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ABSTRACT

Memory and information processing were studied with public school students, aged 10-15, who had educable mental handicaps (n=60), trainable mental handicaps (n=60), and no mental handicaps (n=60). Study participants completed a picture recall and relocation test, in order to determine if differences existed between the groups based on developmental level and whether information was processed automatically or effortfully. Within each developmental level, students were randomly assigned to one of three encoding conditions: nonsemantic, semantic, or clustered. It was found that students without mental retardation recalled and relocated more pictures correctly than did students with educable mental handicaps, who recalled and relocated more than did students with trainable mental handicaps. Significant interaction effects resulted when retention interval was included in the analysis. The results suggest that both automatic and effortful memory processing are influenced by developmental level and conditions under which new information is received. The encoding instructions did not alter relocation performance dependent on developmental level, however. It is concluded that instructions given to students and their developmental level will affect the amount of information retained. Implications for teaching are suggested. (Contains 38 references.) (SW)

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Suzanne B. Thomas
University of Florida

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F.E.R.C. NOTES ON THIS BULLETIN

Those who teach EMH and TMH students especially of ages 10-15 should find this research of practical value to them immediately. It is also equally important to parents of these children, teachers involved in inclusion models and administrators at the district level as well as those at the school site. FERC is pleased to publish this bulletin for its readers.

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Table of Contents

AUTOMATIC AND EFFORTFUL MEMORY PROCESSING BY STUDENTS WITH AND WITHOUT MENTAL RETARDATION

Executive Summary

This study examined memory processing by students with and without mental retardation to determine if differences existed based on developmental level and on whether the information was automatically or effortfully processed. A picture recall and relocation test was completed by 180 students aged 10 to 15. The students represented three developmental levels: students classified as trainable mentally handicapped (TMH), educable mentally handicapped (EMH), and students without mental retardation. Within each developmental level, students were randomly assigned to one of three encoding conditions: nonsemantic, semantic, or clustered.

Statistical analysis revealed that students without mental retardation recalled and relocated more pictures correctly than students classified as EMH who recalled and relocated more than TMH students. Significant interaction effects resulted when retention interval was included in the analysis

The results suggest that both automatic and effortful memory processing are influenced by developmental level and the conditions under which new information is received. The encoding instructions did not alter relocation performance dependent on developmental level, however. When a student is required to retain information, both the developmental level of the student and the instructions given will have an impact on the amount of information retained.

Implications

1. As differences were experienced in both automatic and effortful processing of information by students of different developmental levels, these differences should be considered in educational placement and program decisions.

2. Based on the findings that students with mental retardation were deficient in relocation performance, attention should be paid by educators as to how learning occurs. Teachers should

(a) emphasize recognition and organization of incoming information, (b) analyze the capacity requirements for each task to determine what the student is expected to learn incidentally, (c) not expect that spatial information or environmental cues will be attended to without specific direction to do so, and (d) give specific instructions and task-specific strategies in order to maximize learning.

3. Attention should be directed toward enhancement of automatic encoding skills. Automatic encoding performance can be enhanced by practice, use of familiar materials and meaningful activities, and use of retrieval cues to test original learning situations.

4. Based on the findings of this investigation, automatically processed information was held in long-term memory as well by students with retardation, both TMH and EMH, as by students without mental retardation. Therefore, when steps are taken to facilitate automatic processing, as described above, retention can occur in students both with and without retardation.

5. Based on the findings that clustering and elaboration strategies increased recall and relocation performance, attention should be paid to the enhancement of strategy use by both students with and without retardation. To remediate performance problems, educators should emphasize relevant categorical aspects of incoming information, teach strategic behaviors, and concentrate efforts on enhancement of existing knowledge and experiences.

Introduction

The focus of this study was memory and information processing by persons with and without mental retardation. Memory processing is crucial in the development of intellectual behavior, problem-solving abilities, and adaptive functioning (Turnure, 1991). Memory has been defined as (a) the retaining and recalling of past experiences, (b) the capacity to behave in a way modified by past experiences, or (c) the power to reproduce or recall what has been learned (Katims, 1987).

Researchers of theories of information processing hypothesize that memory is influenced by how information is acquired or encoded. In the theory of automaticity, Hasher and Zacks (1979, 1984) described two types of mental or cognitive processes: effortful and automatic. Effortful encoding involves strategic processes in the intentional application of such operations as clustering, imagery, rehearsal, and elaboration. Automatic processes, on the other hand, occur incidentally, without attention or awareness (Posner & Snyder, 1975). Automatic processes are used to encode such item attributes as spatial location, frequency, and temporal order and are not sensitive to encoding variables or individual differences (Hasher & Zacks, 1979, 1984).

