The Effects of Visual and Verbal Coding Mnemonics on Learning Chinese Characters in Computer-Based Instruction

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The effects of different approaches to learning Chinese characters were investigated. Ninety-two high-school students were randomly assigned to one of five treatment groups: translation, verbal mnemonics, visual mnemonics, dual coding mnemonics, or self-generated mnemonics. All groups received instruction and completed posttests in a computer-based environment. The results indicate that participants who generated their own mnemonics demonstrated higher posttest performance than those in visual coding, verbal coding, and translation groups; subjects in the dual coding group scored higher than those in the translation group. Those who generated their own mnemonics spent more time on task than any other group, and those in the verbal coding group took more time than those in the translation group. Survey and qualitative data suggest that learners' interpretations of the Chinese characters were rooted in their cultural backgrounds and personal experiences.

☐ The phrase "a picture is worth a thousand words" suggests that human memory capacity is greater for pictures than for words (Kobayashi, 1986). Yet, important questions remain concerning the potential of images to support learning. One issue concerns how varying information displays on computer monitors influence learning. Researchers have questioned whether pictures provide more information than words during the memory coding processes, or vice versa (Mayer & Anderson, 1992; Mayer & Sims, 1994; Rieber, 1991; Towers & Anglin, 1994). A related question concerns the extent to which learners should be supplied with ideas as opposed to generating their own meaning. Foreign language instructors, for example, are interested in the value of self-generated versus supplied mnemonics (Wang, 1998; Wang & Thomas, 1992). Some researchers claim that supplied mnemonics enhance memorization and increase vocabulary recall. However, others suggest that self-generated mnemonics have a better long-term effect than experimenter-supplied mnemonics (Butler & Blake, 1973; Wang & Thomas, 1992; Wang & Thomas, 1996; Wang, Thomas, & Quellette 1992). The purposes of the present study were to investigate the effects of diverse computer-based visual and verbal presentations while learning Chinese characters, and to find out if self-generated mnemonics have benefits that extend instructor-supplied mnemonics.

Dual Coding

Paivio's (1986) dual-coding theory supports the superiority of pictures over words as memory aids (Kobayashi, 1986; Rieber & Kini, 1991). Dual coding theory (Paivio, 1986) posits that human memory consists of two subsystems, one verbal and one visual. The visual system processes and stores more-concrete information such as images, sounds, and feelings. The verbal system processes and stores language and other abstract information.

The two systems are independent, but connected. The construction of a verbal representation from a visual stimulus, or vice versa, is referred to as a referential connection. Information that is registered both visually and verbally (i.e., referentially connected) is said to be dual coded (Clark & Paivio, 1991; Mayer & Moreno, 2002; Mayer & Sims, 1994; Paivio, 1971; Steffensen, Goetz, & Cheng, 1999).

Information is better remembered when dual rather than single coded, because when one memory trace is lost the other remains available. Moreover, pictures are better remembered than words because pictures are more likely to activate the image-to-word referential connections, so they can be coded both visually and verbally (Clark & Paivio, 1991; Mayer & Moreno, 2002; Mayer & Sims, 1994; Paivio, 1986; Sadoski, Paivio & Goetz, 1991).

Dual coding is more likely to occur when the learning content is highly imageable (Paivio, 1986; Sadoski, Goetz, & Avila, 1995). Also, the learning of concrete concepts is easier than the learning of abstract concepts because concrete concepts are processed and stored as images and verbal presentations, whereas abstract concepts are primarily stored as verbal presentations, which have less access to the nonverbal code (Rieber & Kini, 1991; Sadoski et al. 1995; Sadoski et al., 1991).

Learning Chinese Characters

Chinese characters are highly imageable logographic words (Steffensen et al., 1999). Many of the earliest Chinese characters were pictographs, which are also known as *image-shape* words. The ancient Chinese created written language by drawing pictures of objects according to their shape and form, rather than their sound. Pictographs referred to concrete objects, such as animals, plants, humans and their attributes, and phenomena in nature. Over time, many contemporary characters emerged from extant pictographs. New characters were formed by combining two or more symbols to represent more complex or abstract concepts.

