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ABSTRACT

This study examined the effects of the second level (intermediate acoustical processing of rhyming words) and the third level (deep-semantic processing of words in sentences) of the "levels of processing" framework on memory performance of four types of intermediate-grade students (52 "normal" students, 50 students with learning disabilities, 25 students with mild mental disability, and 25 students with emotional disability). Statistical analysis revealed that "normal" students and students with emotional disability performed significantly higher than students with mild mental disability. However, the analysis did not reveal significant differences among "normal" students, students with learning disabilities, and students with emotional disability. Nor were there significant differences between students with learning disabilities and those with mild mental disability. Data on the memory test showed that the mean number correct for all students was the highest when stimulus words were presented and encoded semantically and were retrieved using a congruent semantic cue. Findings indicate that appropriate use of levels of processing, congruity, and encoding specificity for retrieval cues enhances recall of information. (Contains 30 references.) (Author/JDD)

LEVELS OF PROCESSING IN MILD DISABILITIES

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Abstract

This study examined the effects of the second level (intermediate-acoustical processing of rhyming words) and the third level (deep-semantic processing of words in sentences) of the "levels of processing" framework on memory performance of four types of students (52 "normal" students, 50 students with learning disabilities, 25 students with mild mental handicap, and 25 students with emotional handicap). Statistical analysis revealed that "normal" students and students with emotional handicap performed significantly higher than students with mild mental handicap. However, the analysis did not reveal significant differences among "normal" students, students with learning disabilities, and students with emotional handicap. Nor were there significant differences between students with learning disabilities and those with mild mental handicap. Further, the statistical analysis revealed that the interaction among the four groups of students, encoding levels of processing, and types of retrieval cues was not significant. However, a significant interaction was found between types of retrieval cues and encoding levels of processing. The data on the memory test showed that the mean number correct for all students was the highest when stimulus words were presented and encoded semantically and retrieved using a congruent semantic cue. A mismatch between encoding processing conditions and retrieval cues produced poor memory performance regardless of levels of processing. The findings indicate that appropriate use of levels of processing, congruity, and encoding specificity for retrieval cues enhances recall of information. Recommendations for classroom instructions and future research are discussed.

While several models of information processing have been formulated to study human memory, two models that receive more attention than others are those of Atkinson and Shiffrin (1968) and Craik and Lockhart (1972). Atkinson and Shiffrin's 1968 model describes hypothetical "structures" termed sensory register, short-term store, and long-term store and the interrelations among them using "executive control" processes. Information flows through these stores.

Craik and Lockhart (1972) critically stated that Atkinson and Shiffrin's (1968) stores are differentiated from each other in terms of their properties to aid recall. For example, in the short-term memory store, information is coded acoustically with limited capacity, while in the long-term memory store, information is coded semantically with unlimited capacity.

Briefly, the "levels of processing" framework views cognitive processing for memory tasks as consisting of three distinct levels. At the first level, subjects deal with the superficial characteristics of the stimuli. The analysis of the stimulus at this level is quite "shallow" in that only obvious characteristics are explored with little cognitive processing being directed toward recall of the stimulus. This level is often called the "shallow" level.

At the next, and deeper level the emphasis is often on the acoustic properties of the stimulus. Since most research has been concerned with language and words, this level is often referred to as "phonemic", focusing on the acoustic characteristics of words to be remembered. In many studies, subjects have been asked to remember if two words rhyme, thereby using a "deeper" level of processing which focuses on acoustic, rhyming, or phonemic analysis. This level is often called the "intermediate" level.

At the third and deepest level of cognitive processing, the focus of the subject is on the meaning of the words and how the words are used correctly, typically within a language context. In some studies, subjects have been asked to determine if a particular word "fits" into a sentence. For example, given the word "dog", the student might be asked to determine if the word fits logically in the sentence "The _____ gnawed on his bone". Therefore, this level is often referred to as requiring semantic (word meaning) elaboration. Elaboration means the use of any cognitive process such as mental imagery and paraphrasing to facilitate recall. When the cognitive process of elaboration deals with the use of words, then the term semantic elaboration is frequently used. It is easy to see that this approach to memory has also been called the "depth of processing" model. This level is often called the "deep" level.

This study used the "levels of processing" framework to explore memory characteristics of students with and without disabilities. Specifically, it examined the effects of the second level (intermediate-acoustical processing of rhyming words) and the third level (deep-semantic processing of words in sentences) of the framework on memory performance of four types of students (students without disabilities and students with learning disabilities, with emotional handicap, and with mild mental handicap) in elementary school. Two other variables were also studied by incorporating them within the second level (intermediate-acoustical processing of rhyming words) and the third level (deep-semantic processing of words in sentences).

The first variable is congruity (Schulman, 1974) which is used to indicate that two words rhyme with each other (e.g., Pig and Wig) or that a word is used correctly in terms of its semantic property in a sentence frame (e.g., using the word "Pig" in the sentence "The _____ rolled in the mud"). Non-congruity is examined when two words did not rhyme (e.g., Pig and Saw) or when a word did not fit into a sentence frame and therefore did not make sense (e.g., using the word "Pig" in the sentence "The man bought new tires for the ____.").

The second variable is the encoding specificity principle (Tulving & Osler, 1968; Tulving & Thomson, 1973; Tulving, 1983) which means that if retrieval cues are to be effective in recall, they have to be presented with the to-be-remembered words at input. The same retrieval cues have to be presented at input and output. The encoding specificity principle is used in this study to examine the effect of matching and mismatching retrieval cues on memory performance.

Matching retrieval cues are evaluated in a situation where a stimulus word such as "Pig" is encoded with a retrieval cue such as "Wig" and later cued with the word "Wig". Similar situations where the same retrieval cue is used at input and output are termed as "the original level of processing".

Mismatching retrieval cues are evaluated in a situation where a stimulus word such as "Pig" is encoded with the sentence "The ____ rolled in the mud" and later cued with the word "Wig".

Matching and mismatching retrieval cues are used in congruent and non-congruent contexts at both the second and the third levels of the framework levels of processing. The examples mentioned above are described as congruent. Non-congruity is achieved when the two words do not rhyme or when the stimulus word does not fit into the sentence frame.

METHOD

Subjects

Three hundred fourth and fifth grade students participated in this study. One hundred fifty two students met the criterion to continue with the task. The 148 students who were excused from participating in this study needed assistance in reading more than six stimulus words or their accompanied cue words. All students were enrolled in elementary schools in central Indiana.

Of the 152 subjects who participated in this study, 52 had no identified learning problems and were labeled "normal" (N) for the purpose of this study, 50 were in programs for students with learning disabilities (LD), 25 were in programs for students with mild mental handicap (MIMH), and 25 were in programs for students with emotional handicap (EH). A large number of students in the four groups (especially the "normal" group) came from families of low socioeconomic status. Table 1 and Table 2 contain information about the number of students who participated in this study and their gender, race, grade, age, Cognitive Skills Index (CSI) and Otis-Lennon scores for cognitive ability for "normal" students, and IQs for EH, LD, and MIMH students.