Differences in memory processing experienced by persons with mental retardation have been the subject of prior investigations. While the findings of these early research efforts have contributed significantly to the understanding of mental retardation, changes have been noted in the population of students involved in these studies. MacMillan (1989) reported that research literature published in the 1960s and early 1970s, which serves as a basis for current understanding of the cognitive characteristics of persons with mental retardation, was conducted with samples of students with educable mental retardation. This population generally included persons with intelligence quotient (IQ) scores close to, or exceeding, the current upper limit for defining mental retardation in most, but not all states, and who had been long-term residents of large institutions (Forness & Kavale, 1993). A large percentage of these study participants had cultural-familial retardation and, therefore, cognitively resembled their nonretarded peers. As the functioning level of students currently classified with mental retardation differs from the samples used in the original studies, MacMillan (1989) urged caution in extrapolating findings of these early studies to today's population as the "time-period specific validity... may be of little relevance for current educators" (p. 13). Turnure (1991) urged the inclusion of students with more severe disabilities in the study of memory processing to increase the appreciation of individual differences and to analyze and understand the learning processes of the variations in mental retardation subgroups.

This study was designed to examine the effortful and automatic information processing by students with and without mental retardation. In their theoretical framework of automaticity, Hasher and Zacks (1979, 1984) hypothesized that memory for spatial location should not benefit from either encoding variables (instructions) or individual differences. The use of strategic behaviors or strategic tactics is reported to be inadequate in persons with mental retardation, but it is not known how the use of these behaviors varies by developmental level (Belmont & Mitchell, 1987; Brown 1974). Therefore, students classified with educable mental handicaps (EMH), trainable mental handicaps (TMH), and peers without mental retardation of similar chronological age were included in the present study to determine if memory processing is similar for these three groups.

Review of the Literature

The theory of automaticity as developed by Hasher and Zacks (1979, 1984) is based on the idea that memory of an event entails encoding of multiple attributes of that event. These attributes may be encoded either automatically or effortfully. Automatic processing is independent of the use of conscious, effortful strategies, and is not influenced by individual characteristics, such as cognitive ability or motivation, that routinely influences performance. Intelligence, prior knowledge, and educational attainment typically play a significant role in the performance on memory tasks for effortfully processed information (Hasher & Zacks, 1984).

According to Hasher and Zacks, as people differ in systematic and predictable ways in available memory capacity, the capacity to execute various mental processes may vary. Automatic processes require less effort and, therefore, less memory capacity. Effortful processes require more capacity and include the intentional application of strategic behaviors.

Persons with mental retardation have been reported to be deficient in (a) structural processes, (b) the spontaneous use of adequate control processes, (c) active mediational devices, and (d) the ability to strategically transform input (Brown, 1974). The interrelatedness of these factors has been found to affect both short-term memory (Meador & Ellis, 1987) and performance of tasks that require the active use of control strategies or cognitive effort (Brown, 1974; Merrill, 1990).

Prior researchers have reported that automatic or incidental processing is developmentally insensitive, as incidental learning is not dependent on the application of control strategies (Brown, 1974; Ellis, Woodley-Zanthos, & Dulaney, 1989). Involuntary memory results from incidental learning and an active exploration of the environment. According to Hasher and Zacks (1979, 1984), automatically encoded information is processed as successfully by persons with mental retardation as by their peers without retardation. The use of strategic behaviors required to process effortfully encoded information is reported to be inadequate in persons with retardation, but it is not known how the use of these behaviors varied by developmental level (Belmont & Mitchell, 1987).

Methodology

In this study a picture recall and relocation test was used to assess the affect of encoding condition and developmental level on memory of students with and without mental retardation. Three experimental encoding conditions were used and participants of three developmental levels were assessed. Recall and relocation tests were completed with each participant with a follow-up test of secondary memory completed approximately 24 hours after the initial testing. The following sections describe the study participants, research methods, procedures, and data treatment.

Selection and Description of Participants

Participants of this study were 180 students, aged 10 to 15, enrolled in a large public school district in west central Florida. The participants constituted three groups: 60 EMH, 60 TMH, and 60 peers without retardation of similar chronological ages. Within each group, students were randomly assigned to one of three experimental encoding conditions.

Classification of the students with mental retardation was based on local district classifications. Participants classified as TMH were required to have an IQ score between 30 and 55. Participants classified as EMH were restricted to students with an IQ score between 59 and 73. The participants who were not retarded were required to have scores indicating functioning on grade level on the Comprehensive Test of Basic Skills (CTBS) and not receiving special education services. These restrictions were imposed in order to decrease the possibility of the overlap of IQ scores among the groups.

Research Methods

Each participant was seen individually for approximately 30 minutes. A follow-up test probe, which paralleled the original experiment, was conducted approximately 24 hours following initial testing.