Chinese characters were often created through careful observation and logical reasoning, each character reflecting a story or suggesting a logical or philosophical idea (Li, 1996). Logographic words provide graphic and semantic contexts that can lead to successful character recognition even when the reader does not know the character's etymology (Ke, 1996). Moreover, the visual appearance of a character helps learners to differentiate and identify the character (Turnage & McGinnies, 1973).

Although Chinese characters contain considerable visual and verbal information, Chinese language teachers often use traditional methods to teach symbol meanings. Traditional methods tend to ignore the meaning inherent in a symbol (Li, 1996; Wang, 1989; Wang, 1998). Instead, students often copy a character repeatedly (i.e., 10 to 20 times) in an attempt to improve recall, resulting in inefficient learning and poor retention. Rather than copying symbols mechanically, Wang (1998) recommended that students should create mnemonics, using the visual and semantic information coded in the characters to generate meaning.

Mnemonics Strategies

Wang and Thomas (1996, p.104) defined mnemonics as ". . . learning strategies that make elements of abstract information more familiar and encourage students to form meaningful association to these familiar elements." More generally, mnemonics can be defined as learning strategies, comprising either visual images or words, that can enhance memorization and recall of information. Mnemonics act as mediators between the learning stimuli and the information to be remembered, and are used later by the learner to recall information through a self-cueing process (Bellezza, 1981).

Two questions about the effectiveness of mnemonics for language learning concern (a) the relative benefits of mnemonics for immediate and delayed recall, and (b) the efficacy of self-generated versus supplied mnemonics. Although many studies demonstrate the benefits of using mnemonics to enhance immediate recall in second language learning (Butler & Blake, 1973; Wang & Thomas, 1992; Wang, Thomas, & Quellette, 1992), evidence does not support the efficacy of mnemonics for long-term retention. For example, Wang and Thomas (1992) demonstrated that when image-based mnemonics (i.e., mnemonics describing and highlighting the visual aspects of Chinese characters) were compared to rote learning, mnemonics were superior for immediate recall, but not for delayed recall. Indeed, on the delayed posttest, more characters were forgotten in the mnemonics group than in the rote-learning condition.

Wang and Thomas (1992) further explained that when testing is administrated immediately, experimenter-supplied encoding may be retrieved easily because temporal and contextual cues associated with the encoding are still available. However, after a delay, spontaneous subject-generated encodings regain their influence and hinder the supplied mnemonics retrieval.

Another question concerns the relative benefits of self-generated versus supplied mnemonic cues. The essential element of a mnemonic may be the role played by the student in the creation of the memory aid (Mantyla & Nillson, 1983). From a constructivist perspective, learners use personal experience as a foundation on which to build knowledge (Bednar, Cunningham, Duffy, & Perry, 1991; Jonassen, 1991). Such experiences may conflict with the meaning inherent in supplied mnemonics. Moreover, learners must be actively engaged to construct and interpret individual meaning. Such involvement in a learning task is assumed to stimulate deeper information processing (Wittrock, 1990).

The apparent benefits of self-generated mnemonics are illustrated in several studies. In one experiment, subjects were encouraged to create mnemonic cues to learn words, but were given either their own or others' cues for retrieval. Not only did the mnemonic groups outperform a control group, but also subjects performed better when they used their own cues rather than supplied cues (Mantyla & Nillson, 1983).

Another study compared visual mnemonics with an unelaborated rehearsal technique for learning foreign-language vocabulary, and examined the relative benefits of a supplied visual mnemonic and one invented by the student (Butler & Blake, 1973). Strategies involving verbal or visual mnemonics were considerably more effective than a repetition technique, and students using a self-generated visual mnemonic outperformed those using a supplied mnemonic.

In a third study, participants either created stories, or were given stories created by others, connecting a list of unrelated words (Wall & Routowicz, 1987). Although no difference was found for immediate recall, both self-generated and supplied stories produced superior performance compared to a control group using a repetition technique on a delayed test.