The following criteria were used to select the "normal" group: (1) none of the students should have had significant difficulty in any academic area or had received special remedial instruction of any kind during all their schooling period or had been referred for special education assessment. They had to be free of any gross motor impairment, sensory impairment, and emotional or psychotic disturbances. They had to have an average or above average academic performance based on the Comprehensive Tests of Basic Skills, Fourth Edition (CTBS/4), achievement measure. "Normal" students who participated in this study were those who returned the permission form signed by their parents or gardians; (2) the students earned a score of not less than 84 on either the Otis-Lennon School Ability Test, Sixth Edition, or the Test of Cognitive Skills (TCS) which yielded a cognitive skills index (CSI) standard score describing students' performance on TCS. The CSI used in this study is a measure of overall cognitive ability or academic aptitude. CSI scores were taken from the school records.

Table 1

Numbers, Gender, Race, Grade, and Age Information about the Four Groups of Students

	Number of Students		Race		Grade		Age		
Groups	Male	Female	White	Black	4th	5th	Range in Yr/Mo	Mean in Yr/Mo	SD in Months
N	23	29	44	8	31	21	9-6/13-0	10-9	9.19
LD	33	17	48	2	26	24	9-5/13-0	11-3	9.09
EH	24	1	24	1	15	10	9-6/12-1	10-10	8.69
MIMH	11	14	22	3	9	16	9-6/12-10	11-2	10.92

Table 2

TCS-CSI, Otis-Lennon, and IQ Information about the Mental Ability of the Four Groups of Students

	TCS-CSI			Otis-Lennon			IQ		
Groups	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD
N	84/141	105	14.49	91/122	105	8.94			
LD							81/119	98	9.49
EH							73/123	95	12.61
MIMH							52/77	67	5.62

All students in the three groups of special education (LD, MIMH, and EH) who participated in this study had been those who returned the permission form signed by their parents or gardians. They were assessed by a school psychologist and diagnosed by a multidisciplinary evaluation team as students with learning disabilities, with mild mental handicap, or with emotional handicap according to the definitions in Title 511 Indiana State Board of Education Article 7, Rules 3-16 and in accordance with federal regulation PL. 101-476, the Individuals with Disabilities Education Act (IDEA). The subjects in the three groups of special education were receiving special education services as specified in their individualized educational program (IEP) at the time this study was conducted.

The three groups of special education students had no signs of sensory or motor problems that might have impaired their performance on the assigned tasks. All displayed appropriate attending behavior (e.g., following directions and instructions) and were able to do the tasks in this study.

The intelligence tests and achievement tests mentioned below were selected to evaluate the three groups of special education students. The achievement tests were:

- The Kaufman Test of Educational Achievement (K-TEA)
- The Peabody Individual Achievement Test-Revised (PIAT-R)
- The Woodcock Reading Mastery Test-Revised (WRMT-R)
- The Woodcock-Johnson Psycho-Educational Battery (W-J)
- The Basic Achievement Skills Individual Screener (BASIS)
- The Wide Range Achievement Test-Revised (WRAT-R)

Not every student was given all these tests. The students' psychoeducational evaluation confidential records showed that some students had taken two tests while others had taken three or four achievement tests. That is, students were given different tests to measure their achievement.

The following were the intelligence tests used to diagnose students with learning disabilities, students with mild mental handicap, and students with emotional handicap:

- The Wechsler Intelligence Scale for Children-Revised (WISC-R)
- The Wechsler Intelligence Scale for Children-Third Edition (WISC-III)
- Stanford-Binet Intelligence Scale: Fourth Edition
- The Kaufman Brief Intelligence Test (K-BIT)

No one specific test was used all the time to measure students' intelligence. That is, students were given different tests whenever they were evaluated to measure their intelligence. Since there were many test scores available for each student as a result of many years of testing, the WISC-III and WISC-R scores were selected and reported in Table 2.

For the LD sample there was a significant discrepancy between the students' intellectual ability as measured by performance on individualized intelligence tests and their actual academic performance as measured by standardized achievement tests. Only 4 students had an IQ below 85. The remaining students had average or above average general intelligence (i.e., IQ > 85) as measured by the individualized intelligence tests.

As stated in the definition, students classified with emotional handicap must exhibit an emotional symptom that, over a lengthy period of time and to a significant degree, consistently interferes with students' learning. Emotional symptoms may include cases such as a tendency to develop physical symptoms or fears associated with personal or school problems, a general pervasive mood of unhappiness or depression, an inability to learn which cannot be explained by intellectual, sensory, or health factors, an inability to build or maintain satisfactory interpersonal relationships, and inappropriate feelings under normal circumstances. In the sample used for this study, one student had an IQ of 73 and another student had an IQ of 75. The remainder of this sample had IQs of 80 and above.

The criteria used to identify students with mild mental handicap were below average mental ability, as measured by an individually administered intelligence test, and assessed deficits in adaptive behavior as measured by tests such as the Vineland Social Maturity Scale. One student had an IQ of 77. The rest of this sample had IQs of 73 and below.

After obtaining the approval of the local school district and the school principal to carry out this study, parent(s) or guardian(s) of each subject involved in this research were asked to sign a consent form approving the child's participation in the experiment. The consentor received information about the purpose of the study, the methods to be employed, and the possible advantages and disadvantages of using such procedures.

Materials and Procedures

The technique of examining levels of processing, introduced by Walker (1987), was used in this study. He constructed stimulus words, retrieval cue words, and sentence frames from primer, first, and second grade reading materials to control the vocabulary presented to the students in the experiment. Walker's thirty-two stimulus words, which were common concrete nouns, were presented to the participants in this study via a microcomputer (Apple IIe).

The intermediate level of processing was tapped by requiring the subjects to answer "yes" or "no" to the question of whether or not two words rhyme. For example, the student might see the stimulus word "Pig" and the cue word "Wig" and then be asked to respond with yes or no to the question "DOES THIS WORD RHYME WITH THE ONE AT THE BOTTOM OF THE SCREEN?".

Deep level of processing was tapped by requesting the students to respond to the question of whether or not a stimulus noun fits into a sentence frame. This was achieved by asking the student to respond to the question "DOES THIS WORD FIT INTO THE SENTENCE AT THE BOTTOM OF THE SCREEN?". For example, when a stimulus word such as "Nose" and a retrieval cue sentence frame such as "He broke his ____ when he fell' appear on the computer screen, the student responded with either "yes" or "no", based on the correct semantic use of the word in the sentence, to whether or not the stimulus word fit into the sentence frame.

Acquisition Phase

Sixteen of the 32 stimulus words were presented individually with their cues on the computer screen. The subjects were asked to respond "Yes" if the two words rhymed, and "No" if they did not. The two words are described as "congruent" if they rhyme and "non-congruent" if they do not. The level of processing being tapped by this task is the intermediate (phonemic, rhyming, or acoustic) level.