The stimulus for this experiment consisted of a book of 50 pictures. Plastic photo pages lined with black poster paper were inserted into a spiral ring binder. The pages were divided into quadrants by the ring binder and a horizontal white line. Four pictures were included in the 2-page area, one in each quadrant. The pictures were all black and white and represented up-to-date and easily recognizable reproductions of common objects. The 50 pictures represented five items from each of 10 conceptual categories. The pictures were randomly arranged except that the four pictures in a viewing area each came from a different conceptual category. Two blank pages were included at the end of the book for the relocation test. A set of 50 randomly arranged pictures identical to those in the book was used for the relocation test. Table 1 lists the pictures used as stimuli.

Table 1
Pictures Used as Stimuli

Animals	**Body Parts**	**Food**
Cat	Ear	Apple
Cow	Eye	Hamburger
Fish	Foot	Ice cream
Horse	Hand	Milk
Rabbit	Lips	Pie
Toys	**Clothing**	**Vehicles**
Ball	Belt	Airplane
Bat	Dress	Car
Bicycle	Hat	Fire truck
Kite	Shoe	Train
Doll	Suit	Truck
Kitchen Utensils	**Furniture**	**Tools**
Cup	Bed	Hammer
Fork	Chair	Ladder
Pan	Desk	Paintbrush
Spoon	Sofa	Saw
Toaster	Table	Shovel

Table 1 (continued)

School Supplies
Book
Computer
Pencil
Ruler
Scissors

Procedures

There were four phases for each participant: memory task, recall test, relocation test, and follow-up. The activities included in each phase are described below.

Memory Task

Activity 1: Encoding instructions. The experimental condition assigned to each participant determined the encoding instructions received by that participant. Participants from Group 1, the nonsemantic-encoding instruction group, were told to "name each picture." Participants from the semantic-encoding condition, Group 2, were told to name each picture and either tell what the object is used for or tell something interesting about the picture. Participants from Group 3, the clustered encoding group, were asked to name each picture and then name another item from the same conceptual category. All participants from all groups were told that they would be asked to recall as many pictures as possible following completion of the task.

Activity 2: Materials. Participants were asked to look at the pictures at a self-paced rate. They were not allowed to turn back to the pages previously seen.

Activity 3: Practice set. Participants were shown the 8-picture practice set and were asked to recall as many pictures as possible. Participants not able to name any two pictures from the practice set were excluded from the remainder of the task and replaced from the available pool of potential participants. No mention of location was made during the practice set phase.

Activity 4: Task. When each subject was comfortable with the procedures of the experiment, the main task was introduced. Participants were told that the task for this part of the experiment was the same as the practice set, just longer. If the participant was unable to name a picture, the experimenter provided the name. Appropriate substitutions (e.g., substituting shoe for boot) were accepted and noted on the data sheet by the examiner. Inability to name pictured items correctly could indicate difficulty encoding item information or lack of understanding of task requirements. Therefore, participants not able to name two or more pictures were excluded and an additional participant was randomly selected.

Recall Test: Test of Effortful Processing

Activity 1: Recall activity. After viewing and naming the pictures, participants were given 4 minutes for recall. Free recall was requested from participants from Groups 1 and 2. For free recall procedures, participants were asked to name as many pictures as could be remembered. For participants from Group 3, recall was requested in categories. For example, participants in Group 3 were asked to name as many vehicles as could be remembered.

Activity 2: Recall outcomes. As participants recalled the items pictured, the names were recorded by the examiner. Incorrect names consistently used, for example, objects named incorrectly and recalled with this same name, were accepted.

Relocation Test: Test of Automatic Processing

Activity 1: Relocation activity. Following the 4-minute recall interval, participants were asked to place the pictures in their original locations using the blank pages at the back of the picture book. Identical procedures were used for item relocation for all experimental conditions.

A set of pictures identical to those in the picture book were randomly arranged and used for the relocation test. Participants were shown one picture at a time and asked to name the quadrant where it had first appeared. No feedback was given as to the correctness of the response. Two or more pictures from the same location were not tested consecutively.

Activity 2: Relocation outcomes. The picture location named by the participant was recorded by the examiner to determine the total number of pictures correctly relocated. This task was performed to test the ability to recall location when encoding had not been provided for that task.

Follow-up: Test of Secondary Memory

Activity 1: Recall follow-up. The recall exercise was repeated approximately 24 hours after the initial testing. During follow-up testing, the participants were not shown the picture book. As on day one, participants were given a 4-minute recall period with free recall requested from Groups 1 and 2 and clustered recall requested from Group 3.

Activity 2: Relocation follow-up. Participants were presented with a reordered version of the 50 pictures and the relocation test was repeated using the same procedures as used in the original relocation test. As test-wiseness now existed for the relocation test, relocation data could no longer be considered a measure or automatic processing. This phase was repeated, however, to determine if deterioration of automatically processed information occurred differentially based on encoding condition or developmental level.