Although self-generated cueing strategies appear to benefit learning, other studies suggest that some groups may have difficulty generating effective mnemonics: Creating effective mnemonics may require considerable effort and creativity. Swanson (1988) found that supplied images were more effective than self-generated images for college students with learning disabilities. In Carrier, Karbo, and Kindem's (1983) study, the effects of rote repetition, self-generated visualization, and supplied visuals were investigated using gifted children in grades four through six. The hypothesis that self-generated imagery techniques would be superior to supplied visuals was not supported. Their findings indicated that self-generated visuals may not be effective mnemonics in memory tasks with young children. Kibler and Blick (1972) suggested that if the learner is too young or if the task of discovering an appropriate mnemonic is too difficult, then providing the learner with mnemonics will be more helpful.

In summary, dual-coding theory suggests that better recall can be expected when information is dual coded, because two mental representations are more powerful than one. Moreover, dual coding is more likely to occur when the learning content is highly imageable. Many Chinese characters are highly imageable, each character reflecting a story or suggesting a logical or philosophical idea. The rich visual and verbal information encoded in Chinese characters may help learners to memorize a character's meaning. Mnemonic devices are powerful memory-enhancing strategies, that improve immediate recall dramatically. However, to enhance long-term retention, educators may encourage learners to generate their own mnemonics, rather than to use supplied mnemonics.

Although many studies have examined the effects of dual coding on language learning (Paradis, 1978; Paivio & Lambert, 1981; Steffensen et al. 1999; Taura, 1998) and science instruction (Mayer & Anderson, 1991, 1992; Mayer & Sims, 1994; Rieber, 1989, 1990, 1991), and other research has investigated the effects of mnemonic devices on second language learning (Butler & Blake, 1973; Wang & Thomas,1992; 1996; Wang et al., 1992), little research has examined the effects of using graphics and words as mnemonic devices to memorize Chinese characters. Therefore, the primary goal of this study was to examine the effects of visual and verbal mnemonics on memorizing Chinese characters in a computer-based instructional environment for Chinese as a second-language. We also examined whether generating one's own mnemonics, rather than using supplied mnemonics, would facilitate long-term retention of Chinese characters. Furthermore, since the effort taken to generate a mnemonic may reduce learning per unit of time (Williams, 1996), we examined the effects of instructor- and self-generated mnemonics on time.

Specifically, we asked the following primary research questions:

1. Will students who use self-generated mnemonics to study Chinese characters demonstrate higher achievement than participants who use experimenter-supplied mnemonics?
2. Will students who use dual coding mnemonics to study Chinese characters demonstrate higher achievement than participants who use only single coding mnemonic (i.e., either visual or verbal)?
3. Will students who use visual mnemonics to study Chinese characters demonstrate higher achievement than participants who use verbal mnemonics?

METHOD

Participants

A sample of 100 high-school students from four computer classes participated in the study. All participants were in their second semester in the class and were participating voluntarily. The study was conducted at a suburban high school located in a middle-income neighborhood near a large midwestern city. All the participants were native English speakers and had no previous knowledge of the Chinese language. Although 100 students completed the experiment and the immediate posttest, 8 of the original participants were absent from the delayed posttest. Therefore, a total of 92 students completed the study. Only data from participants who completed all phases of the study were used in the data analyses.

Experimental Design and Treatments

The study employed a single-factor multiple-treatment design. The five experimental treatments are described briefly below. Sample screen shots for each treatment are presented in Appendix A.

1. *Translation group.* Each character was presented simultaneously with its English translation. Subjects were told to memorize the meaning of the character.
2. *Verbal coding group.* Each character and its English translation were presented simultaneously. In addition, a brief verbal description of each character's etymology was presented.
3. *Visual coding group.* Chinese characters and their English translations were presented simultaneously. In addition, a picture representing a concrete or abstract word was presented.
4. *Dual coding group.* A Chinese character, its

English meaning, a corresponding picture, and a verbal description of its etymology were presented.

5. *Self-generated coding group.* This treatment was identical to that of the Translation group, with the addition that subjects in this treatment were encouraged to create their own memory aids by drawing a picture, writing a sentence, or inventing a story associating the character with its meaning. Sample pictures and verbal descriptions were provided to illustrate this process (see Appendix B). Worksheets, which were collected for analysis, were provided for students to record their mnemonics.

