frequently occurring forms or those with demonstrable meanings (e.g., *-s* as in *dogs; -ing* as in *sleeping*) to less frequent (e.g., *-ment* as in *payment*) or linguistically constrained forms (e.g., *ir-*as in *irregular*), and lastly to historical roots and bound forms from which current English words are derived (e.g., *aud,* a Latin root meaning

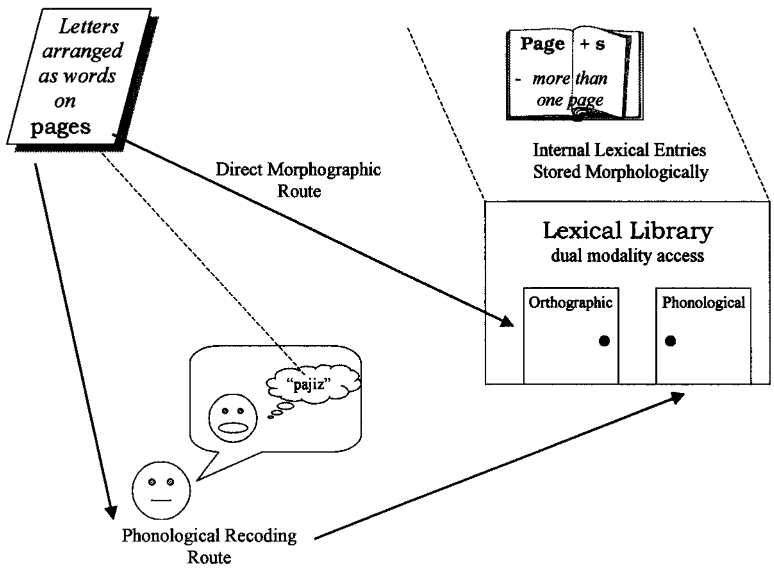

Figure 1 Phonological and morphographic routes to identification of the word *pages.*

"hear," and *gram,* a Greek root meaning "record," as in *audiogram,* meaning "graph of hearing"; *uni-*, a Latin prefix meaning "one" and *cycl,* a Greek root meaning "circle," as in *unicycle,* meaning "one-wheeled vehicle").

Figure 1 depicts the difference between the phonological recoding route and a morphographic route from the printed word to the reader's lexicon. The diagram shows that, in identifying the word *pages,* typical beginning readers rely heavily on an intermediary loop of phonological recoding before advancing to direct memorized activation of lexical meaning by the specific graphic configuration of the word. With practice, the time required to execute word identification is reduced as the direct associative connection between the visual print stimulus and mental meaning is developed.

The value of a morphographic approach to word analysis is apparent when one considers the frequency with which readers encounter multimorpheme words in print. In general, the length and complexity of any particular word is inversely related to that word's frequency (and likely familiarity). The length of a word to a great extent reflects the number of morphemes in it. The most frequent words are short and contain only one morpheme (e.g., *can, run*). The more morphemes a word contains, the more complex or precise its meaning. Specificity in meaning limits the contexts in which a particular word has utility, so the most complex words are also usually low in frequency of occurrence in samples of text. Infrequent exposure to a word reduces its visual familiarity and so increases the decoding difficulty of the word (i.e., the time required to identify it). One feature of advanced, more conceptually abstract and complex text is increased morphemic content and structural complexity within individual words. Any skill that increased the analyzability of less frequent, less familiar words would have the potential of increasing word processing speed. In an optimistic note for students and teachers, words with the lowest frequency of occurrence in texts (less than once per 1 million words) most often fall into the category of very "analyzable" words, those that are compounds, affixed derivations, or inflections of more familiar words. In typical school materials (a significant proportion of the texts children read), affixed words are four times as common as simple words (Nagy, Osborn, Winsor, & O'Flahavan, 1994). One way to improve the readability of advanced texts, then, would be to improve students' ability to identify the meanings of affixed words.

In order that a child have sufficient "readiness" for learning to decode, certain knowledge and skills must be within the potential reader's competence. Gough et al. (1992), in addressing the requisites for development of word identification proficiency, suggested that four conditions were critical: (1) cryptanalytic intent,

(2) awareness of letters in the written word, (3) awareness of phonemes in the spoken word, and (4) exposure to written words paired with spoken words. The first condition supposes that a reader understands the segmental nature of words and how to apply this knowledge in approaching print materials. The second condition involves primarily visual skills such as discrimination and sequencing of print segments, whereas the third specifies similar abilities in the auditory domain. The fourth and final condition requires that, for each reader, a solid connection be made between elements of the language that individual has come to know through conversation and the expression of that language in printed form. With the exception of phonemic awareness (i.e., the ability to perceive and discriminate linguistically significant sounds), Gough and his colleagues believed that these conditions were "easily provided (or encouraged) by instruction, if not by the child's natural environment" (1992, p. 40). In other words, the step or leap taken in learning to read is the association of specific configurations of print with specific configurations of conversational language.

Utilization of a morphographic model of word identification eliminates the requirement for phonemic awareness. Instead, this version of the model substitutes a more general notion of *segmental awareness* in conjunction with visual analysis of both conversational and printed language forms. So readiness requirements would still include (1) the intent to analyze words, (2) well-developed visual skills and segmental awareness (morphological and orthographic), and (3) experience with the connections between printed (morphographic) segments of words and the meanings they encode. Morphographic connections would be instructed just as phonics instruction seeks to clarify graphophonemic correspondence.