Data Treatment

For this experiment, dependent variables included number of pictures recalled and number of picture locations recalled. An optimum score of 50 was available for both variables. Independent variables included encoding condition (nonsemantic, semantic, and clustered), developmental level (EMH, TMH, and nonretarded), and retention interval (immediate and long term). Statistical analysis was conducted to examine immediate and 24-hour delayed recall and relocation performance.

Examiners for this study were persons with training or experience in working with special education students. Training and monitoring was provided to the examiners to ensure consistency in task presentation. Additionally, each session was audio recorded with reliability verified for both data recording and data computation.

Data Analysis

The dependent measures were the number of pictures recalled and the number of picture locations recalled. An optimum score of 50 was available for both variables. A summary of recall and relocation performance by developmental level and encoding condition appears in Table 2.

Table 2
Means and Standard Deviation of Recall and Relocation Performance by Developmental Level and Encoding Condition

	Recall 1	Recall 2	Relocation 1	Relocation 2
Non-retarded				
Gr. 1	17.8	19.9	36.5	28.0
	(5.9)	(7.0)	(7.0)	(6.7)
Gr. 2	20.6	22.0	39.6	29.9
	(4.9)	(4.5)	(5.0)	(6.7)
Gr. 3	28.9	31.0	39.2	30.9
	(3.9)	(5.0)	(5.7)	(6.4)
EMH				
Gr. 1	11.4	11.1	29.7	23.6
	(3.9)	(4.0)	(10.3)	(8.5)
Gr. 2	13.2	13.4	33.5	21.1
	(3.2)	(4.0)	(9.8)	(8.8)
Gr. 3	22.6	21.8	28.6	22.0
	(6.7)	(5.7)	(10.5)	(7.9)
TMH				
Gr. 1	8.6	8.6	20.5	15.1
	(3.8)	(5.6)	(9.1)	(4.1)
Gr. 2	12.5	7.4	19.3	16.5
	(7.4)	(4.6)	(9.0)	(6.3)
Gr. 3	16.1	18.3	20.7	16.4
	(7.7)	(7.6)	(11.9)	(6.6)

Recall Performance

Recall of item information was examined as a test of effortful processing. The recall performance on both day one and day two for all students is shown in Table 3 for both developmental level and encoding condition.

Table 3
Mean Number of Items Recalled by Developmental Level and Encoding Condition

	Recall Day One	Recall Day Two
Developmental Level		
Nonretarded	22.4	24.3
EMH	16.1	15.8
TMH	12.4	11.4
Encoding Condition		
Nonsemantic	12.6	13.3
Semantic	15.4	14.2
Clustered	22.3	23.7

On both days, the students without mental retardation recalled more than those classified a EMH who recalled more than students classified as TMH. On both days, the clustered encoding group as a whole recalled more than those participants in the semantic group who recalled more than those from the nonsemantic group. The differences noted in the number of items recalled by the clustered encoding group and the semantic group and between the clustered and nonsemantic groups was statistically significant, but differences between the semantic and nonsemantic groups were not.

As students without mental retardation recalled more than students with retardation, evidence is provided for asserting that effortful processing deficits exist for persons with mental retardation. These deficits also were present dependent upon how the students encoded the information.

The fact that students without mental retardation recalled more than students with mental retardation is not surprising. Effortfully processed information, such as the recall of item information, requires the intentional application of strategic processes, sufficient memory storage capacity, and effective and efficient retrieval mechanisms. All of these areas have been shown to vary by developmental level and be deficient in persons with mental retardation (Belmont & Mitchell, 1987; Brown, 1974; Hasher & Zacks, 1979, 1984; Merrill, 1990).

Differences in performance among encoding condition groups verifies that persons with mental retardation can be induced to use elaborative or clustering techniques, and that these mediators can improve recall performance. Problems have been noted, however, in the long-term retention of control strategies by persons with mental retardation and the generalization of the use of these strategies to new tasks (Brown, 1974).

Relocation Performance

Recall of relocation information refers to being able to tell the examiner where the picture was located previously on the page. This was examined as a test of automatic processing because the students were not instructed to attend to this dimension. Table 4 shows the relocation performance on both day one and day two for all students by both developmental level and encoding condition.

Table 4
Mean Number of Items Relocated by Developmental Level and Encoding Condition

	Relocation Day One	Relocation Day Two
Developmental Level		
Nonretarded	38.4	29.5
EMH	30.6	22.2
TMH	20.1	16.0
Encoding Condition		
Nonsemantic	28.8	22.1
Semantic	30.8	22.5
Clustered	29.5	23.0

Both immediate and 24-hour delay relocation performance indicates that students without retardation relocated more pictures correctly than those participants classified as EMH who relocated more pictures correctly than TMH. No differences were shown in the number of pictures correctly relocated based on encoding condition. Assigned condition failed to affect relocation ability.