The remaining 16 of the 32 stimulus words were used to complete 16 sentences presented individually on the computer monitor. The subjects were asked to response "Yes" if the word fit into the sentence and "No" if it did not. The context is described as "congruent" if the word fits into the sentence and "non-congruent" if it does not. The level of processing tapped by this task is the deep (semantic) level.

In general, 16 of the stimulus words were in a congruent context since they required "Yes" response and the other 16 stimulus words were in a non-congruent context since they required "No" response. The intermediate and the deep levels of processing had both congruent and non-congruent contexts for the intermediate level tasks and for the deep level tasks. Thus, there were four encoding levels of processing at which stimulus words were presented. These encoding levels were rhyming-intermediate congruent and non-congruent, and deep-semantic congruent and non-congruent.

There were two retrieval cues (rhyming words and sentence frames). In the acquisition phase, on the first task, at the intermediate (rhyming) level, two words were presented on the computer screen. One word was considered as the stimulus word and the other word was used as a retrieval cue later in the recall phase of the experiment. The subject was asked if these two words rhyme.

On the second task, at the deep (semantic) level, a new stimulus word and a sentence frame with a blank space for a word were presented on the computer screen. The sentence frame was used as a retrieval cue. The subject was asked if the stimulus word fits into the sentence frame.

Recall Phase

In the recall phase of the experiment, at the intermediate (rhyming) level, on the computer screen, the subject was presented with a word that was presented earlier in the acquisition phase. This word served as a retrieval cue because the subject was asked to state the word with which the retrieval cue was paired during the acquisition phase (see example 1 in Table 3)

Also during the recall phase, at the deep (semantic) level, the subject was presented with a sentence frame which was presented earlier during the acquisition phase. This sentence frame served as a retrieval cue because the subject was asked to recall the word (also presented earlier during the acquisition phase) which was presented with the sentence (see example 6 in Table 3).

Sometimes the retrieval cue (word) and the retrieval cue (sentence frame) were congruent with the stimulus word and sometimes they were non-congruent, as chosen randomly by the computer program. The retrieval cue (word) was congruent if it rhymed with the stimulus word presented during the acquisition phase which the subject was asked to recall (see example 1 in Table 3). The retrieval cue (sentence frame) was congruent if the stimulus word presented during the acquisition phase (which the subject was asked to recall) fit into the sentence frame (see example 6 in Table 3). The retrieval cue (word) was non-congruent if it did not rhyme with the stimulus word presented during the acquisition phase (see example 3 in Table 3). The retrieval cue (sentence frame) was non-congruent if the stimulus word presented during the acquisition phase did not fit into the sentence frame (see example 8 in Table 3).

Also during the recall phase, "cross-level" tasks were used. These tasks were presented in congruent contexts. A new sentence frame (representing

Table 3

Examples of Stimulus Word and Retrieval Cue Combinations at the Eight Randomly Assigned Conditions

Encoding Level	Retrieval Cue Type	Encoding Stimulus/Cue	Retrieval Cue
1. Rhy/C	Rhy	Fan/Man	Man
2. Rhy/C	Sem	Fan/Man	On a hot day the___ feels good.
3. Rhy/NC	Rhy	Fan/Street	Street
4. Rhy/NC	Sem	Fan/Street	On a hot day the___ feels good.
5. Sem/C	Rhy	Fan/On a hot day the ___ feels good.	Man
6. Sem/C	Sem	Fan/On a hot day the ___ feels good.	On a hot day the___feels good.
7. Sem/NC	Rhy	Fan/The ___ Saw us and ran.	Man
8. Sem/NC	Sem	Fan/The ___ Saw us and ran.	The ___ Saw us and ran.

Note: Rhy/C = Rhyming Congruent Encoding; Rhy/NC = Rhyming Non-Congruent Encoding; Sem/C = Semantic Congruent Encoding; Sem/NC = Semantic Non-Congruent Encoding; Rhy = Rhyming Retrieval Cue; Sem = Semantic Retrieval Cue. This table is adopted from Walker and Poteet (1989), p. 28.

the deep-semantic level) was presented and the subject was asked to recall a word (presented earlier in the intermediate-rhyming level) which fit into the sentence frame (see example 2 in Table 3). Also, a word was presented and the subject was asked to recall a word which had been seen before which rhymed with it (representing the intermediate-rhyming level). The word to recall was presented earlier as the stimulus word to fit into a sentence (representing the deep-semantic level) (see example 5 in Table 3). The purpose of "cross-level" recall tasks was to evaluate the original processing level and the manipulation of retrieval cues when the recall task was requested. That is, in half of the cases, the retrieval cues were changed to assess the memory performance that was due to encoding in the original learning activity and that was due to the type of the presented retrieval cue. This step assessed the encoding specificity principle and the encoding and retrieval processes.

These next tasks were presented regarding items which were in non-congruent contexts at the acquisition phase. Four of the retrieval cues (words) were one of the words presented in non-congruent tasks at the intermediate-rhyming level during the acquisition phase. The subject was asked to recall the word which was paired with the retrieval cue (see example 3 in Table 3). Four of the retrieval cues were sentence frames for which the subject was required to recall a non-congruent stimulus word at the intermediate-rhyming level which fit into the retrieval cue (sentence frame) (see example 4 in Table 3).

Four retrieval cues (sentence frames) which were presented during the acquisition phase were presented. The subject was asked to recall the stimulus presented with the sentence frame during the acquisition phase. The stimulus word was non-congruent with the sentence frame at the acquisition phase (see example 8 in Table 3). Four retrieval cues (words) which rhymed with a stimulus word for a non-congruent sentence frame at the acquisition level were presented. The subject was asked to recall the stimulus word. Note that the stimulus word rhymed with the retrieval cue (word), but originally did not fit into the sentence frame during the acquisition phase (see example 7 in Table 3).

Computer Program

Both the stimulus words and the cue words (i.e., words and sentences) in the recall phase were selected and presented in a random order by the computer. Other randomly selected elements were processing levels (intermediate-rhyming or deep-semantic), congruity of the task, and the level of the retrieval cues.

Randomization of all conditions in this experiment was achieved by using a computer program which generated random numbers. The first random number generator program was executed before the memory activity started. Then it was interrupted to run the memory activity. The second random number generator was built into the memory activity. This process presented each subject in the experiment with an entirely unique order and treatment of each of the thirty-two stimulus words. Random presentation prevents the effect of high imagery or low imagery words on the obtained results. The randomizing process can control the systematic biasing influences of words familiar or meaningful to a specific subject because of recent encounters or experiences (Walker, 1987).