Materials

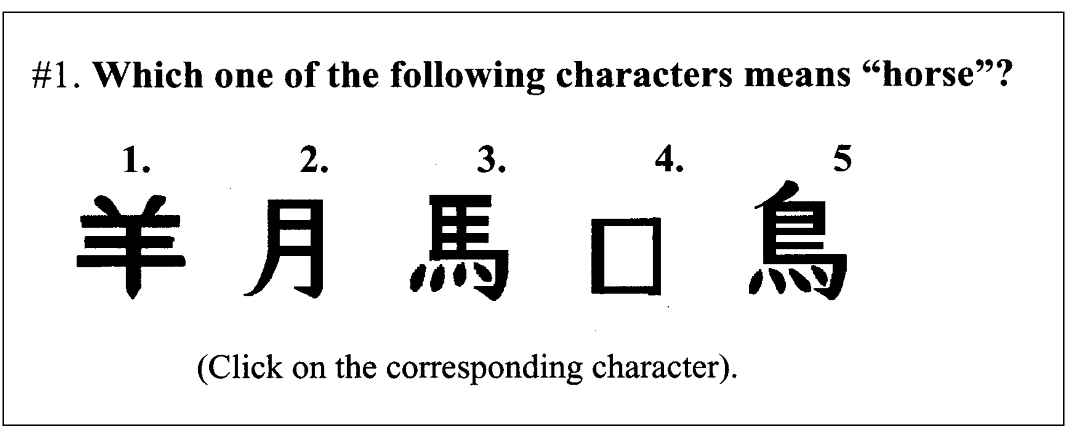
The materials used in the study consisted of a computer-based tutorial and posttest, and an open-ended learning-strategies survey.

Computer-based tutorial. The tutorial was a software program designed to teach Chinese characters to nonnative Chinese speakers. The tutorial included 30 characters, divided equally between *concrete words* (words that represent physical objects) and *abstract words* (words with no direct referents). The characters were selected because they are commonly used and it was estimated that they would be appropriate for high-school students. The concrete words were people, child, mouth, tree, eye, ear, hand, sun, door, fire, mountain, water, horse, fish, and pig. The abstract words were east, rest, confine, peace, love, divide, senior, high, winter, interact, fly, compare, say, see, and hear. The symbols and their meanings are included in Appendix C. Sample visual and verbal mnemonics used for abstract words are included in Appendix D. The primary task for the participants was to read and learn the characters and their English meanings.

Posttest. The posttest consisted of 30 multiple-choice items (including one correct answer with four distracters) measuring the ability to recognize the characters. The characters were the same as those used in the tutorial for all treatments. The number of correct answers on the posttest was used as the achievement score for each participant. The posttest was administered twice using the same testing questions, but the test item-order was shuffled for the second posttest. Cronbach's Alpha was used to calculate the internal consistency of the immediate and delayed posttests, and was found be .79 and .77 respectively. A sample question can be seen in Figure 1.

Learning strategies survey. A 4-item open-ended survey was used to generate insight into student thinking processes and strategies for learning the characters. Questions investigated how much participants remembered their learning task, the tactics they used to answer the test

Figure 1 □ A sample posttest question.



questions, and their learning strategies. One question, which was customized for each treatment, investigated participants' perceptions about how each treatment affected their learning. The survey is included in Appendix E.

Dependent Measures

Two quantitative measures were used: (a) achievement test scores and (b) time on task. Achievement was assessed through two posttests that measured student's lesson-based learning. Time on task represented the time in seconds (recorded by the computer) taken to complete the section of the tutorial that involved learning the 30 characters, but did not include the time taken to complete procedural tasks such as reading directions or completing the posttest.

Data Analyses

A repeated-measures analysis of variance (ANOVA) was used to analyze the achievement scores for the immediate and delayed posttests. A separate one-way ANOVA was used to analyze time on task. Multiple-comparison tests were conducted using Tukey's post hoc contrasts. For all quantitative analyses, alpha was set at .05.