The finding that students without mental retardation relocated more pictures correctly than did any of their counterparts with mental retardation was unexpected in light of the theoretical contention that automatically processed information is insensitive to developmental differences. In their discussion of memory for frequency of occurrence, Hasher and Zacks (1984) did acknowledge that the use of memory skills and knowledge about the function of memory in general and a person's own memory in particular both show developmental trends at least through age four or five. While they did not discuss persons with mental retardation per se, this interpretation may be applied to explain the findings of the present study. Brown (1974) agreed that the decreased ability of persons with mental retardation to automatically encode spatial location information may be due to immature development of memory skills in general or differences in the development of memory capacity. The fact that students classified as EMH relocated more than their TMH peers but less than students without retardation contributes to the explanation that, at least for some people, ability to benefit from incidental learning is developmentally influenced.

It is important to note that a disparity in relocation performance was noted by students classified as TMH. The number of items correctly relocated on day one for this group ranged from 7 to 46. Of the 60 students in this group, 8 located more than 30 of the 50 items correctly. Six participants relocated less than 10 correctly. The variance in the ability to correctly relocate pictures may indicate that at least some of the students classified as TMH were sensitive to this information. It is important to note that the TMH participants were those most likely to be influenced by organic etiology (Burack & Zigler, 1990) or to experience problems in retrieval (Turnure, 1991).

It is possible, also, that participants classified as TMH found the tasks overwhelming and abandoned efforts based on expectancy for failure (Beirne-Smith, Patton, & Ittenbach, 1994). Belmont and Mitchell (1987) stated that performance on automatic processing tasks is influenced by prior experiences and expectations of task difficulty. Processes become automatic with practice or when working with familiar materials and within known ability levels (Belmont & Mitchell, 1987). While the present research did not test either the effect of practice or perceptions of task difficulty with students with retardation, anecdotal evidence was provided by examiners who reported apparent enhanced attention and performance when (a) demands were decreased when students were asked to "name one additional picture" instead of being asked "what else did you see" or "tell me other pictures you saw" (b) nonspecific praise was given, and (c) interruptions and distractions were used to break perseveration patterns in relocation recall.

Recall and Relocation Interaction

Following the main effect analyses, the researcher questioned the interaction of recall and relocation performance with developmental level and encoding condition between immediate and 24-hour delayed performance.

Recall. The source table for the Lindquist Type III split-plot ANOVA with repeated measures design used to investigate the presence of significant interaction effects for recall is shown in Table 5. As seen in this table, the interaction of developmental level and encoding condition between immediate and 24-hour retention is not significant ([$F(4,171) = .39$ $p<.8141$]). This failure to find a significant interaction effect between developmental level and encoding condition when the performance from both day one and day two were considered together establishes the fact that relationships among encoding conditions within each developmental level did not differ significantly. An illustration of this finding can be seen from the data provided in Table 2. The mean number of items recalled for the students classified as TMH were 8.6 for the nonsemantic encoding group, 12.5 for the semantic group and 16.1 for the clustered encoding group. For students classified as EMH, these totals were 11.4, 13.2, and 22.6 respectively. While, as previously discussed, all EMH encoding groups recalled more than their TMH counterparts, the relationships among the groups did not differ significantly.

Table 5
Source Table of Repeated Measures ANOVA for Recall

Source	df	F	p
Level	2	78.27	.0001*
Condition	2	68.82	.0001*
Level * Condition	4	.39	.8141
Error	171		
Retention	1	.43	.5138
Retention * Level	2	7.72	.0006*
Retention * Condition	2	5.28	.0060*
Retention * Condition *Level	4	6.07	.0001*
Error	171		

*$p < .05$

Turnure (1991) described the lower performance of persons with mental retardation on memory tests as indicative of qualitative memory deficiencies. Turnure continued, however, that when persons with mental retardation show patterns of performance similar to other populations, such as the patterns just described, only quantitative deviations from normal performance are implied. While Brown (1974) maintained that the ability to construct and execute a plan or to benefit from the use of control strategies may be dependent on maturity level, Turnure's belief emphasized that persons with mental retardation do have both implicit (unintentional) and explicit (intentional) memory systems, although one or both systems may operate quantitatively different from typical performance.

Significant interaction effects for retention interval, developmental level, and encoding condition ([$F(4,171) = 6.07, p<.0001$]); retention interval and encoding condition ([$F(2,171) = 5.28, p<0060$]); and retention interval and developmental level ([$F(2,171) = 7.72, p<.0006$]) are illustrated also by the source table presented in Table 5. Thus, further analysis was needed to investigate recall differences from day one to day two for encoding condition within the three developmental levels.

