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MNEMONIC INSTRUCTION FOR STUDENTS WITH LEARNING DISABILITIES: WHAT IT IS AND WHAT IT DOES

Thomas E. Scruggs and Margo A. Mastropieri

Abstract. **One of the characteristics of learning disabled (LD) students most commonly mentioned by teachers and researchers is difficulty with semantic memory. Recently, an instructional model has been developed, referred to as *mnemonic instruction*, which is directly targeted to learners with difficulties in semantic memory. This article describes the concept of mnemonic instruction and how it interacts with the specific learning characteristics of LD students. Additionally, the extraordinary effectiveness of the techniques with LD students, as reported in numerous published research studies, is described. Implications for classroom instruction and further research are provided.**

One of the most commonly described characteristics of learning disabled (LD) students is their failure to remember important information. In addition to frequent reports by teachers of LD students, this characteristic has often been demonstrated in experimental research (e.g., Cooney & Swanson, 1987).

Previously considered only one in a cluster of deficits that limit the achievement of LD students (e.g., Kirk & Kirk, 1971), deficits in memory, particularly with respect to recall of semantically based information, have come to be regarded by many researchers as a central characteristic of learning disabilities (see Swanson, 1987). These deficits contribute in many cases to problems in reading and math and acquisition of academic vocabulary and content (e.g., Kail & Leonard, 1986). It could be argued, therefore, that intervention strategies that specifically target these memory deficits could be expected to prove beneficial in the education of LD students. Recently, such techniques, referred to as "mnemonic instruction," have been implemented with learning disabled students with very positive results.

In this article, we describe what mnemonic instruction *is*, and how it interacts with specific characteristics of learning disabilities. We also describe what mnemonic instruction *does*—that is, what gains have been documented in specific instances of school learning. Further, we argue (and provide evidence) that mnemonic instruction delivers the greatest learning increases seen in the history of learning disabilities intervention research. Finally, we describe implications for classroom practice and further research.

WHAT MNEMONIC INSTRUCTION IS

A "mnemonic" is a device, procedure, or operation that is used to improve memory. Defined in such broad terms, however, virtually any instructional practice could be defined as "mnemonic." So this definition—while correct—is not particularly useful. What we mean by "mnemonic" in this article is a specific reconstruction of target content intended to tie new information

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more closely to the learner's existing knowledge base and, therefore, facilitate retrieval. A variety of techniques have been developed for this purpose (described below), including keywords, pegwords, acronyms, loci methods, spelling mnemonics, phonetic mnemonics, number-sound mnemonics, and Japanese "Yodai" methods.

History of Mnemonics

Mnemonics have been used for thousands of years. The first documented use was among ancient Greeks, who, having limited access to writing materials, developed complex mnemonic systems for remembering stories, poems, plays, and lectures (see Yates, 1966, for a comprehensive discussion of the history of mnemonics). A common technique for storing and recalling narrative or lecture information was the "method of loci," attributed to the poet Simonides, who first employed the technique to identify the bodies of persons who had been killed and disfigured after a banquet hall had collapsed on them.

The Greeks who wished to remember oral presentations first developed their own set of "loci," or places, with which they could associate information in sequence. For example, they developed these loci by spending many hours inside a temple (or other building) carefully memorizing ornaments, statues, and other places in the temple, in the particular spatial sequence in which they occurred. When they had thoroughly mastered this set of loci, to the extent that they had created a very familiar and easily retrievable image of the place, they used it as a framework to which they tied incoming information, in sequence. Then, as they listened to a lecture, they would tie each important point to a *locus*, or place, in their set of loci. For instance, if the first major point to recall was the issue of human mortality, and the first locus in the set was the steps leading to the temple, the mnemonic listener could, while listening, actively create an interactive visual image of a dead or dying person on the steps of the temple. If the image were carefully elaborated and visualized, learners later had little difficulty retrieving the image and the corresponding first point of the lecture.

This example underlines an essential feature of learning: the realization that, to be useful, information must be both comprehended *and* remembered. Therefore, when Ancient Greeks encountered new, important information, they actively encoded it into their memory system, as they listened for comprehension. These ancient arts are mostly lost today, as people rely (sometimes excessively) on notetaking and on the printed page. With little access to writing materials or books, the Ancient Greeks used strategies that did not require the use of pencils and books. Similar strategies have proven highly successful for learning disabled students of today, who have access to, but little skill in interpreting, written materials and books.