Two other types of data were analyzed: (a) survey responses and (b) qualitative data from the worksheets. The mnemonics created by participants in the self-generation treatment were sorted by character, and analyzed for common patterns. The self-generated and supplied mnemonics were then compared. The results of these qualitative data were used to supplement the findings obtained from the quantitative analysis.

Procedures

On the first day of the experiment, participants were assigned randomly to one of the five treatment groups. After finishing the learning materials, participants completed the computer-based posttest. Students were allowed to complete the tutorial at their own pace, but the learning time was recorded. The entire tutorial (including directions, introduction, time to learn the characters, and the posttest) took 15–40 min to complete. The students' names, group numbers, time on task, and aggregate test results were stored in the computer. Four intact classes participated in the study on the same day during their regular class period.

To deter students from studying during the interval between the immediate and delayed posttests, students were not informed about further testing. However, the delayed posttest was administered one week later.

Following the delayed posttest, a subsample of the original participants was selected to complete the survey. The subsample was chosen to reflect a representative cross-section of the participants' abilities: Those with the highest, median, or lowest scores on the immediate posttest were selected. Consequently, 15 participants answered the survey (3 from each of the 5 treatment groups).

RESULTS

In this section, we report the quantitative results and those of qualitative analysis of the mnemonics created by the self-generation treatment. We also offer samples from the open-ended survey to help explain the findings.

Table 1 presents the means and standard deviations for the immediate posttest, delayed posttest, and time on task for each of the treatment groups. Effect sizes were computed for individual contrasts as follows: $(M_1 – M_2) \div$ (pooled standard deviation). Effect sizes can be interpreted as follows: small is below 0.2, medium is 0.5, and large is greater than 0.8 (Cohen, 1988).

Achievement Scores

There was a significant difference among the five treatments $F\,(4, 87) = 2.56$, $MS = 133.03$, $MS_e = 52.01$, $p < .05$ for combined posttest performance. The means were further analyzed via Tukey's follow-up procedures. Results indicated that the combined-mean score of the self-generated group (M = 22.69) was significantly higher than those of the visual coding (M = 19.63), the verbal coding (M = 18.97), and the translation (M

Table 1 ☐ Means and standard deviations by treatment.

	n	Translation 18	Verbal 19	Visual 18	Dual 19	Self-generated 18	Combined 92
Immediate Posttest Range: 5–30	M	19.33	20.42	20.56	23.42	24.44	21.64
	SD	5.30	5.47	5.29	4.75	5.27	5.46
Delayed Posttest Range: 4–28	M	16.33	17.53	18.72	19.05	20.94	18.51
	SD	5.16	5.44	5.72	5.36	5.47	5.53
Combined Posttests Range: 12–57	M	17.83	18.97	19.63	21.23	22.69	20.08
	SD	5.37	5.57	5.51	5.46	5.58	5.70
Time Range: 126–2378	M	275.00	441.00	322.00	307.00	1,256.00	517.00
	SD	124.00	155.00	159.00	116.00	595.00	467.00

= 17.83) treatments. Respective individual effect sizes were: +0.54, +0.65 and +0.85. In addition, the combined-mean score of the dual coding group (*M* = 21.23) was significantly higher than that of the translation treatment; effect size = +0.60.

There was also a significant difference F (1, 87) = 94.08, MS = 447.27, MS_e = 4.75, p < .01, effect size = +0.57 for posttest. Participants scored higher on the immediate (*M* = 21.64), than on the delayed (*M* = 18.51) posttest. The interaction between posttest and treatment was not significant F (4, 87) = 1.66, MS = 7.90, MS_e = 4.75, p = .17.

Time on Task

ANOVA indicated a significant effect for Treatment, F (4, 87) = 36.89, MS = 3127727, MS_e = 84770, p < .01. Follow-up procedures indicated that students in the self-generation group (*M* = 1256 seconds) spent significantly more time learning than did students in the verbal coding group (*M* = 441), visual coding group (*M* = 322), dual coding group (*M* = 307), and the translation group (*M* = 275). Respective individual effect sizes were: +1.75, +2.00, +2.03 and +2.10. In addition, students in the verbal coding group spent significantly more time learning than did those in the translation group; effect size = +0.36.