Incidental Learning Task

An incidental learning paradigm was used in the acquisition phase in which the subjects were unaware that there would be a cued recall memory test later in this study. During the acquisition phase the order of presentation of items (stimulus words and retrieval cues) that required yes or no responses was assigned randomly by the computer. The cued recall memory test was a cue (a word or a sentence each determined randomly by the computer) presented on the computer screen for 15 seconds during which time the subject was to respond with one of the thirty-two stimulus words from memory that went with the "cue". For example, the student was told that "a word or a sentence will appear on the screen. It will be shown to you to help you remember the words you saw in the earlier activity" (i.e. acquisition phase). All students participating in this study were told that they were involved in an experiment to understand how they learn new things in schools. No mention was made to the cued recall test that would follow the acquisition phase. This procedure increased the confidence that incidental learning in this study was assessed without contamination from mnemonic techniques that might usually be used in the intentional learning paradigm.

<u>Testing Session</u>

The instruction, testing, and recording of the results for each individually tested subject were presented by the microcomputer. When the instruction appeared on the screen, the experimenter read it aloud. The computer presented a stimulus word and the accompanied cue (word or sentence). The subject was required to say "yes" or "no"; both words were written on two color marked keys to make the response. The experimenter pressed the appropriate key after each response by the student. In the acquisition phase, the computer program advanced to the next trial the moment the "yes" or "no" key was pressed. Each subject had two practice trials in order to become familiar with the task. If a subject was not successful in correctly answering either of the two trials after two times of practice on each trial, that subject was excused from participating in this study. Any subject needing assistance in reading more than six stimulus words, or their accompanied cue words, was excused from participating in this study.

In the recall phase of this study, cued recall memory test (where a word or a sentence appeared on the computer screen to help remember the words seen in the acquisition phase), each subject was given 15 seconds to recall each stimulus word. If the 15 seconds were expired and the subject was not able to recall the word, the subject proceeded to the next recall cue. The experimenter typed each subject's responses on the memory test into the computer. After the session with each subject, the computer recorded and printed a "Subject Profile" of all the subject's responses of yes and no during the acquisition phase as well as the responses during the recall phase on the memory tests. The "Student Profile" was used for analysis purposes. The results obtained from this experiment were coded to provide anonymity. Each experimental session per subject lasted approximately 25 minutes.

RESULTS

A 4 X 4 X 2 (4 subject types X 4 presentation conditions of encoding levels of processing X 2 retrieval cues) factorial analysis of variance (MANOVA) with repeated measures on the last two variables was used. The four between-subject factors were subject types specified as "normals", students with learning disabilities, students with mild mental handicap, and students with emotional handicap. The within-subject factors were the four presentation conditions of encoding levels of processing (intermediate (rhyming) level congruent and non-congruent and deep (semantic) level congruent and non-congruent) and the two retrieval cues (rhyming and semantic).

The performance data for the four groups of students ("normals", learning disabilities, mild mental handicap, and emotional handicap) are presented in Table 4. The data on the cued recall memory test showed that the mean number correct for all groups was the highest when stimulus words were presented and encoded semantically and retrieved in the memory test with a congruent semantic cue (Sem/C/S). The average performance for the four groups at this level of processing (deep-semantic) and using this type of retrieval cue (semantic cues) was 3.408 correct out of 4 responses.

Main Effects

The analysis of variance revealed that there was a significant main effect for the between-subject variable at the .05 level, F (3, 148) = 3.55, p = .016. There were significant differences in memory performance among the four

Table 4

Cell Means for Encoding Levels and Retrieval Cue Types

Encoding Level and Retrieval Cue Type	Mean Performance N	LD	MIMH	EH	Total
Rhy/C / R	1.750	1.420	1.280	1.720	1.559
Rhy/C / S	.577	.580	.600	.920	.638
Rhy/NC / R	.192	.140	.200	.200	.178
Rhy/NC / S	.615	.560	.440	.880	.612
Sem/C / R	.981	1.040	1.000	1.200	1.039
Sem/C / S	3.558	3.380	3.040	3.520	3.408
Sem/NC / R	1.000	1.000	.680	1.000	.947
Sem/NC / S	2.115	1.680	1.840	1.880	1.888

Note: Rhy/C = Rhyming Congruent Encoding; Rhy/NC = Rhyming Non-Congruent Encoding; Sem/C = Semantic Congruent Encoding; Sem/NC = Semantic Non-Congruent Encoding; R = Rhyming Retrieval Cue; S= Semantic Retrieval Cue; N = "Normal" students; LD = Students with Learning Disabilities; EH = Students with Emotional Handicap; MIMH = Students with Mild Mental Handicap; Number of "N" = 52; LD = 50; EH = and MIMH = 25; Total = 152.

groups of students regardless of levels of processing and types of retrieval cues. There were significant main effects at the .05 level for the two treatment variables that received repeated measures (encoding levels of processing and types of retrieval cues). There were significant differences in memory performance for the four encoding levels of processing regardless of types of retrieval cues and subject types, F (3, 444) = 217.46, $p < .001$. There were significant differences in memory performance between the two types of retrieval cues regardless of encoding levels of processing or subject types, F (1, 148) = 140.67, $p < .001$.

Interactions

The interaction of student types and encoding levels of processing was not significant. Also, it was found that the interaction of student types and types of retrieval cues was not significant. The three-way interaction among subject types, encoding levels of processing, and types of retrieval cue was not significant. A statistically significant interaction was found between encoding levels of processing and types of retrieval cues, F (3, 444) = 144.86, $p < .001$. Differences in memory performance due to retrieval cues are not the same across encoding levels of processing.

Generally Speaking, this interaction, based on the cued recall memory test used in this study, supports the levels of processing framework (e.g. Lockhart & Craik, 1990; Fisher & Craik, 1977) and the Encoding Specificity Principle (e.g., Tulving & Thomson, 1973; Tulving, 1983) as used with students with disabilities and those without disabilities.

These analyses revealed that while there are significant differences among the four groups of students on the test of memory performance during the recall phase, these differences do not interact with the significant two-way interaction between encoding levels of processing and types of retrieval cue.

Post-Hoc Analysis

Based on the review of the literature (e.g., Winer ,1962, 1971; Hinkle, Wiersma, & Jurs, 1988; Ferguson & Takane ,1989) and the type of data and subjects this study had dealt with, different post-hoc tests were used . The Student-Newman-Keuls was used to find differences among the four groups of students. It was used because it is less conservative than the Tukey and

Scheffe tests. Considering the organization of the within-subject factors (the four presentation conditions of encoding levels of processing and the two retrieval cues), a paired t-test was viewed as the best to use in the situation described later in this section. The Tukey was used to compare differences between means. It is powerful when used with all possible pairwise comparisons between means.

Table 5

Means of All Cells Combined for the Four Groups of Students on the Memory Test

	Total Score	Means
Normals	10.788	1.3485
LD	9.800	1.225
MIMH	9.080	1.135
EH	11.320	1.415

The Student-Newman-Keuls post-hoc analysis revealed that there were significant differences at the .05 level on memory performance between "normal" students and students with mild mental handicap, on the one hand, and between students with emotional handicap and students with mild mental handicap, on the other hand. However, the analysis did not reveal significant differences among "normal" students, students with learning disabilities, and students with emotional handicap. Nor were there significant differences between students with learning disabilities and students with mild mental handicap. Regardless of types of retrieval cues and encoding levels of processing, "normal" students and students with emotional handicap performed significantly higher than students with mild mental handicap (see Table 5).