Specifically, I am proposing that, for deaf readers, morphographic analysis can be a more efficient (faster and more reliable) route to word identification for multimorpheme words than phonological recoding is. If word identification speed interacts with constraints of the working memory processes underlying comprehension, a more efficient word identification process would be expected to improve comprehension. As depicted in Figure 1, graphophonemic analysis is inefficient for word identification because each phoneme in a word must be identified along the way and phonemes are the smallest, thus most numerous, components of any word. The morphographic model, in addition to relying on direct visual→memory learning and inherently meaningful segments from the start, has the added advantage of utilizing the largest constituents of print stimulus words (i.e., fewer morphemes to identify, compared to phonemes or syllables). Readers sensitized to meaningful associations for orthographic segments would identify patterns within words directly as they encounter them in print (i.e., visual form→lexical entry). The principal distinction between the models is the nature of the segment addressed in analyzing words (i.e., morpheme vs. phoneme). The reliance upon larger morphographic segments in vision rather than sound-based word analysis should still accommodate the processing constraints of working memory by permitting more print to be handled in any given time frame. Such an approach would be of benefit to deaf readers generally but is especially appropriate as a principal strategy for those readers whose hearing losses (or other learning difficulties) preclude substantial access to phonology.

The Case for Morphology in Word Identification

The flexibility and the recombinative possibilities of English morphemes make needed lexical expansion (e.g., *Internet, superstructure*) both facile and precise. I would like to suggest a number of reasons why the formality and predictability of English morphology should be used as the basis for word analysis in print decoding by deaf readers.

In discussing dyslexia, Frith (1985) outlined various types of developmental reading and spelling problems. In doing so, she identified "compensatory" development of skills in nonimpaired areas that was "way beyond" normal expectations. For example, readers with phonological coding deficiencies developed greater logographic skills, acquiring exceptionally large sight word vocabularies (as do many deaf readers). Naturally or incidentally developed compensatory strategies, however, will not likely be sufficient to enable high levels of achievement in deaf readers, owing to underlying linguistic deficits or insufficient exposure to varied vocabulary resulting from reduced reading experiences.

A rationale for morphology as a basis for instruction in word identification skills for deaf readers derives from the current conception of reading, especially related to vocabulary knowledge and print processing, as well as from the data available on visual processing and English performances of deaf individuals. This section presents evidence concerning the utility of morphographic analysis in fulfilling the conditions necessary for word identification.

Morphographics as a Cryptanalytic Focus

Nagy et al. (1994) provide a clear picture of the word identification task facing elementary students, especially in relation to decoding school reading materials. The average fifth grader, reading English, will encounter a million words of text in a year. A relatively small set of those words will occur repeatedly, whereas the vast majority of words occur very infrequently. Of the million words a student reads, perhaps 10,000 will be seen only once (many of them new to the student, therefore potentially problematic). Let us examine these 10,000 words in more detail. It can be expected that 4,000 of them will be derivatives of some more commonly known forms (e.g., *multisensory, departmentalize*). Another 1,300 will be inflected forms of more common words (e.g., *institutions, deliberating*). Proper names will account for approximately 1,500 words in the text sample whereas another 2,200 will be specialized forms of familiar words (e.g., capitalizations, abbreviations, numbers). That leaves only 1,000 words that will be truly new words for the student, previously unencountered and unrelated to words he or she already knows. In summarizing their findings, Nagy et al. (1994) stated: “Skilled readers are not readers who never encounter words they do not know but rather are readers who effectively deal with words that are new to them” (p. 46). The ability to use a storehouse of morphological knowledge to analyze newly encountered words greatly enhances the reader’s facility in decoding nearly all of the text he or she reads.

Wysocki and Jenkins (1987) note that vocabulary size increases for hearing readers by 100% between grades 3 and 7. They proposed that this huge increase could only be partly a result of direct vocabulary instruction or of learning words incidentally from context during reading (both important processes). They concluded that it was most likely derived from the cumulative result of word analysis skills developed through a process labeled “morphological generalization.” That is, over time, with experience, a reader learns to segment and recognize individual printed morphemes comprising words (i.e., bases words with affixes) and to associate individual meaning with each morpheme. Then, while reading, in a process well described by White, Power, and White (1989), the individual utilizes such information to decode words: step 1: remove the affixes to expose a root form; step 2: check the lexicon for the meaning of the root; step 3: add the meanings of stem/root and the associated affixes to arrive at the meaning of the whole word. The resulting meaning would then be checked for its sense in the context within which the word is embedded (Nagy et al., 1994). Over time, through the process of morphological generalization, readers evolve a comprehensive and productively flexible vocabulary.

Wysocki and Jenkins (1987) have called morphological generalization a “powerful generative tool” for expanding vocabulary. Rather than learning individual words, a developing reader may learn elements and rules for combining elements that permit both recognition and construction of a far greater number of vocabulary items. Nagy et al. (1989) note that for each common English root (e.g., *act*) there are, on average, three to four additional forms closely related through derivational processes (e.g., *active, enact, react*). The potentially huge difference in identifiable vocabulary they describe does not even take into account additional words resulting from inflection of the same root (e.g., *acting, acted, acts*).

As I noted above, factors of time and experience are important in the development of skills in morphological generation. It is apparent that requisite morphological knowledge is related both to a reader’s age and to exposure to print materials. Nagy et al. (1989) showed that, with the frequency of a word already taken into account, the age when one acquires a word affected participants’ reaction time in identifying it. In other words, the longer the length of time a pathway from print to lexicon for a particular word has been exercised, the quicker will be a reader's response to it. Exercise of such pathways requires that a potential reader be exposed to print. Wysocki and Jenkins (1987) make it clear that children who read less will benefit less in using the regularities of print to develop generative competence incidentally.

These findings are particularly relevant considering the diminished language input and subsequent abridged language development typically experienced by deaf readers. These students need instructional access to vocabulary building experiences and the means to evolve subsequent analytical and productive vocabulary skills. They require an alternative reading program, designed especially for them (Kusché, 1985: Marschark & Mayer, 1998), to reverse the downward spiral of inadequate conversational language development leading to late and reduced acquisition of reading skills, leading to comparatively worse and worse vocabulary and comprehension performances over time. Morphographic instruction can provide segmental skills that have proven utility in both vocabulary building and word identification.