Further investigation of the developmental level and encoding interaction for immediate and 24-hour retention interval revealed significant differences within the group of students classified as TMH. No significant difference was shown between immediate recall and 24-hour delayed recall for TMH students in the nonsemantic group ([$F(1,19) = .00$ $p<1.00$]). As shown in Table 2 this group recalled an average of 8.6 items on both days of the procedure. A significant difference was shown by the TMH students in the semantic encoding group between immediate recall and 24-hour delayed recall ([$F(1,19) = 16.81$, $p<.0006$]).

Summary of interaction effects for recall. When performance was assessed from day one to day two, a significant three-way interaction resulted. Recall performance was significantly different from day one to day two dependent on developmental level and encoding condition. Students without retardation from all encoding conditions showed an increase in the number of items recalled from day one to day two. This ability to recall more items after 24 hours than at immediate recall did not hold true for all encoding groups from the other developmental levels.

The use of clustering and semantic strategies is of particular interest when comparing performance from day one to day two for participants with retardation. The students in the clustered encoding condition who were classified as EMH had a slight decrease in recall performance from day one to day two while their TMH counterparts showed an increase in the number of items recalled. The opposite was true for students in the semantic group. Therefore, the encoding condition assigned had varying degrees of effectiveness on recall performance depending on the developmental level of the student. When tasks require the application of effort or intention, individual differences and instruction can prejudice the outcome.

Relocation. A second Lindquist Type III split-plot ANOVA with repeated measures was completed to determine if interaction effects existed in the number of items correctly relocated between immediate and 24-hour retention. Results of this investigation are exhibited in Table 6.

Table 6
Source Table of Repeated Measures ANOVA for Relocation

Source	df	F	p
Level	2	69.87	.0001*
Condition	2	.36	.6995
Level * Condition	4	.49	.7444
Error	171		
Retention	1	228.82	.0001*
Retention * Level	2	10.03	.0001*
Retention * Condition	2	1.55	.2145
Retention * Condition * Level	4	2.75	.0298*
Error	171		

*$p<.05$

It can be noted from this table that there was no significant interaction between developmental level and encoding condition for the number of items correctly relocated from immediate to 24-hour relocation for all subjects ([F (4,171) = .49, $p<.7444$]). When performance from both day one and day two were considered, however, the interaction of developmental level, encoding condition, and retention interval was significant ([F (4,171) = 2.75, $p<.0298$]). This significant interaction provided evidence that the encoding condition within each developmental level made a difference in relocation performance from day one to day two. As the interaction of retention interval and developmental level was significant ([F (2,171) = 10.03, $p<.0001$]), further investigation was undertaken. Fewer items were relocated correctly from day one to day two by all participants. However, the relationship of day one to day two relocation performance for EMH students in the semantic encoding group was significantly different from the performance of EMH students in the other two groups.

For those EMH students in the nonsemantic encoding condition, 29.7 items were relocated correctly on day one compared to 23.6 on day two. This difference of 6.1 items was significant at the .05 level ([F (1, 17) = 39.78, $p<.0001$]). Participants in the semantic encoding condition relocated 12.4 additional items on day one than they did on day two (see Table 5). This difference was also significant ([$F(1, 19) = 74.64, p<.0001$]). Those EMH participants in the clustered condition relocated 28.6 items correctly on day one compared to 22.0 items on day two for a significant difference of 6.6 items ([$F(1, 21) = 18.87, p<.0003$).

Summary of interaction effects for relocation. In conclusion, the findings of this study exposed differences in relocation performance due to developmental level and encoding condition. From the interaction effects present when retention interval was included in the analysis, it can be concluded that memory for relocation is subject to differential rates of forgetting as well.

Interpretation and Discussion of Related Findings

Developmental Level

In the present study, the developmental level of the participant was associated with both recall and relocation performance. Prior researchers into memory performance of persons with mental retardation have made comparable findings for effortfully processed information. Recall performance and ability has been found to be related to both age and IQ (Calfee, 1969; Dugas & Kellas, 1974; Ellis, Meador, & Bodfish, 1985; Ellis et al., 1989; Lamberts, 1979). Additionally, persons with mental retardation have been found to not retrieve as many items from storage as persons without mental retardation (Glidden & Mar, 1977). Varnhagen, Das, and Varnhagen (1987) explained that persons with mental retardation have less efficient effortful memory processing systems, faster stimulus decay, and greater stimulus interference.