A paired t-test was used to clarify the interaction between the types of retrieval cues used and the encoding levels of processing with regard to differences due to retrieval cues (i.e., Rhyming or Semantic). It was used to find out how the eight combinations of two retrieval cues and four encoding levels of processing differed in pairs. The result of this analysis is in Table 6. This analysis revealed that there were significant differences in memory performance due to the types of retrieval cue used in all combinations. Memory performance is the highest when semantic retrieval cues were used. In this case using semantic retrieval cues was more effective than using rhyming retrieval cues (see Figure 1). Also, rhyming retrieval cues were effective in one combination where words were encoded at the congruent intermediate-rhyming level and later cued with congruent rhyming retrieval cues. These results as shown in Figure 1, which displays the cell means presented in Table 7, provide support to the levels of processing framework (e.g. Lockhart & Craik, 1990; Fisher & Craik, 1977) and the Encoding Specificity Principle (e.g., Tulving & Thomson, 1973; Tulving, 1983). Also, the results indicated that when the cue level matched the original processing level task, performance was higher.

Stimulus words encoded semantically were best recalled when semantic retrieval cues were employed in the recall memory phase. The enhanced durability of memory trace seemed to result from semantic processing which was fostered by using a congruent semantic retrieval cue during the recall memory test. This is true for words encoded at the congruent deep-semantic level and later cued with congruent semantic retrieval cues yielding the highest memory performance on the memory test. These results support the levels of processing framework for significantly influencing memory performance for elementary students with and without disabilities. Also, these findings support the notion that during the recall phase, the most effective retrieval cues are the ones that were originally encoded with the

Table 6

Paired t-test Between Retrieval cues at four Encoding Levels of Processing

Encoding Level and Retrieval Cue Type	Mean	d.f	t	p
Rhy/C/R	1.559	151	9.26*	.001
Rhy/C/S	.638			
Rhy/NC/S	.612	151	-6.35*	.001
Rhy/NC/R	.178			
Sem/C/S	3.408	151	-21.93*	.001
Sem/C/R	1.039			
Sem/NC/S	1.888	151	-7.07*	.001
Sem/NC/R	.947			

* p<.05, two-tailed.

Note: Rhy/C = Rhyming Congruent Encoding; Rhy/NC = Rhyming Non-Congruent Encoding; Sem/C = Semantic Congruent Encoding; Sem/NC = Semantic Non-Congruent Encoding; R = Rhyming Retrieval Cue; S = Semantic Retrieval Cue.

stimulus words. This finding provides further support that the encoding specificity principle is not only appropriate for "normal" students, but also for students with learning disabilities, mild mental handicap, and emotional handicap.

Additional post-hoc analyses were performed to clarify the interaction between the two treatment variables (i.e., types of retrieval cues and encoding levels of processing) using the Tukey (HSD) procedure to compare individual cell means. These cell means were presented in Table 4 and are graphically displayed in Figure 2 to show the effect of treatment interaction. The

Table 7

Cell Means for Two Retrieval Cue Types at Four Encoding Levels

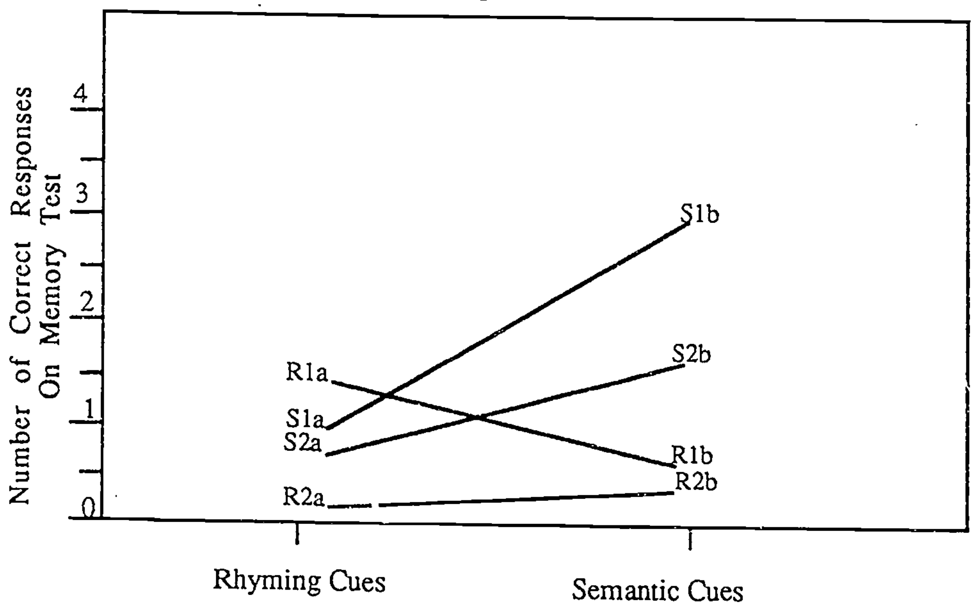
Rhyming Retrieval Cues at Four Encoding Levels	Mean Performance	Semantic Retrieval Cues at Four Encoding Levels	Mean Performance
Rhy/C	1.559	Rhy/C	.638
Rhy/NC	.178	Rhy/NC	.612
Sem/C	1.039	Sem/C	3.408
Sem/NC	.947	Sem/NC	1.888

Note: Rhy/C = Rhyming Congruent Encoding; Rhy/NC = Rhyming Non-Congruent Encoding; Sem/C = Semantic Congruent Encoding; Sem/NC = Semantic Non-Congruent Encoding.

disordinal interaction indicates the encoding specificity principle and the relationship between encoding processing levels and types of retrieval cues in facilitating recall. The Tukey post-hoc test was used to compare the cell means differences among the four encoding processing levels due to semantic retrieval cues across all groups of students (see Table 7). It was found that all differences were significant except stimulus words processed at the intermediate-rhyming level. The words processed at the intermediate-rhyming level and then prompted with semantic retrieval cues were poorly recalled. The differences in memory performance due to whether the words were originally processed with congruent or non-congruent rhyming activity were not significant. However, the Tukey test indicated that words processed at the deep-semantic level and then prompted with semantic retrieval cues were recalled the highest. What is interesting is that congruity has influenced the number of words recalled. The differences in memory performance due to whether the words were originally processed with congruent or non-congruent semantic activity were significant. Words processed in a congruent context at the deep-semantic level and cued with congruent semantic

Figure 1

Relationship of Cell Means of Four Encoding Levels of Processing at Two Retrieval Cues