Many of the Ancient Greek techniques were revived in the Middle Ages, where they were sometimes associated with mysticism and the occult (Yates, 1966). However, with the invention and development of the printing press, the use of mnemonics, particularly the method of loci, became less popular. Around the turn of the 19th-20th centuries, a renewed interest in mnemonics began. For example, James (1890), in the first major psychology text, wrote of the "phoneme-digit" mnemonic for recalling strings of digits. However, during the behavioral era of psychology, mnemonic strategies were discounted as "unobservable."

Later, Miller, Galanter, and Pribram (1960) wrote of the "pegword" method of associating numbers with things, and in 1970, Bower described the usefulness of mnemonic strategies, such as the method of loci, and their legitimacy for psychological study.

Perhaps the greatest modern impetus for the study of mnemonics came in 1975, when Atkinson published an experimental study of the "keyword" method for teaching Russian vocabulary. Although keyword-type mnemonics were described by the Ancient Greeks, Atkinson's paper initiated a resurgence of interest in mnemonic strategies, partly because of the extraordinary versatility of the keyword method. The powerful potential of mnemonic strategies for school-aged populations was soon recognized (Pressley, Levin, & Delaney, 1982), and research in mnemonic strategy use by learning disabled students began in earnest during the early 1980s.

Memory and Learning Disabilities

With the failure of earlier explanations of learning disabilities to yield effective remedial techniques (see Kavale & Forness, 1985), researchers began to uncover deficits in memory as characteristic of many LD students (e.g., Torgesen & Goldman, 1977; Torgesen & Houck, 1980; Torgesen & Kail, 1980). Other researchers have suggested that these memory deficits may be language based (Swanson, 1987; Vellutino & Scanlon, 1982). For example, Baker, Ceci, and Herrmann (1987) reviewed evidence that learning disabled students exhibit problems in the *structure* (storing and organizing) as well as the *process* (operating on stored information) of semantic memory. Kail and Leonard (1986) described "word finding" problems of a subset of learning disabled students, attributed to inadequate representation of words in memory, in addition to other basic deficits in language-based information retrieval. Ceci (1985) presented research evidence that LD students exhibit greater deficits on purposive, rather than automatic, semantic processing, and recommended,

> instead of advocating intervention plans that are directed at remediating alleged cerebral insult or dysfunction, a more profitable approach to children with semantic processing difficulties . . . is to train purposive information-processing strategies like elaborative encoding, clunking, anticipation, type 2 rehearsal, and so on. (p. 219)

Such accumulated research evidence suggests strongly that interventions that are intended to impact directly on LD students' purposive semantic encoding and retrieval processes are likely to affect academic achievement positively. Mnemonic strategies, which directly provide such encoding and retrieval routes, have been found highly successful at improving LD students' semantic memory deficits. Although mnemonics have proven very helpful for many types of students (Pressley et al., 1982), mnemonic strategies appear to serve a particularly useful purpose in that they may interact directly with the disability area of many, if not most, LD students.

Types of Mnemonic Strategies

Loci methods have already been described. Other mnemonic strategies include the keyword method, the pegword method, acronyms, reconstructive elaborations, phonic mnemonics, spelling mnemonics, number-sound mnemonics, and the Japanese "Yodai" mnemonics for learning mathematics procedures. These mnemonic systems are too varied and complex for us to describe adequately in a single article. However, we will provide a brief summary. (For a complete description of all school-relevant mnemonic systems, see Mastropieri and Scruggs [in press].)

Keyword method. The keyword method employs acoustically similar keywords as meaningful proxies for unfamiliar words that must be learned. These keywords are presented in a picture in which they are shown interacting with the associated information. For example, to teach that *vituperation* means "abusive speech," learners are first given a keyword for vituperation, such as *viper*, which sounds like vituperation but is easily pictured, and shown an interactive picture, in this case, a viper speaking abusively. When asked to define "vituperation," learners retrieve the keyword, *viper*, remember the picture of the viper, retrieve what the viper was doing, and respond, "abusive speech" (see Mastropieri, 1988, for more examples).