Findings of prior researchers into automatic processing by persons with mental retardation have not been as straightforward. Incidental memory has been found not to be deficient when compared to that of peers without retardation and to be unrelated to age, intelligence, or type of instruction by some researchers (Burack and Zigler, 1990; Ellis et al., 1989; Schultz, 1983). Katz (1987) reported that age-related deficits for automatically processed information have been found. Merrill (1990) reported differences in information processing between persons with and without mental retardation exist primarily when effortful, but not automatic, memory is required. Stratford (1979), on the other hand, found short-term memory deficits for the automatically processed attributes of size, form, and order. Possible explanations for the discrepancies found in the study of automatic processing include (a) prior instructions received by the student, (b) the type of information and procedures used to study automatic processing, and (c) the size of the memory load. One possible explanation for the present finding that automatic processing differed by developmental level may be based on comparisons among students of similar chronological ages. Chronological age comparisons generally had not been the subject of prior researchers.

Encoding Condition

Encoding refers to the establishment of an internal representation of a stimuli for storage and retrieval. Persons with mental retardation have been reported to be encoding deficient while persons who claim to use memory strategies are found to have higher and more accurate recall (Ellis et al., 1985). Encoding condition was found to be a significant variable in both recall and relocation performance in the present study.

In agreement with the findings of the present study, the use of semantic or clustering strategies has been found to influence recall (Becker & Morrison, 1978; Bilsky, 1976; Gerjouy & Alvarez, 1969). Brown (1974) reviewed studies reporting that persons with mental retardation are deficient in the use of control strategies, although they can be prompted to use these techniques. Persons with mental retardation may not be efficient at recognizing and using organizational patterns (August, 1980; Spitz, 1966), may not be able to understand categorical or organizational labels (Burger & Erber, 1976), or may lack the semantic network required to benefit from externally provided prompts to cluster (Bilsky, 1976; Engle & Nagle, 1979). McBane (1976) agreed that the ability to benefit from strategy use varies by developmental level. Nonetheless, when encoding strategies were externally supplied by the examiner, persons with mental retardation were able to use these strategies to enhance their recall performance.

Again, prior research findings are less clear on the effect of encoding strategies on automatically processed information. Fox and Rotatori (1979) reported that incidental learning is influenced by prior instructions to categorize, while Merrill (1992) found that encoding strategies can increase the speed on encoding. This later finding does not support the assumption that familiar stimuli are encoded automatically. Differences in the effectiveness of strategy use with automatic processing may be the result of the materials and procedures used (Maisto & Jerome, 1977; Phillips & Nettelbeck, 1984), the type of information to be encoded (Ellis et al., 1989), and the inability to encode beyond preliminary stages (Mar & Glidden, 1977). Bilsky, Whittemore, and Walker (1982) attributed deficits in strategy use to the inability to screen out irrelevant information or attend to appropriate mediators in novel situations, both areas that effect performance on automatic processing tasks. Merrill (1992) concluded that the relationship between strategy use and automatic processing may be inconclusive because there may be some processes that can be executed without attentional resources but are performed better when resources are allocated to them.

In the present study, the encoding condition to which a participant was assigned was associated with recall performance but not relocation performance until retention interval was included in the analysis. All encoding conditions were not equally effective with all developmental levels. These findings supplement the current literature that when retention of automatic processed information is expected, strategy use can increase performance.

Conclusions

Within the context of the findings and the prior research into automatic and effortful memory processing, this study makes the following conclusions.

1. Based on the findings of lower performance by students classified as EMH and TMH in both automatic and effortful memory processing as a result of this investigation, educators should consider performance differences in placement and program decisions. This research effort supplements previous limited evidence that cognitive performance differs under automatic processing conditions, especially when comparisons are made between persons of similar chronological ages. Therefore, prior planning by educators is needed when students of the same chronological ages receive similar placements or educational programs, in order to minimize the anticipated differences in the amount of information that students of varying developmental levels may process. Differences in memory performance may be due to a decreased memory capacity, a decreased ability to produce memory strategies, or an inability to select

and attend to relevant stimuli. By anticipating differences in memory performance, as found by this study, educational approaches can be designed to help overcome the potential performance differences.

Additionally, anecdotal evidence revealed differences in processing strategies. Examiners reported that students without retardation frequently rehearsed picture order by repeating names of the pictures aloud or repeating names of pictures seen on previous pages; looked for environmental cues to increase recall; recalled items by category when not in the clustered encoding condition; recalled paired associates (e.g., bat and ball, car and truck); or recalled alphabetic clusters (e.g., bat, bed, book, ball). Use of these mediators was not noted routinely with students classified as TMH or EMH.

Differences in memory performance are significant for both educators and persons in educational leadership positions. As educational programs are designed and placement decisions are made that encourage the inclusion of students of similar chronological ages, attention must be paid to designing programs that accommodate the differences in memory processing as shown by this investigation. For example, educational programs that include students of varying developmental level should allow for and encourage modification of both how information is presented and how recall of information is requested in order to overcome potential information processing differences.