Morphographic Analysis Maximizes Visual-Linguistic Capabilities

Fundamental to our discussion of deaf readers, morphology as a word identification factor is accessible through vision. Evidence from a variety of visual processing and print-related performances indicates that morphographic analysis has good potential as a focus for word identification with profoundly deaf readers. When researchers first noted apparent phonological recoding in deaf readers, they found that it correlated with subjects' lip-reading ability. This finding is of particular interest because it illustrates the point that deaf individuals accomplish tasks apparently similar to those of hearing subjects but, as is frequently discovered, in very different ways. Although the early evidence of phonological coding in reading achievement by deaf readers confirmed the popular theoretical conceptualization of the reading process, it was also puzzling. The expectation had been that phonological coding would not be available to persons with significant hearing loss because the auditory input presumed to generate underlying phonemic awareness was, at best, greatly compromised.

Research has demonstrated that an abstract system for phonemic representation of language apparently can be developed through visual mediation. That is, a connection between what can be seen on the lips and specific elements of spoken language can be established (Campbell, 1987, 1992; Dodd, 1987a, 1987b; Hanson, Goodell, & Perfetti, 1991), especially under circumstances of intensive training. Orally trained deaf readers appear to use something labeled for hearing readers as "inner speech" (Campbell & Wright, 1990; Conrad, 1979). That is, processing is facilitated by recall of the visual features of lip-read sounds or sensations associated with their pronunciation. Further, it appears that supplemental manual systems for "cueing" phonemic distinctions as they are produced in speech may help deaf students to master the English phonological code (Leybaert, 1998). It is important for purposes of this discussion that an alternate visual avenue for acquisition of a phonological code appears to exist and to be effective for those deaf individuals who can learn to utilize it. In more recent work, Sutcliffe, Dowker, and Campbell (1999) have clarified what may underlie this performance. They explain that deaf persons may be using wholly visual strategies in producing responses to a spelling task that appear to be phonologically derived. They conclude by cautioning "that evidence for phonological sensitivity in deaf people, particularly deaf children, should be examined very carefully before it is accepted" (p. 121). Furthermore, research designed to examine phonological skills presumed to affect reading performance does not present a full picture of the visually based capabilities of deaf persons in processing linguistic information. Predominant reliance on vision for information processing, and the influence of visual-spatial language in particular, affects perceptual and cognitive development of deaf individuals. Although not compensating for loss of hearing with mythically superior visual acuity, deaf individuals do generally develop habits and skills that utilize vision to code and manipulate information in ways not common to hearing people. These range from patterns of conceptualizing and remembering spatial information to dreaming in sign (Bellugi, Klima, & Siple, 1975; Campbell & Wright, 1988, 1990; Odom, Blanton, & McIntire, 1970).

Studies investigating the nature of visual and sign-based processing indicate multifaceted ties to cognitive organization. Deaf persons respond to semantic relationships as well as to formational characteristics among signs just as they and hearing persons respond to words either spoken, printed, or lip-read (Hoemann, Andrews, & DeRosa, 1974; Moulton & Beasley, 1975; Shand, 1982; Treiman & Hirsh-Pasek, 1983). Under the right conditions, when a hearing person might mistakenly recall the word *cat* as *cot* or *sat* (sound confusions), a signing person might recall -the erroneous items *name* or *short* for the stimulus *sit* (sign confusions). Treiman and Hirsh-Pasek (1983) showed the visual-manual equivalent of tongue-twister effects ("finger fumbler" effects) (Klima & Bellugi, 1979) with deaf individuals who reported that they were using sign coding to process sentences.

Visual coding strategies interact with other variables such as constraints on processing speed or order to affect the efficiency of processing. At times, visual processing results in slower or less accurate responding (Hanson, 1982), while at other times it may result in greater speed but less accuracy, for example, in judging the semantic acceptability of sentences (Hanson et al., 1991). Marschark and Mayer (1998) note, with regard to memory research, that variations of stimulus and response conditions result in "deaf individuals having better, equal or worse memory as compared to hearing individuals" (p. 67). They conclude that working memory that utilizes sign coding functions in much the same way as spoken language coding but that the cognitive organization and strategies employed by deaf individuals as these relate to variables of linguistic coding are still not clearly delineated.

During the 1970s, much was made in the developmental literature generally of the establishment of hemispheric lateralization and its presumed relationship to reading performance, handedness, and so forth (Geschwind, 1979). Since then, comparisons of deaf with hearing persons have attempted to determine the effects of sound-based versus visually based language on brain organization and functioning (e.g., Kelly & Tomlinson-Keasey, 1977; Rhodda & Grove, 1987). Recent investigations have revealed uniqueness in perception and cognitive organization in deaf persons. Wolff and Thatcher (1990), using patterns of EEG responses, found evidence of differences between deaf and hearing persons on neurological organization and connectivity. They attributed the asymmetries they noted to lesser auditory and greater visual stimulation experienced by their participants with severe to profound bilateral hearing losses occurring before or during infancy. Courtin (1997) conducted a study suggesting the importance of the nature of visual input to deaf children. He examined categorization performance of young second-generation French signers and found not only differences in this specific ability but increased cognitive flexibility when compared to hearing children. He attributed the results to effects of transparency in underlying relationships as reflected in the formational characteristics of the sign language to which the deaf children had been exposed.

Emmorey (1998) conducted an extensive review of related research, stemming principally from faculty and colleagues of the Salk Institute, on cognition and the use of sign language. Her review makes the point that long-term intensive visual linguistic processing does alter the cognitive dynamic of an individual. Presumably because manipulation of spatial relations is incorporated into the grammar of American Sign Language (ASL), deaf signers were shown to be more accurate in constructing, identifying, and remembering distinct arrangements of spatial configurations. In the course of describing these findings, Emmorey makes it clear that the results do not reflect a generalized heightened visual-spatial capability stemming from deafness itself but rather are a function of exposure to and experience with the production and comprehension of sign (visual-manual) language. In an important addendum to the review as a whole, she notes that lifelong experience with sign is not a requirement for certain enhanced cognitive performances but that more research is needed to clarify differences in neurological development and organization as a result of early versus later sign exposure.