Much of the early research with the keyword method involved vocabulary learning (e.g., Atkinson, 1975; Mastropieri, Scruggs, Levin, Gaffney, & McLoone, 1985); however, keywords can also be used to teach scientific root words (Veit, Scruggs, & Mastropieri, 1986), accomplishments of important people (Scruggs & Mastropieri, 1989), and complex scientific concepts, such as "radial symmetry" (Scruggs & Mastropieri, in press). In addition, keywords can be employed in teaching mathematics vocabulary, such as "multiplier," and "multiplicand."

Pegword method. This method employs rhyming pegwords (one is *bun*, two is *shoe*, etc.) to facilitate recall of numbered or ordered information, such as the first 10 amendments to the Constitution, or the order of admission of states to the United States. Pegwords also can be combined with keywords to link unfamiliar names with numbers. For example, to teach that the hardness level of the mineral *hornblende* (according to Moh's scale) is *five*, students can be shown a picture of a *horn* (keyword for hornblende) with a *hive* (pegword for five) in it. Therefore, when asked for the hardness level of hornblende, learners can think of the keyword, *horn*, think of the picture with the horn in it, remember that a hive was in the horn, and retrieve the number equivalent for the pegword *hive*, five (Mastropieri, Scruggs, & Levin, 1985). Pegwords have also been used to teach possible reasons for dinosaur extinction, ordered by relative plausibility (Mastropieri, Scruggs, & Levin, 1987), and to instruct LD students in multiplication facts (Willott, 1982). In the latter investigation, combinations of pegwords were used to represent higher numbers (e.g., fifty = "gifty," i.e., gift-wrapped, 6; = "sticks", therefore, fifty-six = "gifty sticks").

Acronyms. Acronyms are perhaps the most familiar mnemonics. Almost everyone has used the acronym *HOMES* to retrieve the names of the Great Lakes: *H*uron, *O*ntario, *M*ichigan, *E*rie, and *S*uperior. Such acronyms are helpful when a *set* of responses, rather than a single response, is required. Sometimes (but rarely) they can be used to represent information in order (e.g., *F-A-C-E* to retrieve the names of notes on the spaces in the treble clef). Kilpatrick (1985) reported the use of the acronym FOIL to retrieve the sequence of operations in multiplying two binomials. The product (a+b) (c+d) is the sum of the *F*irst terms (ac), the *O*uter terms (ad), the *I*nner terms (bc), and the *L*ast terms (bd). Information can also be re-ordered as an *acrostic* in which the first letters of words combine to facilitate retrieval (e.g., *E*very *G*ood *B*oy *D*eserves *F*udge, to retrieve the names of the notes on the lines of the treble clef).

For acronyms to work well, the *response* information should be sufficiently familiar so that retrieval can be easily accomplished by provision of the first letter. That is, students must be familiar enough with *Superior* that they can retrieve the name, given only the first letter. Additionally, acronyms work best when they are effectively elaborated with the stimulus information (e.g., a picture of *homes* on *great lakes* to prompt learners to retrieve the acronym when asked, "What are the names of the Great Lakes?"). For another example, Scruggs and Mastropieri (1989b) created the acronym *TAG* to refer to the countries in the Central Powers during World War I—*T*urkey, *A*ustria-Hungary, and *G*ermany. However, to ensure that learners would associate these countries with the Central, rather than the Allied, Powers, the game of tag was shown being played in Central Park (keyword for Central Powers).

Reconstructive elaborations. Scruggs and Mastropieri (1989) first described the model of "reconstructive elaboration" for adapting entire domains of content to mnemonic instruction, including U.S. history (Mastropieri & Scruggs, 1988; Scruggs & Mastropieri, 1989a); state history, including transportation and natural resources (Mastropieri & Scruggs, 1989b); and science content, including invertebrate animals, vertebrate animals, earth science, and earth history, (Scruggs & Mastropieri, in press). This model uses mnemonic elaborative systems based on the principle that the more *familiar*, *concrete*, and *well-elaborated* information is, the better it will be learned and remembered.

The reconstructive elaborations model employs keywords (acoustic reconstructions) for encoding unfamiliar information, symbolic pictures (symbolic reconstructions) for encoding familiar-but-abstract information, and literal pictures (mimetic reconstructions) for familiar, concrete information. Examples of keywords have been given above. An example of a symbol for familiar-abstract information could be *scales* for *liberty*, or a *church* for *religion*. Mimetic pictures for familiar, concrete information could include literal pictures of information such as *worms*, *birds*, or *pioneers*. All reconstructed target information is carefully elaborated pictorially with its referents. When appropriate, pegwords and acronyms are used. The reconstructive elaborations model is described in detail in Mastropieri and Scruggs (1989c).