Figures 2 and 3 show the posttest scores and time on task among the five groups. Figure 3 illustrates dramatically the high time taken for the self-generated coding group.

Summary of the Self-Generated Mnemonics Treatment

Participants from the self-generated treatment groups were provided with worksheets on which to record their mnemonics. These worksheets were collected for analysis. In general, there was a high degree of similarity between

Figure 2 ☐ Posttest scores by treatment.

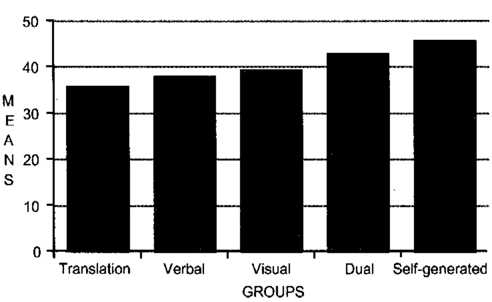
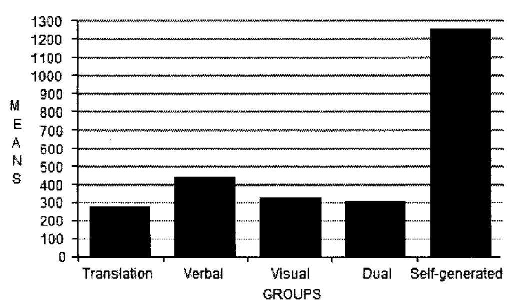


Figure 3 ☐ Time on task by treatment.



students' "stories" and the experimenter-provided mnemonics. About 60% of the self-generated memory aids were able to describe the key point of the characters. However, differences between the self-generated and the experimenter-supplied mnemonics were found (particularly in the abstract word section). For instance, for the character *east,*[1] the experimenter-provided statement was: "The character is a combination of the sun and a tree. The sun rising behind a tree means east- the direction from which the sun rises." Only one student in this group made a similar statement: "Sun rising above the tree, sun rises in the east." A few students deconstructed the character and identified the alphabetic letter *E* as a cue for east.

Participants in the self-generated treatment group created fewer mnemonics for abstract words than for concrete words. There were 49 cases of missing answers for abstract words, but only 21 cases of missing answers for concrete words. Student's mnemonics for the abstract words were also briefer and less descriptive than the mnemonics for the concrete words. Moreover, more posttest errors were made for abstract than for concrete words. On the immediate posttest, 36% of the wrong answers were associated with concrete words, while 64% were associated with abstract words.

Analysis of the descriptions by the self-generated treatment suggests that their memory aids reflect their backgrounds and life-experiences. First, for the character for *door,*[2] 8 of 15 respondents used the image of swinging doors in western movies to relate the character. Second, for *winter,* 12 of the 14 responses used "snow falling" or "footprints in the snow" to describe the character. Third, students used sunbathing-related ideas to remember the character *sun*[3]. Fourth, the reference to a Christmas tree for *tree* is also related to a Western cultural background. Finally, participants used a strategy to find cues for the least familiar words using alphabetic letters or numerals to associate the characters with their English meanings. For example, some students used *M* for mountain; *W* for water; *E* for east, ear, and elder; *T* for tree; and *3* for a young child.

Summary of the Open-Ended Survey

Within each treatment, responses from the three participants who completed the survey were sorted and analyzed for emergent patterns. Two themes are reported here. First, responses indicate that the supplied mnemonics groups (i.e., visual, verbal, and dual coding) employed learning and test-taking strategies that reflected the mnemonic techniques that they were given. That is, they used, individually or in combination, pictures and text to remember character meanings. For example, in response to the question "When you took the test, how did you choose the answers?" one student from the visual coding group stated: "I just remember the picture that was shown along with the character. . . . I try to find similarities between the character and picture." Another stated: "I tried to remember the similar pictures that were provided last week and how they evolved into Chinese [characters]." A student from the dual coding group said "[W]hen I took the test, I kind of saw the picture in the character, and I remember the [descriptive] words about the character." Similarly, in response to the question "What were your learning strategies for memorizing the Chinese characters?" a student from the verbal coding group said: " I read the description carefully and remember why and what the character parts represent." Another stated: "I just remember the 'story' with each word [character] . . ."