A few other studies have specifically examined the behaviors of successful deaf readers (mostly second-generation deaf adults) and provided evidence of visually directed decoding. In a series of three experiments utilizing word meaning, wording segmentation, and sentence completion procedures, Hirsh-Pasek and Freyd (1983a, 1983b) determined that deaf readers used visual cues from the text to accomplish morphological segmentation and processing. Further, in their comparison of the performances of poorer hearing and deaf readers in their study groups, they found that poorer deaf readers were able to use such information better than poorer hearing readers. A later study showed that deaf readers appeared to approach the segmenting/ storage of words in a word boundary + ending format (Hirsh-Pasek & Freyd, 1984).

Treiman and Hirsh-Pasek (1983) determined that whereas morphologically based processing of English text appeared to be accomplished by some subjects through translation into their native ASL, the performance of the best readers did not show such sign mediation. In an explanatory note, they added that sounding out through ASL would not be an optimal strategy because it "does not take advantage of the structure inherent in the English orthography" (p. 5). Leybaert (1998) has explained how visually mediated manual Cued Speech signals facilitate the process of phonological encoding of English. (Under cueing conditions, full encoding of morphological elements is also accomplished.) Detailed research on the processing of manual English as it relates to specific aspects of decoding performance has yet to be conducted.

Merrills et al. (1994), in experiments that manipulated the orthographic characteristics of English words, concluded "that deaf readers access the meanings of words through the spontaneous use of visual mechanisms . . . even under conditions in which it is inefficient to do so" (p. 380). Researchers have speculated that deaf individuals might be coding information at the level of whole words (Waters & Doehring, 1990) or signs (Treiman & Hirsh-Pasek, 1983). I would like to suggest an intermediate hypothesis that potentially accounts for larger than phonemic segmentation, in the presence of evidence for visual coding. Such performance may reflect word analysis at the morphemic level.

There are two important conclusions apparent from all of the research presented in this section. First, deaf individuals readily adjust to and use the available visual input to accomplish linguistic processing. Second, deaf readers, even poorer deaf readers, use available orthographic regularities in printed English as the basis (however mediated through other visual-manual elements) for decoding. Given this propensity of deaf readers to utilize orthographic information, formal and organized instruction concerning the morphological relationships that are expressed graphically in printed words will serve to facilitate word processing.

Morphographic Analysis Is Segmental and Reliable

There is nothing natural or obvious about the association between printed symbols and the sounds they represent. As Mann (1991) has stated, in the case of reading, unlike the acquisition of spoken language, the critical fact may be that segmental or phonemic analysis of language in printed form appears to be a learned skill. If it can and must be consciously learned, then means to facilitate this learning must be pursued.

Part of what makes the task of word identification in English difficult is that the correspondence between English orthography and spoken English is complex. The inconsistencies in English are bi-directional; that is, for many phonemes there are multiple spellings and for many letter clusters there are multiple pronunciations. Mastery is a very challenging endeavor even for hearing beginning readers. In recognition of this, instruction of graphophonemic segmental skills is a principal component of early reading instruction. Consequently, research has shown that the component graphophonemic skills that result in decoding facility in hearing children (i.e., letter-sound correspondence) show a marked increase after the age of five or six, not uncoincidentally the age at which these children are usually systematically instructed in such skills (Liberman, Shankweiler, Fischer, & Carter, 1974).

Elbro and Arnbak (1996) utilized the perspective provided by reference to a number of languages in discussing the role of morphology in reading and spelling. They observed that, in English, the reliability of the relationship between morphemes and their written representation is good, compared to its "notoriously irregular" graphophonemic correspondence. Further, these authors supported an earlier conclusion of Liberman (1983) that this unpredictability, of the transfer from the sounds of English to representation of those sounds in print, was a source of significantly more difficulty in both reading and spelling for students with learning or reading disabilities. Elbro and Arnbak pointed out that some difficulties that normal readers have with English orthography could be eliminated by focusing on morphology instead, because many words with spellings that appear to be "irregularities" from a phonics point of view appear regular when analyzed morphographically (e.g., *bomb* from *bombardment,* p. 210). It is enlightening that a strategy commonly employed by published spelling programs in general education to alleviate the typical errors produced by irregularities in English graphophonemic correspondence is morphographic analysis of the structures of words (i.e., reference to meaningful orthographic patterns). In fact, an entire program developed for corrective spelling training was based on morphographs (Dixon & Engelman, 1979). Deaf students will find reliability in word analysis if they are provided with instruction that links the stable letter patterns they discern and use in spelling to segments of meaning.

Observed spelling performance can reveal much about students' print processing. The effects of irregular correspondence between sound and print in English are easy to see, especially in hearing children's written products. In the receptive mode, reading, the problems resulting from imprecise print coding are just as significant but less easy to diagnose specifically or to remediate. Comparative skill in spelling and reading among deaf students sheds additional light on their orthographic processing strategies and capabilities. Studies have shown that deaf students typically are not delayed in learning to spell (Hoemann, Andrews, Florian, Hoemann, & Jensema, 1976) and that their spelling is better than what would be predicted based on their reading levels (Meadow, 1980). A number of studies indicated some influence of phonological processing in spelling with deaf individuals but at much lower levels than for hearing individuals (Dodd, 1987b; Hanson, 1985). Research with groups of severely and profoundly deaf students using English and French has recently concluded that all of these individuals relied principally upon sensitivity to visual patterns in both their spelling and reading of words (Sutcliffe et al., 1999; Transler, Leybaert, & Gombert, 1999). As a result, these deaf spellers were not as often fooled by the irregularities of graphophonemic correspondence as their hearing peers were. Further, more detailed research has indicated that deaf persons parse printed words for both syllable and morpheme boundaries. The studies of Prinzmetal, Treiman, and Rho (1986) and Transler, Leybaert, and Gombert (1999) have demonstrated that printed units employed by deaf readers show the influence of "higher order" lexical information (i.e., they are morphologically substantive).