Phonic mnemonics. Most of us remember seeing phonetic prompts in our classrooms consisting of a letter next to an object whose first sound is represented by that letter sound (e.g., the letter "a" next to a picture of an "apple"). Unfortunately, this arrangement is not truly "mnemonic," at least in the sense employed here, because the stimulus and its referent are not effectively elaborated. Ehri, Deffner, and Wilce (1984) described the effective use of phonic mnemonics, in which letters were incorporated *within* the item that represents the letter sound (e.g., an interactive picture in which the letter "a" is drawn to resemble an apple). Such mnemonics could be expected to greatly improve initial acquisition of sound-symbol relationships—a substantial problem for many LD students.

Spelling mnemonics. An important use of mnemonics lies in drawing firm associations in content or skill areas where the relationships are arbitrary. For example, in English the "schwa" sound—the most common vowel sound—is not represented by any one letter but may be represented by any given vowel. The word "cemetery," for example, could be spelled in a variety of ways that all capture the appropriate vowel sounds, but is spelled with three e's—a convention that must be remembered. An effective mnemonic elaboration, described by Shefter (1976), incorporates the three e's with the word in the elaborative sentence, "She screamed 'E-E-E' as she walked by the cemetery." Students who retrieve the sentence can remember the correct spelling of "cemetery."

Number-sound mnemonics. This type of mnemonics is used to recall strings of numbers, such as telephone numbers, addresses, zip codes, locker combinations, social security numbers, or historical dates. To use them, learners must first learn the number-sound relationships: 0=s; 1=t ; 2=n; 3=m; 4=r; 5=l; 6=sh, ch, or soft g; 7=k, hard c, or hard g; 8= f or v; and 9=p. Acquisition of these relationships can be facilitated by remembering the sentence, "Satan may relish coffee pie," in which the consonants represent the appropriate letter sounds, in the order 0-9. To encode a series of digits, therefore, the learner must first find the appropriate consonants, and then arrange vowels between the consonants to create a word or words that can be elaborated with the associated information. For instance, to remember the date 1492, the learner uses the associated consonant sounds, t, r, p, and n, and inserts vowels to create a meaningful word or words. In this case, "terrapin" could be used (there is only one r sound, even though two r's are represented in "terrapin"). An effective mnemonic picture or image could be constructed of Columbus discovering land, on which is a *terrapin* (1492).

A related type of mnemonic for retrieving types of digits involves associating number proxies (either pegwords or physically similar proxies, such as 0=tire, 1=pencil, etc.) with the *head*, *hand*, and *foot* of a *father*, *mother*, and *child*, respectively. Thus, the first number proxy would be presented on the *head* of the *father*, whereas the fifth number proxy would be placed on the *hand* of the *mother*. Such systems have facilitated digit-span recall in learning disabled students (Laufenberg & Scruggs, 1986).

"Yodai" methods. In Japan, schoolchildren are taught a variety of mathematical procedures using rhymes and visual imagery. Many of these mnemonics have employed bugs as visual images. Although little of this work has been translated into the English language and American culture, one aspect of Yodai mnemonics, involving swimming pools and joggers, has been described by Machida and Carlson (1984). One rhyme used is "POOL (i.e., put together) shirts (numerators) to shirts, patches (denominators) to patches." Students are shown a picture of a swimming pool in the shape of the multiplication symbol. A jogger, wearing shirt and shorts (with patches), is on each side. The numerator of a fraction is shown on each shirt, with the denominator on the patches. These Yodai methods are consistent with mnemonic principles by employing pictures or images of familiar things to promote learning and comprehension of new, unfamiliar information. With respect to LD students' deficits in semantic memory, it must be remembered that many mathematics tasks contain highly verbal components. In fact, on commonly used intelligence tests, the arithmetic subtest is included on the Verbal, rather than Performance, scale.

Summary

In this section, we have described the history of mnemonics and the potential of mnemonic strategies for students with learning disabilities, followed by a review of several school-relevant mnemonic systems. In the section that follows, we will discuss the extraordinary effectiveness of these strategies when employed with LD students.

