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Objects, pictures and words as recall clues in a memory experiment with mentally retarded students.

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OBJECTS, PICTURES AND WORDS AS RECALL CUES IN A MEMORY EXPERIMENT WITH MENTALLY RETARDED STUDENTS

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DEDICATION

This thesis is dedicated to Ourlaine, who endured its lengthy evolution gracefully.

ABSTRACT

The purpose of the present research was to investigate the function of various types of cues (verbal, pictorial and three-dimensional) and a directive cuing procedure in the initiation and facilitation of the categorization strategy of remembering in mentally retarded individuals, and to measure the resultant effect upon free recall performance. The relationship between vocabulary age and the ability of mentally retarded subjects to learn to organize for remembering was also examined.

During the presentation of the to-be-remembered items (pictures of common objects), the experimental subjects received cues informing them of the categorical nature of the material. For all experimental groups, the cued presentation was the same, except for the specific type of cues used (Cue Type). One third of the subjects received three-dimensional object cues, while the others got either picture or verbal cues (Object vs Picture vs Verbal).

The experimental groups differed with respect to the presence or absence of retrieval cues during the recall test (Recall Condition). Half of the subjects received standard free recall instructions, with no cues present at recall (Free Recall). The remainder received directive cuing, that is, the same category cues that were used during presentation were also present for the recall test, and the subjects were instructed to use them (Directive Cuing).

In addition, a single control group of 16 subjects received no category cues at either presentation or recall, with standard free

recall instructions during the recall test. Finally, each group was divided into high and low mental age groups (Mental Age Level).

A total of three training trials, each consisting of a presentation phase and a recall phase, were used. The fourth trial, the transfer trial, was also given, during which no category cues were present at either presentation or recall.

In general, it was hypothesized that the clustering of material recalled by mentally retarded subjects would be increased through experimental manipulation and that increased clustering would result in an increased number of items recalled. The hypotheses covered three stages in the experiment: a) initial effects, recall performance on training trial one before the involvement of inter-trial learning; b) training effects, recall performance on training trials one through three, and c) transfer effects, recall performance on the transfer trial, the fourth trial, compared to the training trials.

The subjects were 112 trainable mentally retarded students ranging in age from 60 to 252 months. Half of the subjects were from a rural school and the other half from an urban school. Grouping was done controlling for: mean mental age, chronological age and basic recall ability, as well as sex and the presence of Down's syndrome.

The present study demonstrated that mentally retarded subjects can learn to use the categorization strategy of remembering, though they do not use it spontaneously. A number of factors proved to be relevant to the acquisition of that strategy and increased amount recalled: a) a subject's mental age; b) the type of training given; c) the type of cue used. Higher mental age was related to greater recall of items during both training and transfer. The directive cuing procedure resulted in increased clustering and amount recalled in all phases of the experiment. In the case of the type of cues used, a definite difference in effects was observed only on the transfer trial, where object cues proved superior to picture and verbal cues within the directive cuing procedure. Thus, the results demonstrated that the directive cuing technique is an effective method of training mentally retarded persons to use the categorization strategy of remembering, thereby improving their recall performance. It was also shown that when using the directive cuing technique, object cues are better than picture or verbal cues, in promoting transfer of learing.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Memory plays a functional role in most of our daily activities. For the normal individual, memory performance tends to improve with age, as part of the developmental process. Sykes (1976) noted that the improvement is not due solely to increased memory span or some physiological development. Memory may be viewed as a process including three phases: detection, storage and retrieval. Learning and using rules and organizational strategies, such as chunking (Miller, 1956) or categorization (Bousfield, 1953), play an important part in the development of an efficient memory process.

Researchers, notably Bilsky and Evans (1970), Ellis (1970), Herriot, Green and McConkey (1973) and Spitz (1966), have suggested that many of the functional deficits of the mentally retarded person could be due to inefficient organization of memory processes. The purpose of the present research was to investigate the function of various types of cues (verbal, pictorial and three-dimensional) and a directive cuing procedure in the initiation and facilitation of the categorization strategy in the mentally retarded individual, and to measure the resultant effect upon free recall performance. As was done by Green (1974), who used retarded adults, the subjects in the present study were divided into high and low vocabulary age groups.

The relationship between vocabulary age, as measured by the Peabody Picture Vocabulary Test (Dunn, 1965), and the ability of the mentally retarded subjects to learn to organize for remembering was examined.

Organizing Processes and Memory

Learning to remember and the efficiency of different methods of organizing for remembering have been under study for many years, with formal experiments being reported as early as 1885 by Ebbinghaus. More recently, Miller (1956) noted the "magical number seven, plus or minus two" as the normal limit to immediate memory. Miller also observed that some subjects used a strategy called "chunking" to increase the capacity of immediate memory by grouping, or chunking, items into memory units or chunks, each unit taking up only one of the five to nine storage positions, thereby allowing for the storage of a larger number of items. Worden and Ritchey (1979) reported the same strategy in elementary school children, and suggested that for children there is a limit of three plus or minus two items per chunk.