One frequently cited reservation pertaining to the reliability of morphographic analysis in decoding English is the issue of multimeaning words (i.e., single forms that correspond to more than one meaning). In many respects, this is an unreasonable concern. First, the vast majority of multimeaning words are single morpheme words like *can* and *run*. These are very analyzable from context. Multimorpheme words, which may indeed require more analyzing, usually result in very specific meanings (e.g., *disrespected*); multimorpheme words are rarely multimeaning words. Second, there are not many multimeaning affixes. Third, the issue of multiple meanings is not as critical to general comprehension as may be implied. White et al. (1989) reported that 60% of the time successful comprehension of multimorpheme words can be obtained by morphographic analysis that relies on the first or most common meaning of a root. Approximately another 20% can be added by analysis that includes the second most common meaning of a root. Also, the minor meanings of the most prolific words are usually idiomatically associated and, as such, would be learned wholly within such expressions and their decoding greatly facilitated by both linguistic and thematic context.

Research reviewed in this section demonstrates that, in instructing deaf students to read, we are not taking advantage of morphological and orthographic skills that they clearly display in other tasks such as spelling. Providing direct instruction to link meaning with graphic representations of morphemes can facilitate (as does phonics instruction) the process of unraveling print to word mapping.

Morphographic Coding Expedites Processing

We know that segmenting and combining the fundamental units of conversational language is an automatic and requisite component of acquiring conversational language. And later, relating patterns of letters to identifiable segments of conversational language is a necessary step in learning to read. (Otherwise all reading would be whole word association and greatly tax memory capacities). However, a great amount of the research about word identification, on which discussion of teaching strategies is based, concerns English. Phonological recoding for word identification purposes is particularly troublesome in languages like English, which use alphabetic systems to represent spoken language. For languages where print coding better parallels the make-up of spoken words (e.g., Chinese, Japanese kana and kanji), the acquisition of word identification skills is more direct (specific printed segment = specific spoken segment) and easier to learn. Indeed, evidence is accumulating that for children reading these languages with character- (idiographic) or syllabic-based writing systems, some early reading behaviors are seen to develop at younger ages (Liberman et al., 1974). Perhaps we should focus more closely on the underlying skill of segmental matching itself. The results of longitudinal and crosslinguistic research suggest, as Mann (1991) states, that we should "replace knowledge of an alphabetic orthography with experience in manipulating the internal structure of words" (p. 62).

The collective evidence presented in Ehri (1992) demonstrated that skilled readers of English paid more attention to visual than to phonological composition of read words, so the critical issue appears not to be the need for phonological recoding at the front end of the process (because that is just one way to get to analytical whole word sight processing). A second question is whether phonological representation is necessary at the point of lexical access.

Marslen-Wilson et al. (1994) examined lexical processing using an interaction of visual and auditory modalities with verbal stimuli having various morphological, semantic, and phonological characteristics. In a complex series of six experiments, these researchers related the effects of morphological and phonological features of heard and seen words to facility in accessing corresponding internal lexical entries. Significant findings led to confirmation of a modality-independent internal representation of a word, a lexical entry, which is morphologically organized (i.e., into groupings akin to stems and affixes). In addition, they determined that a variety of representations can serve the lexical access function. These included an independent orthographic channel with direct access to the internal lexicon.

The work of Marslen-Wilson et al. (1994) highlights the remaining question regarding the feasibility of a morphographic word-processing strategy. What are the nature and requirements of postlexical representation and how might these interact with morphological rather than phonological input?

The results of studies of text processing speed and semantic organization in long-term memory offer further support for the expediting effects of morphology in word identification. This research indicates that (1) lexical entries may be "filed" via morphological relationships into long-term storage (i.e., in groupings according to the meaning associated with their underlying lexical stems) (Nagy et al., 1989) and (2) that speed of identification for a particular word is increased in proportion to the number of lexical "neighbors" that word has (Nagy et al., 1989; Wysocki & Jenkins, 1987). These positive findings were found to apply to stems with inflectional or derivational affixing as well as to basic root forms (Nagy et al., 1989). Noting research from other languages, which further suggests that the mental lexicon may be organized sublexically (i.e., considering stems, derivational and inflectional endings), Elbro and Arnbak (1996) conclude: "If this is the case, then a reading strategy that identifies words by means of an analysis in stems and endings will map directly onto the lexicon and thereby ease the identification and access to meaning" (p. 212).

These facilitative processing results reflect transparency and productivity characteristics of morphemes. Semantic transparency (White et al., 1989) refers to analyzability, the notion that a word is the sum of its parts. In other words, recognizing and integrating the meaning of the morphemic segments that comprise a multimorpheme word will result in understanding of the meaning of the entire word. Above, the word "recombinative" was used to describe a characteristic of English morphology. Its global meaning might be derived in the following way: RE = *again* + combine + IVE = *pertaining to* results in the overall meaning *pertaining to the ability to combine again.* (Some might consider a deeper analysis of *combine* as resulting from COM = *with* or *together* + BIN = *to sort* or *store*). The usefulness of morphological knowledge is apparent when one considers, as Nagy and Anderson (1984) reported, that more than 80% of affixed words in English school materials have a semantically transparent composition.