WHAT MNEMONIC INSTRUCTION DOES

Over the past eight years, numerous research investigations have documented the effectiveness of mnemonic strategies with LD students, sufficient for us to discuss broadly the implications of mnemonic strategy instruction given in this section. (For a complete review of mnemonic instruction research in special education, see Scruggs and Mastropieri [1990].)

The Effectiveness of Mnemonic Instruction

Mastropieri and Scruggs (1989a) recently synthesized the results of 24 experimental investigations of mnemonic instruction in special education settings (21 of the experiments involved primarily LD students, while two involved mildly mentally handicapped students, and one behaviorally disordered students). Subjects included 983 mildly handicapped students, from grades 3 to 12, in four different states. Across all these experiments, students instructed mnemonically outperformed students instructed by a variety of control conditions, including free study; direct rehearsal, questioning and feedback; visual-spatial display conditions; and teacher-led "traditional" instruction employing the teacher-effectiveness variables (Mastropieri & Scruggs, 1987).

The overall effect size of these combined investigations was 1.62 standard deviation units, the highest measure of treatment effectiveness reported to date in a synthesis of special education research. An overall effect size of 1.62 means that an "average" mnemonic-instruction condition student (i.e., 50th percentile) scored at the 98th percentile of the control group. For comparison, Kavale and Forness (1985) reviewed previous quantitative syntheses of special education interventions, reporting overall effect sizes ranging from -0.12 to +0.58, for such interventions as reduced class size, special class placement, psycholinguistic training, perceptual-motor training, stimulant and psychotropic drugs, and diet interventions. In addition, in each of these cases, substantial negative effects (i.e., the control group outperformed the experimental group) were reported (see also Kavale, in press). In the synthesis of mnemonic-strategy instruction experiments, Mastropieri and Scruggs (1989a) reported that all effects were positive and substantial (range = 0.68 to 3.42).

Mastropieri and Scruggs (1989a) also synthesized these findings across experiments by computing the percent correct scored by students in mnemonic and combined control conditions. These analyses revealed that, on average, mnemonic-condition students learned 75.0% of the information presented, while control students learned only 43.8% of the information. As evidenced by this synthesis, the effects of mnemonic instruction are positive, consistent, and very large. Such information can make the difference between passing or failing in school; indeed, in one school, we found that mnemonic instruction improved average weekly grades of "D+" to weekly grades of "B" (Scruggs & Mastropieri, 1989a).

Effects on Recall

Most of the effects of mnemonic instruction reported to date involve recall of target information—the central objective of instruction designed to enhance memory. Thus, positive experimental effects have been documented for immediate learning and delayed recall intervals of 24 hours (Mastropieri, 1983); two to three days (Laufenberg & Scruggs, 1985; Veit, Scruggs, & Mastropieri, 1986); one week (Mastropieri, Emerick, & Scruggs, 1988; Scruggs, Mastropieri, McLoone, Levin, & Morrison, 1987); eight weeks (Mastropieri & Scruggs, 1988); and 10 weeks (Condus, Marshall, & Miller, 1986).

Effects on Comprehension

Kilpatrick (1985), among others, has argued that, although students taught mnemonically are able to effectively retrieve information, they do not comprehend such information. Mnemonic instruction, according to this perspective, is merely a "trick" that enables learners to "parrot" back responses they do not understand. Of course, it is possible to memorize, mnemonically or otherwise, information one does not understand (e.g., $E=MC^2$). Conceivably, therefore, mnemonic instruction could be employed for this dubious purpose. However, such an argument suggests a relationship between memory and comprehension such that information that is "memorized" is not necessarily comprehended, while information that is comprehended is, *ipso facto*, remembered. This putative relationship is untrue; in fact, it has little or no empirical research support.

Most, if not all, teachers of LD students report that their students routinely forget information they had comprehended adequately the day before. Why does this occur? Although the information itself may be comprehended, the verbal label representing it may be a completely arbitrary arrangement of speech sounds that bears no semantic relation to the target information. For students with phonological coding or semantic processing disabilities (i.e., most LD students), the label is soon forgotten, and without access to the verbal label, students cannot retrieve, discuss, evaluate, or "comprehend" the original information. Those who accuse mnemonics of promoting parrot-like responses should be reminded that mnemonic systems impact directly on the *concreteness* and *meaningfulness* of target information, and should, therefore, *enhance*, rather than *detract from*, comprehension.