2. Based on the findings that students with mental retardation were deficient in relocation performance, attention needs to be paid by educators as to how learning occurs. The inability of students with mental retardation to benefit to the extent of their peers without retardation from incidental learning situations supports Brown's (1974) contention that there is a relationship between mental maturity and the ability to disregard irrelevant information. Automatic processing deficits may compromise the ability to discriminate among stimulus events and efficiently use attentional resources, thereby limiting the capacity remaining for effortful processing (Katz, 1987). Furthermore, this deficit in automatic encoding ability may result in decreased retrieval abilities. Spitz (1966) described chaotic retrieval in persons with mental retardation as resulting from a failure to recognize and organize input.

Teachers therefore, should emphasize recognition and organization of those aspects of incoming information relevant for task performance, thus increasing the memory trace for to-be-remembered information and reducing overall memory load. Presenting information as paired associates, pointing out similarities and differences in learning and problem solving situations, or verbal reminders to attend to environmental cues all are examples of strategies that educators can use to decrease memory load and increase memory performance. It should not be expected that spatial information or environmental cues will be attended to without specific direction to do so. For example, instructions may be needed to attend to such cues as illustrations of how objects are assembled or icons that illustrate task procedures (e.g., how to insert a paper money into a vending machine). Tasks should be analyzed into component strategies to determine what the student is expected to learn incidentally. Capacity requirements required for each task should be analyzed. Specific instructions and task-specific strategies should be used to maximize learning.

Deficiencies in relocation performance exhibited by students with mental retardation have particular importance in the design of functional training programs. Many educational activities and most real-world experiences involve automatic encoding of such contextual cues as location, frequency, size, form, shape, and sequence. Spatial location skills, for example, are necessary not only to read a map or orient oneself to the environment but also for such tasks as following assembly line directions or arranging or collating materials.

3. Attention should be directed toward enhancement of automatic encoding skills. Failure of the performance of students with mental retardation to adhere to theoretical expectations for automatically encoded activities may be due to task-related variables or expectancies for failure. Turnure (1991) asserted that automatic encoding performance could be enhanced by practice, use of familiar materials and situations, and testing original learning situations. While this study did not address the effect of practice on automatic processing, evidence was provided that automatic encoding skills were present at some level for all study participants, regardless of developmental level. To enhance the development of these skills, Turnure (1991) recommended that testing situations parallel original learning situations as much as possible as the use of retrieval cues can enhance retrieval and reinstate learning. Materials should relate to meaningful goals and activities.

4. Based on the findings of this investigation, automatically processed information can be retained by both students with and without mental retardation. In this investigation, 24-hour follow-up

of both recall and relocation performance was completed to determine the effect of long-term memory on automatic and effortfully processed information. Automatically processed information was not processed as deeply, and, therefore, it was not expected to be transferred into long-term memory. A significant finding of the study was that item relocation information was held in long-term memory as well by students with retardation, both TMH and EMH, as by students without retardation. Therefore, when steps are taken to facilitate automatic processing, as described in the previous implications, retention can occur both in students with and without retardation.

5. Based on the findings that clustering and elaboration increased recall and relocation performance, attention needs to be paid to the enhancement of strategy use by both students with and without retardation. Additionally, the clustered encoding group had less deterioration of relocation information and higher gains in recall from day one to day two. While not all strategy use was equally effective with all groups, the clustered encoding group of TMH students was the only TMH subgroup to show a gain in recall day one to day two. Based on this information, educators may be able to remediate performance problems by emphasizing relevant categorical aspects of incoming information.

Educators can give attention to this by using clustering strategies in instruction. Clustering strategies, presenting items that are systematically related to others, may include presenting items in semantic or acoustical relationships. For example, when semantically presenting words to be remembered, the relationships may be a direct item-to-item association such as "dog" with "cat" or "bat" with "ball." Superordinate categories such as "dog" with "animal" may be presented as well. Additional types of relationships could include action of ("hand" with "touch"), action upon ("eat" with "food"), or contrasting ("black" with "white"). Clustering items acoustically includes presentation in rhyme-related categories. Additionally, educators should not only teach strategic behaviors, but should also concentrate efforts on enhancement of the richness of existing knowledge and experiences. Engle and Nagle (1979) specified that comprehension and thus memory for new information could be increased by enabling the student to increase his or her semantic network through enrichment of the knowledge and experience base from which student operates.

A Final Comment

In summary, the results of this study have contributed to the continued growth of research on the memory of students with and without mental retardation. It was demonstrated that both automatic and effortful memory processing are influenced by the developmental level of the student and the conditions under which new information is received. Due to the effects of these mediating variables on automatic processing, support was not provided for the theory of automaticity as hypothesized by Hasher and Zacks (1979, 1984). These and other related findings of the present investigation are important to teachers and educational administrators in the design and implementation of educational programs for adolescents with mental retardation.

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