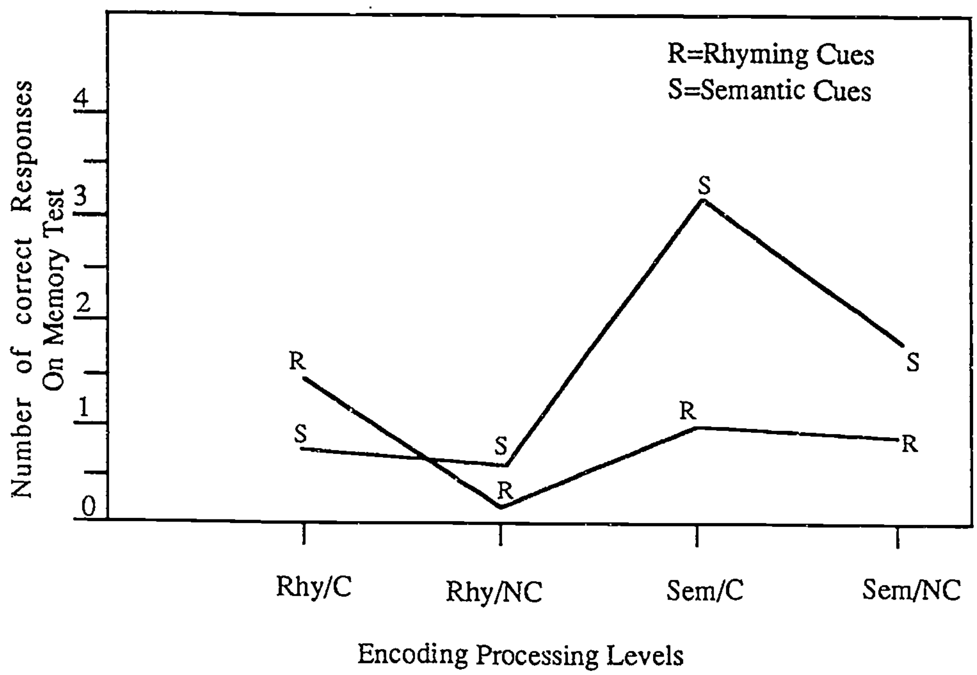
Note. R1a = Rhyming Congruent Rhyming; R1b = Rhyming Congruent Semantic; R2a = Rhyming Non-Congruent Rhyming; R2b = Rhyming Non-Congruent Semantic; S1a = Semantic Congruent Rhyming; S1b = Semantic Congruent Semantic; S2a = Semantic Non-Congruent Rhyming; S2b = Semantic Non-Congruent Semantic.

retrieval cues were recalled higher than words processed in a non-congruent context at the deep-semantic level and cued with non-congruent semantic retrieval cues.

The last post-hoc analysis was conducted using the Tukey test to clarify differences among encoding levels of processing due to rhyming retrieval cues (see Table 7). It was found that words processed at the deep-semantic

Figure 2

Relationship of Two retrieval Cues (Rhyming and Semantic) at Four Encoding Processing Levels



Note. Rhy/C=Rhyming Congruent Encoding; Rhy/NC=Rhyming Non-Congruent Encoding; Sem/C=Semantic Congruent Encoding, and Sem/NC= Semantic Non-Congruent Encoding.

level in a congruent and non-congruent contexts were not highly recalled. The differences in memory performance due to whether the words were originally processed with congruent or non-congruent semantic activity were not significant. However, words processed at the intermediate-rhyming level in a congruent context and cued with a congruent rhyming retrieval cues were recalled the best. Also, words processed in a non-congruent context at the intermediate-rhyming level and retrieved with non-congruent rhyming retrieval cues were recalled the lowest. The differences in memory performance due to whether the words were originally processed with congruent or non-congruent rhyming activity were significant.

The results of the last two post-hoc analyses showed that a mismatch between encoding processing conditions and retrieval cue types produced poor memory performance regardless of the original levels of encoding. Words encoded at the intermediate-rhyming level and then cued with rhyming retrieval cues were recalled higher than words processed at the deep-semantic level and then cued with congruent rhyming retrieval cues.

Also, words encoded at the deep-semantic level and then cued with semantic retrieval cues were recalled higher than words processed at the intermediate-rhyming level and then cued with congruent semantic retrieval cues.

The findings from the last two post-hoc analyses indicate that it is advantageous to appropriately use the levels of processing framework, congruity, and the encoding specificity principle in order to enhance recall of information and understand why differential memory performance takes place. It is important to state that these results were true for "normal" students, students with learning disabilities, students with mild mental handicap, and students with emotional handicap who participated in the cued recall memory test in this study.

Differences among encoding levels of processing due to rhyming retrieval cues and semantic retrieval cues demonstrated that the encoding specificity principle as introduced by Tulving and Thomson (1973) and Tulving (1983) has a significant impact as it interacts with the effect of original processing levels. Congruity (Schulman, 1974) has a significant influence on memory performance as well. Words processed at the intermediate-rhyming level in congruent contexts then cued with congruent rhyming retrieval cues were better recalled than words encoded at the non-congruent intermediate-rhyming level and then prompted with non-congruent rhyming retrieval cues. Words processed at the deep-semantic level in congruent contexts then cued with congruent semantic retrieval cues were better recalled than words encoded at the deep-semantic level in non-congruent contexts and then prompted with non-congruent semantic retrieval cues.

CONCLUSIONS

The statistical analysis revealed that there are differences in memory performances among "normal" students, students with learning disabilities, students with mild mental handicap, and students with emotional handicap regardless of levels of processing and types of retrieval cues, $\underline{F}$ (3, 148) = 3.55, $\underline{p}$ = .016. The Student-Newman-Keuls post-hoc analysis revealed that "normal" students and students with emotional handicap performed significantly higher than students with mild mental handicap ($p<.05$). These are the only significant differences among these four groups. Regardless of students' type in this study (even though it was a statistically significant variable in memory performance among subject types), group membership did produce a large significant difference, as indicated by group means performance on the memory task (see Table 5). After considering measurement, methodological, and theoretical issues, measures of explained variance were not used in this study. O'Grady (1982) emphasized that the uncritical acceptance of measures of explained variances (i.e., calculating the magnitude of an effect or the percentage of variance explained) may be misleading or inappropriate indicator regarding the importance of a specific research finding. These issues, as explained eloquently by O'Grady (1982), may potentially affect research in psychology.

In analyzing the interaction between variables in this study, it is found that the between-subject variable (i.e., the performance of the four groups of students) did not interact with encoding levels of processing, nor did it interact with types of retrieval cues. Also, the three-way ANOVA for interaction of all the variables in this study was not significant.

Even though there was a small statistically significant difference among students ("normal" students and students with emotional handicap performing significantly higher than students with mild mental handicap), the types of students used in this study suggest that intelligence plays a role in their memory performance. Baroff (1991) mentioned that those with a mental handicap learn slowly and less than individuals without a mental handicap. The conclusion that those with a mental handicap performed the lowest on memory test due to low cognitive and intelligence abilities may be warranted since the analysis did not reveal significant differences among "normal" students, students with learning disabilities, and students with emotional handicap who have average intelligence and cognitive abilities.