In addition to the above rational arguments that discredit "comprehension trade-off" views, empirical evidence suggests that mnemonic techniques actually enhance comprehension. Veit et al. (1986) mnemonically taught LD students Greek root words for dinosaur names (e.g., *ptero-*, meaning "winged," *saurus*, meaning "lizard"). The students not only remembered more of these root words than their rehearsal-instructed counterparts, they were substantially more effective at translating complete dinosaur names they had not seen before (e.g., *pterosaur*="winged lizard").

In another investigation, Scruggs et al. (1987) reported that, in addition to recalling more specific information about attributes of North American minerals (color, hardness, use) than their control condition counterparts, mnemonically instructed LD students were also significantly more effective at inferring untrained attribute dichotomies.

Recently, the comprehension question has been investigated directly. Mastropieri, Scruggs, and Fulk (1990) taught difficult abstract and concrete vocabulary words (e.g., *saprophytic*, *intercalate*, *catafalque*) to LD students via either mnemonic keyword instruction or a rehearsal-based picture control. Mnemonically instructed students outperformed controls on recall of both abstract and concrete vocabulary words. In addition, they significantly outperformed controls on a comprehension test of the words, in which learners were required to apply the words in a context different from that presented.

Given the above evidence, we can conclude that mnemonic instruction may be used to *facilitate*, rather than inhibit, comprehension. Although it is possible to remember information without comprehending it, such an outcome is by no means a foregone conclusion of mnemonic instruction. Furthermore, for many LD students, mnemonic instruction may represent the only realistic chance that they *will* comprehend specific academic content.

Metacognitive and Affective Outcomes

Some research studies have shown that LD students recognize the value of mnemonic instruction in enhancing their own learning. For example, in a study of the effects of text-embedded mnemonic pictures (Scruggs et al., 1987), LD students rated mnemonic pictures as significantly more helpful for promoting their own learning than traditional representational pictures of the same information. Similarly, in a recent classroom study of the effectiveness of mnemonic science instruction (Scruggs & Mastropieri, in press), students overwhelmingly preferred mnemonic to traditional teacher-led instruction, both in terms of enjoyment and educational value.

In addition to the empirical evidence outlined above, teachers employing mnemonic instruction frequently report that their students stay on task longer, participate more in class, and appear to enjoy learning more when participating in this type of instruction. The reason for this effect appears to be that LD students typically regard schoolwork as an endless series of memory tasks involving meaningless information, at which they are unlikely to succeed (Licht & Kistner, 1986). Mnemonic instruction, as we have employed it, involves presenting interactive cartoon-like pictures on overhead projectors that focus attention on target information and also provide direct retrieval links between information that must be learned and information that is concrete and familiar to students. When asked questions, then, students know how to go about retrieving the answer. These explicit retrieval steps can serve to create a sense of empowerment in students, who may begin to feel more responsible for their own learning.

Teacher Acceptance

Throughout our research, teachers have consistently reported their approval of, and enthusiasm for, mnemonic instructional methods and materials. In a recent investigation (Mastropieri & Scruggs, 1988), using a standardized instrument to measure the appropriateness of an intervention for target learners, teachers rated mnemonic instruction as significantly more appropriate for content-area teaching of LD students than traditional textbook-based methods.

Material Development

Mnemonic instruction has proven highly effective for promoting LD students' academic performance. However, mnemonic instructional materials are not available commercially for special education teachers—most of the materials used to date have been developed by researchers (often, with access to artists), specifically for their studies. Given the absence of commercial mnemonic instructional materials, what is the potential for teachers to develop mnemonic materials?

We must admit it takes time, energy, and resources to develop these materials, but we have seen some successful teacher applications—even among teachers who have little artistic ability. Mastropieri, Emerick, and Scruggs (1988) reported on an investigation of the effectiveness of mnemonic science instruction for which the teacher had developed her own materials. Rather than using professional line drawings, the teacher used stick figures and cutouts from magazines. With these materials, students taught mnemonically scored significantly higher than when taught using more traditional methods and materials. Students even increased their mnemonic advantage over a one-week delayed-recall interval. Likewise, Mastropieri, Whittaker, and Scruggs (1988) noted the success of teacher-developed mnemonic materials in teaching anatomy, while Mastropieri and Plummer (1988) reported on a mainstream high school teacher who was able to recruit the assistance of a student-artist to draw mnemonic pictures. These reports suggest that teacher development of mnemonic instructional materials, although perhaps difficult, is altogether possible.