The second characteristic, productivity, refers to the usefulness of a morpheme (i.e., the extent of a morpheme's occurrence in separate words) or its prevalence in creating new words (Matthews, 1991). An example in colloquial English is the affix *mega-*, a morpheme of Greek origin meaning "large" and currently used to label anything of great magnitude (e.g., *megalopolis,* a very large metropolitan area) or, more colloquially, something of great importance (e.g., *megastar,* a hit personality in popular music or film).

Together the frequency and analyzability of morphemes in a word help to determine the speed required to recognize that word (Nagy et al., 1989). Nagy and his colleagues have concluded that an individual's internal lexicon contains information about the morphemes of which a word is composed, not simply the patterns of letters in the word but how these segments map meaning. Reaction time effects were not seen to result from analysis of occurrences of bigram patterns in morphologically unrelated words. Nagy et al. (1989) reiterated the important connection between conversational language and reading when they concluded that, due to the nature of their experiment, the observed performances demonstrated not one-time task-specific strategies but "the cumulative results of morphological decomposition during the subjects' years of language use" (p. 278). These findings indicate that improved analytical capabilities can be promoted through systematic early exposure, particularly to meaningful segmental features.

Morphology is a natural alternative to phonology as a basis for printed word analysis. Very recent research on lexical processing has illuminated aspects of lexical organization and access that enhance the potential contribution of morphographic analysis to decoding facility. In reiterating the comparative morphophonemic integrity of English orthography, Marslen-Wilson et al. (1994) speculated that because "orthography preserves the underlying morphemic structure of complex forms more directly than in the phonetic surface form" (p. 30) orthographic access (visual-segmental) might provide a more direct route to the morphologically organized internal lexicon. Phonological recoding is a slower process than sight word reading if a reader has not mastered the phonological system. By contrast, knowledge of the morphological structure of words has the potential for greatly increasing the utility of the visual channel in word identification for deaf students. There will always be the requirement for an equation between orthographic forms and conversational ones—thus the need for systematic instruction of deaf readers on morphemic word structure.

Morphographic Skills Are Trainable

Even if morphographic skills are valuable and capable of being used by deaf readers, the question remains of whether they are trainable. Much in the literature review regarding the development of fluent reading suggests a powerful interaction between a reader and his or her experiences with language and print. Is it possible to teach the important component skills of morphographic analysis?

Research has shown that even young deaf children are aware of and can manipulate basic English morphology. In a study involving young deaf children exposed to manually coded English, Gaustad (1986) documented early morphological development that, while delayed, followed acquisition patterns established for hearing children. For example, free forms used to denote negation (*not*) and future tense (*will*) along with suffixes marking possession (*-'s*) and past tense (*-ed*) were learned before forms for marking present indicative mood (*-s*) and passive voice (*-ed*). More detailed analysis of individual responses revealed that deaf children also used standard English morphemes (e.g., progressive *-ing* or past *-ed*) as they might other lexical forms, to produce original language that was functional, if not always conventional. For example, *-ed* was used as if to mark an entire sentence or proposition, not just the verb component (*boy jump the truck ed*). Because the protocol of this experiment required participants to produce paired sentences (in the foregoing example to contrast present with past tenses), there was little doubt as to the semantic intention (past tense) underlying this unique surface structure production. To accomplish such a production, the deaf student had to recognize *-ed* as a unique and separate morpheme, to associate this form with the meaning "past" and, in this experimental context, to accommodate the need to encode discriminately the appropriate semantic associated with one of a pair of contrasting pictures. The results of this study indicate that deaf learners possess the linguistic raw materials (processing mechanisms and language forms) for working with morphological elements in print.

Unfortunately, there is no direct research documenting word analysis instruction with young deaf students. However, there is encouraging data from abroad in providing such instruction to a comparable population (i.e., hearing dyslexics). Elbro and Arnbak (1996) reported evidence from multiple experiments with Danish adolescent dyslexic students. The results revealed that their participants used the analysis of morphemes as a compensatory strategy to identify printed words in formulating coherent interpretations of text. Specifically, in one experiment, students were better able to use morphological means than syllables in reading segmented text. Comprehension accuracy, response latency, and correctness of word identification were better when stimuli were presented one morpheme at a time rather than one syllable at a time. A separate analysis showed a positive correlation between the use of morphological analysis and reading comprehension. Another of Elbro and Arnbak's experiments demonstrated "modest success" in training young dyslexic students to improve their awareness of morphological components in text, a strategy not dependent on existing phonological awareness. In 36 sessions (15 minutes each, 3 times a week for 3–4 months) dyslexic students were instructed about the morphology of compounds and various derivational forms. Instructional tasks included analysis of real and scrambled forms of compounds (e.g., "song evening" vs. "evening song"), invention of new compounds (e.g., "fold-up spoon") as well as the derivation of less transparent forms (e.g., "dragonfly"). The training also provided specific instruction regarding the meanings of inflectional and derivational affixes (e.g. *un-*, *mis-*, *dis-*) and application of this information to the analysis of word forms (e.g., "mistrustful," "distrustful") and words with pseudo morphemes (e.g., "car/pet"). This short intervention did not produce major alterations of single-word reading. However, it did positively affect passage comprehension. In addition, specific post-training reading behaviors did show an increase in students' misreading of words as other real words rather than as nonsense words, which the authors took as indication of their adoption of a meaning-focused reading strategy. In their conclusion, the authors also noted the importance of exposure to morphology in conversational language, better success with smaller class sizes, and the need for morphological awareness throughout the broader reading curriculum.