However, the result that there was no significant difference between students with learning disabilities and those with mild mental handicap suggests that students with learning disabilities, even though they have higher intelligence, fluctuated and were inconsistent in their learning patterns which affected their response patterns in this study. This finding suggests that they have serious learning problems in spite of their higher IQ scores. Their overall performance in this study may reflect a lack of knowledge base that may have helped "normal" students and those with emotional handicap obtain a higher mean performance in this study. (e.g., see Chi, 1976). It seems that a rich knowledge base is important for incidental learning.

Contrary to Walker's (1987) finding, this study did not find a significant difference between "normal" students and those with learning disabilities. As noted by Walker, his finding that "normal" students performed better than students with learning disabilities should be considered tentative since there was a small difference between the two groups.

In a study conducted by Scott, Perou, Greenfield, and Swanson (1993), the authors found differences among students with learning disabilities, students with mild mental handicap, and "normal" students on a task that required these students to generate rhyming words. "Normal" students generated more rhyming words than students with learning disabilities and both groups of students generated more rhyming words than students with mild mental handicap (see Scott & Greenfield, 1992). When examining the mean performance of students in the current study (see Table 5), it is found that students with mild mental handicap obtained the lowest score followed by those with learning disabilities, who obtained a higher score, then "normal" students, and finally those with emotional handicap who obtained the highest score. However, the difference between students with learning disabilities and those with mild mental handicap, on the one hand, and the difference among students with learning disabilities, "normal" students, and those with emotional handicap, on the other hand, was not significant. The difference in significant results between the current study and the study conducted by Scott and colleagues is due to the methodology used and the task that the students were required to perform. Also, the current study controlled for reading ability by screening out those who made more than six errors in reading.

The small differences among the group mean performance of the four groups of students necessitate further discussions. These differences may partially be attributed to the incidental learning activity used to assess memory performance. Since students did not expect to be required to recall the stimulus words, they did not use strategies to help them remember the words at the time of encoding. This seems to have made the memory performance of the four groups of students competitive with each other, where none of them had the advantage of using mnemonic techniques. This is evident in the four groups' low recall of words encoded at the non-congruent intermediate-rhyming level and cued with non-congruent rhyming retrieval cues (Rhy/NC/R). This combination produced the lowest performance among the eight combinations of encoding levels of processing and retrieval cues (see Table 4).

The competitive performance of the four groups of students on the memory test is also evident for recalling words encoded at the congruent deep-semantic level and cued with congruent semantic retrieval cues (Sem/C/S). This combination yielded the highest memory performance among the eight combinations of encoding levels of processing and retrieval cues (see Table 4).

Another reason for small differences among the four groups of students is that the nature of the levels of processing framework and types of retrieval cues in this study made less variations among group performance. That is, certain combinations of encoding levels of processing and retrieval cues, as shown above, tend to either lower or enhance students' performance. In this study, using elaborations at the deep-semantic level of processing in a sentence frame may have led to deep encoding regardless of students' intention to do so. It is possible that the context in which the material was presented improved the performance of the four groups of students. Another reason for small differences among the four groups of students may also be attributed to the control of the reading level of students by specifying the number of errors that students were allowed to make in this study. This is evident in the large number of students (148 students) who were excused from participating in this study because they needed assistance and/or made more than six errors in reading.

The results of this study suggest that students with mild disabilities (LD, EH, and MIMH) learn, but not equally, in their daily life interaction since what is acquired is based on incidental learning without the intention to learn. This may explain why some of those students' learning problems are mostly related to school-based work since it requires an intention to memorize the presented information. Implications for teachers are that the students' reading level is important, and the context and the requirements of learning tasks may manipulate the memory performance of students. It seems that memory performance of all students ("normals", students with learning disabilities, students with mild mental handicap, and students with emotional handicap) may be improved (as shown in their recall of words encoded at the congruent deep-semantic level and cued with congruent semantic retrieval cues - Sem/C/S) by increasing elaboration and semantic context in the learning activities (Walker, 1987).

The Effect of Levels of Processing

The main effect for the four encoding levels of processing was statistically significant, $F(3, 444) = 217.46$, $p < .001$. It appears that differential memory performance was influenced by the manner used to present the material to students. The mean performance of students on the recall memory test revealed that stimulus words encoded at the deep-semantic level, in which students were asked if a stimulus word is semantically correct when fits into a sentence frame, resulted in more durable memory trace as shown in high memory performance on the cued recall memory test. The mean performance for recalling words encoded at the congruent deep-semantic level and cued with congruent semantic retrieval cues (Sem/C/S) is 3.408 correct responses out of 4 possible responses as compared to 1.559 correct responses for words encoded at the congruent intermediate-rhyming level and cued with congruent rhyming retrieval cues (Rhy/C/R).

Similar to the findings reported by Walker (1987), this study found that words encoded at the non-congruent deep-semantic level and cued with non-congruent semantic cues produced the second most correct responses (1.888 words correct out of 4 possible correct responses). This result may be explained by two factors.

The first factor is the methodological design used by both Walker (1987) and this study. This methodological design was implemented to test the interaction among levels of processing, encoding specificity principle, and congruity, and how they influence the performance on the memory test. For example, stimulus words encoded at the deep-semantic level that were not congruent with semantic retrieval cues (Sem/NC/S) produced significantly less words (1.888) in memory performance across subjects than words that were congruent (Sem/C/S) (3.408).

The retrieval cues used when implementing the encoding specificity principle affected memory performance. For example, recalling the stimulus words using retrieval cues that were different from the retrieval cues that were encoded with the stimulus words in the acquisition phase (words encoded at the non-congruent deep-semantic level and cued with congruent rhyming retrieval cues - Sem/NC/R) produced less words (.947) in memory performance across subjects than using the original retrieval cues (words encoded at the non-congruent deep-semantic level and cued with non-congruent semantic retrieval cues - Sem/NC/S) that were encoded with the stimulus words (1.888) in the acquisition phase.

Without such combinations, the influence of variables such as retrieval cues, encoding specificity principle, levels of processing, and congruity can not be examined.

The second factor is the "novelty effect" (Walker, 1987) and distinctiveness (e.g., Lockhart & Craik, 1990; Jacoby & Craik, 1979; Fisher & Craik, 1977) that might have occurred due to non-congruent encoding. For example, some students found the random presentation of a stimulus word such as "Hen" with the sentence frame "The ____ lost his lunch money", the stimulus word "Mother" with the sentence frame "His ____ was a tree", and the stimulus word "Pig" in the sentence frame "The man bought new tires for the ____ " humorous and did laugh at these combinations of stimulus words and sentence frames because, as they put it, they were "strange". The outcome of these combinations, as reported by Walker (1987), is improved memory performance for these words. As suggested by Walker, more research is needed regarding the effect of humor on memory performance.