Generalization

During our mnemonic instructional research, the question has frequently been asked, "Can LD students be trained to create and use mnemonic strategies independently"? If this goal could be achieved, not only would it be unnecessary to develop materials, but students would be able to use the strategies in any classroom or other setting where their use is appropriate. Although generalization is a desirable outcome, results of generalization studies have been equivocal. For example, McLoone, Scruggs, Mastropieri, and Zucker (1986) trained LD students to transfer the keyword method to another, highly similar list of vocabulary words. The words used (English and Italian vocabulary words), however, were simple, concrete words with relatively "obvious" keywords (e.g., dogbane, bugsha).

On more complex applications, generalization attempts have been less successful. Scruggs and Mastropieri (in press) trained LD students to generate mnemonic strategies as a group in an attempt to learn science content. Although the students developed and employed the strategies successfully, they moved through the content about one third as fast as when teachers provided the strategies. (The perception that students learn faster when strategies are provided is supported by teacher interviews reported by Pressley et al.—to appear in LDQ, Winter 1991.) Most recently, Fulk (1990) trained students individually to generate keyword-type mnemonics for a variety of content domains. After several days of training and guided practice, students were able to generalize effective mnemonic strategies on some, but not all, dependent measures.

Based on the results of mnemonic transfer research, (a) students can be trained to independently generate mnemonic strategies on simple transfer tasks involving simple keywords; (b) students can generate strategies on more complex tasks with teacher guidance at a sacrifice of content covered; and (c) on completely independent transfer tasks, students may exhibit great difficulty developing appropriate strategies. We have been rather pessimistic regarding the transfer potential of mnemonic strategy instruction, because, after eight years of experience, it still takes us a great deal of time and effort to create the strategies. In fact, often the proper strategies do not occur to us until several days after our first attempt. Therefore, it is likely that it will take even longer for LD students to create these complex strategies. For some tasks, teachers must choose between maximizing content learning or maximizing strategy learning (Mastropieri & Bakken, in press). Although educational researchers are often preoccupied by independent strategy use as a "higher level" goal, teachers tend to be concerned with more immediate goals, such as students passing tests and staying in school.

Nevertheless, we do believe that students can be taught about the effectiveness of mnemonic encoding, and that, in time, they can begin to apply at least some aspects of these strategies on their own. We have found that it can be helpful simply to attend to the *acoustic* properties of unfamiliar words—what the new word sounds like that is familiar to the student—even if these acoustic similarities are not effectively elaborated.

Finally, we believe that if teachers begin to practice mnemonic instruction, and use it consistently over a period of months, or even years, students will become more aware of the effectiveness and utility of these techniques, and will gain sufficient experiential background to begin using them independently. It is difficult to imagine successfully training students to use strategies that they do not see teachers use in their own teaching. With further research and development activities, and the emergence of consistent mnemonic teaching practices, including generalization and attribution training (e.g., Fulk, 1990), we believe that LD students can learn to transfer much of the essence of mnemonic instruction to their own learning.

Summary

We have provided evidence that mnemonic instructional strategies have produced some of the largest, most consistently positive outcomes in special education intervention research. Furthermore, we have maintained that mnemonic instruction impacts greatly on recall, comprehension, and affective outcomes. In addition, this instructional approach is highly regarded by both teachers and students, and teacher-developed materials have proven as successful as those developed by researchers. Finally, we have noted only limited success for student generalization of mnemonic strategies. However, we argue that with more intensive and lengthier teacher implementations, coupled with explicit generalization and attribution training, students may learn to incorporate at least some aspects of mnemonic techniques into their own learning.

CONCLUSION

Mnemonic techniques have been with us for thousands of years, but only recently have they been used to address the unique learning needs of students with learning disabilities. Techniques that are at least potentially useful to LD students include loci, keywords, pegwords, acronyms, reconstructive elaborations, phonic mnemonic, spelling mnemonics, number-sound mnemonics, and Yodai methods. When evaluated experimentally, these methods have produced very positive outcomes on the learning, comprehension, retention, and affect of learning disabled students. These powerful techniques are expected to result in greater implementation in special education settings in the near future.

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