Second, some participants commented that they used mental images as mediators to connect the characters with their English equivalents. For instance, in response to the question "What were your learning strategies for memorizing the Chinese characters?" a participant from the translation group stated: ". . . just made a connection with a picture between the character and the [English] word." Similarly, another stated: "I try to imagine a picture in the character." One student from the self-generated group said ". . . sometime I just picture that character and find clues . . ."

東 1. east

門 2. door

冬 3. winter

DISCUSSION

The most interesting results from this study may be the contrasting effects of self-generated and experimenter-supplied mnemonics on recall and time on task. On the combined posttests, the self-generation group outperformed the visual coding, verbal coding, and translation groups. Moreover, the self-generation group scored higher than the dual coding group, although the difference was not statistically significant. In general, generating one's own relationship between a symbol and its meaning appears to be an effective strategy for remembering Chinese characters.

The achievement data presented here support Grabowski's overview (1996) of generative learning strategies. She emphasized that effective instruction involves more than simply presenting information in the most efficient manner. Rather, effective instruction stimulates learners to build two types of relationships; the first being the organization of to-be-learned content, and the second being the creation of meaning between lesson content and the learner's prior knowledge. In contrast, less effective approaches tend to provide relationships to students. In the present study, it might be argued that all treatments, other than self-generation, focused on content presentation. Perhaps only the self-generation treatment would count as generative learning as this was the only treatment that required learners to build relationships between the lesson information and their prior knowledge or experience.

However, generating memory aids increased time to completion. The self-generation group spent significantly longer learning than did all other groups. Examination of time-on-task data reveals that the self-generation group spent approximately three to four times longer on task than did the other groups. The high time to completion for the self-generation treatment raises important questions about instructional efficiency. Given the relatively short instructional treatments employed in the present study, further research is needed to investigate the effects of similar approaches in on-going classroom settings.

Data suggest mixed support for the dual-coding theory, which asserts that information is likely to be better remembered when coded both pictorially and verbally, and that pictures are more robustly coded into memory than words. The posttest results do not support the dual-coding theory. Students in the dual-coding treatment did not have significantly better scores than those in the single-coding (either visual or verbal) groups. Also, the scores of the visual coding mnemonics group were no better than those of the verbal coding group. Yet, all scores were in the predicted direction.

Moreover, other data do support the dual-coding hypothesis. For example, survey responses indicate that dual coding may have occurred in the single-coding mnemonics groups as well as in the nonmnemonics groups. Several responses from the surveys document that participants from the translation and self-generation treatments formed mental images to remember characters. When neither pictorial nor verbal cues are available, students may instinctively form mental images that associate the characters with their meanings. According to Paivio (1986), dual coding is more likely to occur when the content is highly imageable. Chinese characters are graphic by nature (Chuang, 1975; Li, 1996; Wang & Thomas, 1992) and highly imageable. Thus, dual coding may occur spontaneously when learning Chinese characters.

This suggestion is supported by a finding from another study of dual coding in foreign language learning (Taura, 1998). The study examined bilingual students who were proficient in both Japanese and English. Participants were asked to study sets of pictures, Japanese Kanji, and English words, and to write the meaning of the picture in English, to translate the Kanji to English, and to copy the English word. Results on a recall test indicated that pictures were recalled 3.7 times more frequently than the copied words and the kanji translations were recalled 3.2 times more frequently than the copied words (i.e., a ratio of 3.7:3.2:1). Differences between the picture and the translation encoding conditions were not significant.

Taura (1998) noted that the ratio of picture meaning:translation:copying in similar studies of English with French or English with German was approximately 3:2:1. Taura attributed the similarity of pictorial and translation treatments in his study to the nature of Japanese Kanji. Japanese is a logographic language. Hence, the pictorial nature of Japanese Kanji is more likely to activate a word-to-image referential connection than the alphabetic words, and thus result in better memory retention.