Wysocki and Jenkins (1987), in their study to examine the legitimacy of morphological generalization as an explanation for vocabulary growth, tested middle school students' use of context and morphological knowledge to determine the meaning of unknown words in connected text. First of all, they found that students' previous experience with words (reading, spelling) had a positive effect on demonstrated morphological skill (i.e., older students were already sensitive to the use of morphological clues before training). Older students were also better at morphological generalization without help from context. In addition, the training effects showed impressive levels of morphological generalization at all grade levels tested. The particular morphemes used in this generalization training and testing were nonneutral suffixes (e.g., *-ed*), which vary their form to suit the spelling of the stem to which they are attached (e.g., *-ed* + *live* = *lived* not *liveed*). So these findings were somewhat conservative because nonneutral morphemes are harder to segment and thus more difficult to identify and to generalize. Positive results with difficult morphemes across grade levels bode well for possibilities of training with the broader range of morphemes.

Vellutino and Scanlon (1986), in providing segmentation training (phonemic) to hearing poor readers discovered that such activities had a noticeable effect on decoding performance generally by also promoting a "processing attitude." That is, drawing students' attention to orthographic regularities and providing practice in segmentation can lead to the development of the necessary cryptanalytical rather than holistic approach to decoding, an important readiness condition for word identification.

Implications for Intervention and Research

Morphographics as a Component of Decoding Instruction

The summer 1998 issue of the *American Educator* presented guidelines for "Teaching Decoding." Its content echoes the view of O'Rourke (1974) that students need to know about roots and affixes as competencies useful to furthering segmentation skills and to advancing semantic knowledge. After reconfirming the importance of word analysis to decoding and of decoding to overall reading success, Moats (1998) presents a strong case for inclusion of morpheme/orthographic instruction in the general reading curriculum. After a reference to the recent history of phonics followed by whole language emphases in reading instruction, she cautions against using word analysis skills only as a supplementary tool for literature-based reading in the regular classroom. Rather, in a comparison with effective development of phonological decoding, she stresses the need for a broad-based integrated and controlled program for developing and using visually based word analysis skills. Such a program would obviously benefit readers who have not developed sufficient phonological skill to enable efficient text decoding.

The research reviewed in this article has indicated two possible avenues by which improving morphographic processing can facilitate word identification in deaf readers. First is the possibility of speeding processing by utilization of a direct link between learned orthographic representations of morphemic segments and their corresponding lexical entries. Second, in instances when deaf readers encounter unfamiliar or infrequent (but highly analyzable) vocabulary, they would have structural analytical skills by which to derive full meanings. Ability to decode multimorpheme words can increase the students' potential for obtaining more precise interpretations of text.

Research has confirmed the value and availability of morphological information in word identification. There is no research, however, to show the outcome of a fully morphographically oriented approach to reading because that approach does not exist. Such a program would need to provide a visually centered environment and curriculum to train what Mayer and Moskos (1998) call the "inner eye." I would like to suggest that the developmental flexibility of a young child's brain and the visual propensity of deaf individuals are capabilities that might be exploited to promote development of very specific, visually based morphographic processing in deaf children. Refined orthographic sensitivity and integration with morphemic knowledge could, through supportive practices and direct instruction, be honed to provide the segmenting and analytical automaticity needed for word identification in extended text. Competencies requisite to these processes could be developed through a combination of skills evident in the logographic and orthographic stages of normal reading but that appear to be heightened in the deaf. Sight word recognition could be employed to develop a broader base vocabulary including more frequent and regularly spelled words. Morphographic elements that are not experienced as whole words (e.g., roots and affixes) but that are regular in their print-to-meaning relationships can be employed to increase the functionality of orthographic processing already in evidence.

Direct instructional practice would emphasize training and exercise of morphographic awareness, segmentation, and generalization. In their chapter on reading instruction, Gaustad and Paul (1998) have presented a multilevel guideline for developing morphographic analysis as a means of increasing word identification efficiency of deaf readers. Table 1 presents examples of morphemes that illustrate three levels of morphographic analytical development. These represent, respectively, inflectional affixes, then common derivational affixes, then less frequent derivational affixes and roots. Concentration on free morpheme bases and inflectional suffixes at Level 1 capitalizes upon processing universals (Slobin, 1970) and patterns in early acquisition of English morphology (Brown, 1973). Structural analysis at this level is intended to use concepts and forms (compounds, plural, tense) that are familiar in conversational language to introduce the concept of segmenting in print. Students analyze and manipulate structural segments and associated meanings within words like *bathroom, trucks,* and *showed*. The content at Level 2 reflects more complexity in word identification processes. Specifically, as vocabulary difficulty increases with reading level, the processing and interpretation of prefixed structures are introduced. Also introduced at this level are high frequency derivational affixes. Typical instruction might include clustered combinations and comparisons of morphographic elements including both derivational and inflectional components (words such as *untie, unlocks, unopened, retie, relocks,* and *reopened*). Level 3 instruction moves to analysis of words structured by the combination of affixes with roots (*struct* meaning to build as in

Table 1 Sample morphographs for three levels of instruction (English morphemes)

	Bound		Free
	Suffix	Prefix	
Affix: inflectional			
Level 1	-ing		(Early
	-s (pl)		sight
	-s (3rd)		vocabulary)
	-'s		
	-ed		
	-en		
	-er		
	-est		
	-ly		
	-y		
Affix: derivational			
Level 2	-ate	pre-	(Early
	-ent	re-	sight
	-ment	dis-	vocabulary)
	-ile	mis-	
	-tion	super-	
	-ize	im-	
	-al	anti-	
	-ible	inter-	
	-ful	non-	
	-ness	pro-	
	-ence	sub-	
	-ify	un-	
Level 3	-phobia	hydro-	
	-mania	micro-	
	-orama	omni-	
	-itis	auto-	
Root			
Level 3	-phot-	-cycl-	script
	-dict-	-fess-	graph
	-spect-	-vis-	kilo
	-struct-	-chron-	cent
	-phon-	-sect-	gram
			psych
			fact
			meter
			port
			toxic

constuct or *structure; dict* meaning to speak as in *predict* or *dictator*) rather than with full base words (as in the Level 2 examples of *tie, lock,* and *open*). Manipulation of morphographic segments might lead to creation and interpretation of novel but possible English words. Illustrations, graphic or descriptive, could be produced for developed words like *portadesk* (portable work surface), *monoped* (one-footed critter) or *webmusement* (fun on the Internet or web contemplation?). Introduction of additional lower frequency derivational affixes extends the combinatorial possibilities at this level.