<u>The Effect of Retrieval Cues</u>

The statistical analysis revealed that the types of retrieval cues used in this study yielded a significant difference in memory performance of the four groups of students, $\underline{F}$ (1, 148) = 140.67, $\underline{p} < .001$. This significant difference can be noticed at the intermediate-rhyming level. For example, words encoded at the congruent intermediate-rhyming level and cued with congruent rhyming retrieval cues (Rhy/C/R) were recalled better (1.559 correct responses out of 4 possible responses) than words encoded at the congruent intermediate-rhyming level and cued with congruent semantic retrieval cues (Rhy/C/S - .638 correct responses out of 4 possible responses). More dramatic differences were noticed at the deep-semantic level. For example, words encoded at the congruent deep-semantic level and cued with congruent semantic retrieval cues (Sem/C/S) were recalled higher (3.408 correct responses out of 4 possible responses) than words encoded at the congruent deep-semantic level and cued with congruent rhyming retrieval cues (Sem/C/R - 1.039 correct responses out of 4 possible responses). These results indicate the influence of encoding specificity principle on memory performance in a cued recall memory test; the retrieval cues that were originally accompanied the stimulus words during the encoding process should be used to enhance memory performance. They also confirm the results reported by Walker (1987) regarding the impact of encoding specificity principle on memory performance.

Since there was an interaction between encoding levels of processing and types of retrieval cues, it critical to consider only the interaction between these variables and not the main effects they produced. Such an interpretation was made in the above discussions of levels of processing and types of retrieval cues.

Interactions of the Levels of Processing and Types of Retrieval Cues

The effect of retrieval cues which also reflects the encoding specificity principle can be understood clearly when studied in the context of levels of processing. It is the influence of the interaction between these variables (four encoding levels of processing and two types of retrieval cues) that produced differential memory performance. The interaction between these variables, which were the treatment variables that received repeated measures, was statistically significant, F (3, 444) = 144.86, $p < .001$.

The results of this study may influence the teaching practices for the four groups of students, especially the three groups of special education students involved in this study. It is important to emphasize that these students learn as measured by their memory performance in this study. Even though there was a significant difference in the memory performance regarding student group membership (i.e., "normal" students and students with emotional handicap performed significantly higher that students with mild mental handicap), this difference is small as shown in each group mean performance (see Table 5). This study revealed that memory performance can be influenced by semantic elaboration and by making the information distinctive. Previous research (e.g., Moscovitch & Craik, 1976; Fisher & Craik, 1977; Lupart & Mulcahy, 1979; Boyd & Ellis, 1986; Walker, 1987; Dulaney & Ellis, 1991; Schultz, 1983) has indicated the importance of semantic processing in improving memory performance.

The results of this study also revealed that congruity and the types of retrieval cues used for a cued recall memory test are important in either enhancing or suppressing memory recall. In order to maximize students' memory performance, it is important to use retrieval cues that are similar in type and context to the material encountered and studied in the initial learning task. This is important if students are to perform well in a testing situation. Also, it is important to relate new information to previous learning and background knowledge to enhance its recall. This is so since it was noticed during the acquisition phase of this study that some students commented on some stimulus words and retrieval cues shown on the computer screen which enhanced the recall of the stimulus words when retrieval cues were presented during the recall phase. For example, when the stimulus word "Boat" was presented with the cue sentence "The ____ flew high in the sky", some students said that "Boats do not fly. Planes fly in the sky". Another example is when students were asked whether or not the word "Mouse" fit into the sentence "I screamed when I saw the ___ ". Some students said that their younger brother/sister is afraid of a mouse. This act of relating the presented information to what the students knew helped them remember the stimulus words.

RECOMMENDATIONS

When examining and comparing the group mean performance, it was obvious that the differences among the four groups are small (see Table 5). These small differences suggest that the four groups, overall, have no major difficulties in this incidental learning activity where no effortful and deliberate learning are required. The large differences in learning noticed in school settings might be due to problems in (1) self-management, self-regulatory behavior, and/or self-awareness that are needed to monitor one's self during a learning process and (2) the choice and use of learning strategies needed to complete, understand, retain, and transfer given information.

These differences in learning may account for the achievement gap that may exist between "normal" students and those in special education particularly noticed as students in special education get older. Research by Swanson and Trahan (1992) revealed that students with learning disabilities are less proficient than "normal" students in metacognitive skills. In another study Swanson, Christie, and Rubadeau (1993) found that gifted students performed higher on metacognitive and analogical reasoning tasks than "normal" students, students with learning disabilities, and students with mild mental handicap. They also found that students with mild mental handicap on metacognitive and analogical reasoning tasks were inferior to "normal" students, students with learning disabilities, and gifted students. What is interesting is the performance of students with learning disabilities compared to "normal" students. Swanson, Christie, and Rubadeau found that students with learning disabilities performed comparable to "normal" students, in some cases, and higher, in other cases, on metacognitive questionnaire statements. They also found that "normal" students performed higher than students with learning disabilities on metacognitive items related to knowledge of strategies. No differences were found between these two groups on logical reasoning tasks.

It is important to mention that the metacognitive test in both studies identified above was given in a questionnaire format. An accurate measure is needed to test the metacognition process while students are involved in a learning task and not in isolation since some students do not apply what they already know. Possibly, techniques used in blood flow studies and MRI technology can be promising in the future.

This study revealed that novelty and humor, distinctiveness, deep semantic processing, elaboration, and the encoding specificity principle are variables to consider to improve attention and memory performance. The results showed the influence of the interaction between encoding levels of processing and types of retrieval cues and how the interaction influenced learning of new material and hence the memory performance of the four groups of students on the cued recall memory test. This information should be helpful in finding better methods of instruction and remedial techniques for students.

Additional research can address the following issues:

1. Student's socioeconomic status and its impact on memory performance may have influenced the results of this study. Therefore, it should be addressed in future studies. The cooperation of parents and school administrators is needed in this regard to measure this sensitiv : variable.

2. The influence of student's mental ability (i.e., IQ) and reading achievement (oral and comprehension) on memory performance as measured by the levels of processing framework should be investigated. Even

though the reading variable was controlled by the words selected for this study and the number of errors allowed, standardized measures for reading achievement and mental ability might be used in future studies to "partial out" their effect on memory performance.

3. Intelligence theories such as those proposed by Sternberg (1985, 1988) and Gardner (1993) can be considered when examining students' performance and response patterns on the "levels of processing" framework.

4. Consideration should be given to identifying independent principle components or clusters based on students' responses within the levels of processing framework and how they might differ in this regard. Even though there were small differences on the overall memory performance among the four groups of students, there might be different independent components or clusters of responses for each group of students.

5. The four groups of students could be used in intentional learning tasks based on the levels of processing framework with experimenter-induced learning strategies and compare the results to students' use of their own learning strategies to aid recall.

6. In future studies the computer program should be refined to avoid unplanned responses across levels of processing, where two of the 32 stimulus words were good responses to the presented retrieval cues. The unplanned "cross levels" responses happened randomly among the four groups of students. The incidents of "cross level" responses occurred with different stimulus words that were associated with rhyming and semantic cues. The total number of items that all 152 students responded to was 4864. The unplanned "cross levels" responses occurred in 29 items, which represent .6 percent of the total items that all students responded to on the test.

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