It is interesting that no differences were found among the five treatment groups between the immediate and delayed posttests. In previous research, Wang and Thomas (1992) found that long-term forgetting of experimenter-provided coding was greater than that of subject-generated coding, suggesting even greater benefits for self-generation treatments over time. Although the qualitative data do not provide any insight into this outcome, it is worth noting the high degree of similarity for forgetting rates across treatments. Further research is needed to corroborate this outcome and to investigate the effects of self-generation on different learning outcomes. For example, if self-generation stimulates deeper cognitive processing than supplied mnemonics, then achievement differences may be more apparent for higher-level learning than for the recall tasks employed in the present study.

The qualitative data provide several insights into the experiences of the self-generation treatment. Not surprisingly, more posttest errors were made for abstract than for concrete words. Abstract words, having no direct objects to which to make reference, are generally more difficult to recognize. Concrete words are generally understood better, and are less likely to be misinterpreted than is abstract content (Sadoski et al., 1995) because imagability is directly linked to concreteness (Paivio, 1971). Students may need more imagination and creativity to make effective mnemonics for abstract words.

It is possible to speculate on the discrepancies between the experimenter-supplied and student-generated mnemonics. In the tutorial, most character descriptions were derived from their etymological origins that can be traced back thousands of years. However, this writing system has transformed the originally pictorial characters into more abstract combinations of dots and lines (Li, 1996). The origins of these abstract symbols may do little to help people to associate the characters with their meaning. Consider, for example, the character for the word *sun*[4]. The supplied description was as follows: "Sun—a circle with a dot inside. The dot simply indicated that the sun was a substance. Later, the dot became a short horizontal line and the circle began to lose its contours and became more rectangular."

In contrast, participant interpretations of character meanings reflected their backgrounds in Western culture. The life experiences of these students are generally quite different from the conditions that led to the creation of the characters. The observation that participant interpretations of character meanings reflect their cultural backgrounds and experiences (i.e., a Christmas tree, sunbathing paraphernalia, footprints in the snow, etc.), supports McGinnis's (1995) finding that learners of Chinese as a foreign language use personal experiences and stories, rather than the etymology of a character, as a basis for learning. It would be interesting, therefore, to use contemporary rather than traditional descriptions in the stimulus materials in future research.

Several factors may limit the generalization of the results. First, the results may not transfer to Western language learning. This study examined the effects of mnemonics on memorizing Chinese characters. Chinese characters are graphic symbols and are structurally different from alphabetic written forms. However, the findings may provide useful information to understanding relations between different mnemonic strategies and verbal learning.

The goal of the tutorial was for learners to memorize 30 logographic characters. Thus, the results of this study may not apply to other types of language learning, such as speaking, reading, or writing. Moreover, the strategies employed here may not work when the learning time spans weeks or years. There are numerous Chinese characters: a teaching approach that works for 30 characters may not work for larger numbers of characters.

For those in the visual coding treatment, the effectiveness of the visual images to represent abstract words may be influenced by their prior knowledge and ability to interpret the

4. sun

meanings of those pictures. Thus, for example, understanding the symbol for peace may have depended on the participant's ability to associate the symbol of the woman in the shelter with the character.

This study was restricted to using one computer lab and by a school-schedule that resulted in a limiting sample size and brief learning time. Subsequently, the constrained sample size and time on task may have affected the statistical results.

Additional research is needed to examine the impact of visual and verbal mnemonics on the learning of abstract and concrete words. In the present study, students in the self-generation group created more stories for concrete words than for abstract words. Subsequently, participants recognized more concrete words than abstract words. According to Sadoski et al. (1991), concrete words are more likely to activate the words-to-images referential connection than abstract words are. However, it would be interesting to examine how visual and verbal coding strategies influence learning based on the concreteness and abstractness of Chinese characters. In the present study, individual item scores were recorded only for the self-generation treatment. Future research should attempt to record individual item scores for all treatments, to allow comparison of results for abstract versus concrete words. □

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