In a morphemic-based reading program, procedures and materials would be designed to use structural analysis to expose the regularities inherent in printed English. As Liberman (1983) suggests, instructional objectives would include skills in segmenting, identifying, and ordering morphemes in English word and sentence contexts. (As morphemic information is transmitted coincidentally with phonological information in conversational language, supplemental auditory, lip-reading, or sign instruction and experiences would serve to increase the noticeability of morphemic elements. Reciprocally, because morphemes correlate significantly with syllables, this type of emphasis would actually support the development of lip-reading and auditory skills.) Specific instructional materials might include selection or development of morphographically controlled readers with accompanying exercises to highlight and reinforce segmentation skills and morphographic associations. Nagy et al. (1994) provide specific guidelines for utilizing segmental analysis to improve decoding and comprehension skills. They note the importance of helping students to decide when and how to employ segmental techniques and include suggestions for teaching students to use context in conjunction with segmental analysis.

Morphographic analysis will not account for all words in a text. However, knowledge and skill with inflectional and derivational affixes and common English roots should increase the automaticity of word identification, allowing more time for other decoding processes. The ultimate objective would be to get deaf readers to a basic level of fluency so that they could begin to read independently. Then, exposure to the regularities of print through reading would permit the process of morphological generalization to work for deaf students.

Application of acquired morphographic skill to decoding would also necessitate alterations in typical classroom reading practice. Rather than less reading because it is so difficult, reading volume should be increased, both teacher-led and independent reading. As Ehri and Wilce (1986) suggest, much metalinguistic awareness that facilitates later reading develops as a result of reading. As noted earlier, the same is true for the effects of reading experience on vocabulary development. Second, rather than eliminating timed reading (as disadvantageous to comprehension), frequent, if short, speed-reading experiences should be promoted. These might include lists of words for practicing and monitoring single-word identification strategies and accuracy as well as the reading of text passages followed by comprehension questions. The objective would be to systematically decrease reading time for increasingly complex text without compromising accuracy. As Perfetti (1992), Just and Carpenter (1992), and others have concluded, processing speed is critical to general comprehension success. As with other perceptual and motor skills, the combination of speed and accuracy can be achieved only with practice. Never reading for speed likely perpetuates the use of ineffective decoding strategies, nothing like the automaticity in word recognition required of good readers. Practice with regularities in word structure will create and strengthen linguistic neural pathways, a process intended to reproduce developments that result in the type of activation patterns that facilitate automaticity in word identification with hearing students.

Future Research

Research that would contribute to successful implementation of a morphographic approach to decoding is needed in two areas. The first involves more knowledge of the information deaf students have regarding English morphology and the structural analysis of words. The second relates to better understanding the mechanisms of providing morphological information to deaf students through visual means.

Research with deaf individuals concerning word meaning has been confined mostly to examination of meanings deaf students have for vocabulary they can read. There is little information about specific vocabulary they do not know or cannot read that is analyzable and potentially meaningful. These would include function words and affixes, precise morphemes that have grammatical and semantic ramifications for ultimate comprehension in both interpersonal communication and reading. If deaf students have lexical entries for stems but are largely devoid of lexical entries and connections for affixes, the result will be encoding and decoding restricted (through ignorance not choice) to the "gist" of meaning.

Successful design of morphographic instruction and materials will depend on increasing understanding of morphological development and processing by deaf and hard-of-hearing individuals for English print especially, but not exclusively. Much of our general understanding of reading, and most of our knowledge of deaf readers, comes from research with older individuals and successful readers. Specific research is scant concerning structural analysis during reading.

More research is needed at all points in the development of morphological knowledge of deaf readers. If we are to improve word identification, we must have finer detail about the content of the lexicon of typical deaf readers, beyond accounts of vocabulary size or base word semantic associations. How much do deaf readers know about morphemes in conversation and in print? Are there differences between good and poor deaf readers with regard to competencies in morphological analysis and morphographic association? How do good versus poor deaf readers segment English print? How do these competencies differ as deaf students begin to learn to read, as they attain advanced reading status?

The second area for research involves better understanding of the segmenting of language generally by deaf individuals utilizing various modes. How are lipread and fingerspelled input segmented? How are specific morphological elements of ASL and Manually Coded English processed and stored and to what extent is this coding compatible with coding and storage of printed English? (In what ways can sign segmenting facilitate an understanding of English segmenting?) Previous research regarding sign coding has not concerned itself with the fact that signs have segmental composition, the nature and manipulation of which is part of the competence of even very young individuals. Under the typical constraints of memory studies (e.g., lexical decision speed) are the elements of handshape, location, and so on abstracted in any particular order, and how is this affected by initialization or affixing in signed English? Can cherological and morphological knowledge about ASL help to make features of English-based signing more salient for purposes of reading instruction?

There is no debate about the need for more effective instructional approaches to reading in the education of deaf children. The question is what direction to take. Much evidence suggests the importance of phonology to reading even for many deaf students. Yet the path to phonological competence is a calamitously slow, if not impossible, one for profoundly deaf youngsters. It is becoming clear that morphological and orthographic skills also play a significant role in reading for hearing students. The morphographic system in English is visual, segmental, and predictable. Morphographic analysis expedites text processing and is a trainable skill. It is essential to advanced levels of reading. I am proposing that visual and morphological input to the word identification task could be heightened for deaf students through alternative instructional practice with the ultimate result of increasing decoding facility in these readers. This will not, in itself, produce fluent reading but may permit other cognitive operations to function more efficiently, thus improving general comprehension.

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