A different strategy, this one used more in long term information storage was reported by Bousfield (1953) and Mathews (1954). Both of those experimenters gave subjects word lists to learn, lists that could be sub-divided into a small number of conceptual categories (e.g., fruit, animals, furniture). The subjects in those experiments actually regrouped the items by category membership in recalling them and the categorization strategy of remembering was inferred. That strategy was measured through the observation of the clustering of items by category in the subjects' recall protocols. As with the chunking strategy, categorization tended to increase the individual's recall performance, as measured by the amount of information retrieved (e.g., Evans, 1970; Puff, Murphy & Ferrara, 1977; Thompson, Hamlin & Roenker, 1972).

Yet another type of organization was reported by Tulving (1962, 1966), "subjective organization" of unrelated items was observed. Tulving found that even with relatively uncategorizable material, subjects tend to impose some subjective organization on the material they are required to recall.

Spitz (1966) has reviewed the literature with respect to organizational strategies of memorization used by mentally retarded persons. Spitz suggested that retarded individuals are primarily deficient in the categorization and chunking of input, rather than simply in memory capacity. A very comprehensive review of research and training techniques related to memory strategies and the mentally retarded has been amassed by Glidden (1977b). For more detail regarding research in memory organization and other proposed deficits in the memory processes of mentally retarded subjects, the reader is referred to the literature review in Appendix A.

Clustering as a Measure of Retention Efficiency

Many investigators (e.g., Atkinson & Shiffrin, 1968, 1971; Bell & Kee, 1980;Broadbent, 1958, 1963; Burger, Blackman & Tan, 1980; Ellis, 1970; Filan & Sullivan, 1980; Howe, 1967; Puff, Murphy & Ferrara, 1977; Waugh & Norman, 1965) have stressed the importance of organizational strategies in retaining information.

Bower, Clark, Lesgold and Winzenz (1969), talking specifically about retrieval of items from categorizable word lists, noted that subjects who were able to learn a simple rule that related certain items in the list to each other, showed better retention than subjects who did not utilize the rules. The relationship between the utilization of the categorization strategy and efficiency of retention, as measured by amount recalled, will be briefly reviewed for normal and retarded subjects.

Normal subjects. Studying the performance of 60 introductory psychology students on a free recall task with categorizable word lists, Thompson, Hamlin and Roenker (1972) found amount recalled to be positively correlated with the use of the categorization strategy, suggesting that organization aids recall. Using similar subjects, Wortman and Greenberg (1971) reported that subjects naturally tended to code information into hierarchical organizations based on categorical relationships. Those investigators implied that the use of such a strategy provides information for locating items during retrieval, thereby making retrieval more efficient. When Gruenewald and Lockhead (1980) asked their subjects to recall examples of category items, they found evidence of a two-stage process: a) subjects located a semantic field, and b) they then produced whatever items were in the field. Those experimenters showed that information is retrieved in clusters, even within broad category boundaries. Comparing the performance of 30 male undergraduates on two 18-word lists, one containing unrelated items, the other having items from three specific categories, Puff (1970b) supported the notion that recalling in category clusters is advantageous to retrieval performance. Subjects given the categorizable list tended to use the categorization strategy and recalled significantly more items than those subjects exposed to a list of unrelated items, even though the latter group tended to use subjective organization as a retention aid. Dallet (1964) reported a series of five experiments, noting that clustering and amount recalled were positively related, with categorization helping most with lists containing large numbers of categories. Similar results with kindergarten children were reported by Westman and Youssef (1976).

In general, the ability of experimental subjects to utilize the categorization strategy, as measured by the presence of clustering in their recall protocols, has been shown to be positively related to recall performance.

Mentally retarded subjects. Retarded persons seem to lack the spontaneous tendency to use the categorization strategy (e.g., Furth & Milgram, 1965; Griffith, Spitz & Lipman, 1959; Jensen, 1965). They are able, however, to learn and to use that strategy when the experimental situation is properly manipulated (e.g., Bender & Johnson, 1979; Bilsky & Evans, 1970; Bilsky, Evans & Gilbert, 1972; Belmont & Butterfield, 1971; Burger, Blackman & Tan, 1980; Glidden & Mar, 1978; Glidden, Pawelski, Mar & Zigman, 1979; Klein, 1974; Lathey, 1979; Reichhart & Borkowski, 1978; Wambold & Hayden, 1975).

When mentally handicapped individuals do use the categorization strategy of remembering, a positive effect on retention performance is observed, as is with normal subjects. In fact, Gerjuoy and Spitz (1966) found the recall performance of retarded subjects and normal subjects, matched for mental age, to be equivalent when both groups were requested to recall items in a clustered fashion. Evans (1970) gave 20-word lists to a total of 60 male and female retarded students, and found amount recalled and clustering to be positively related, in both the auditory and the visual-auditory modes of presentation. Similar results were reported by Riegel and Taylor (1974), who used the Sampling Organization and Recall Through Strategies Test (Riegel, 1973) with educable mentally retarded and normal children matched for chronological age. They reported that the retarded children who grouped associatively showed significant positive correlations between amount recalled and clustering. Finally, as was also reported by Puff (1970b) for normal subjects, categorically related words were recalled more efficiently than unrelated words by mentally retarded adults, in a study by McConkey and Herriot (1974, Exp. II). Evans (1970) also reported a positive correlation between amount recalled and clustering for mentally retarded subjects.

A Hierarchy of Cue Effectiveness

One hypothesis relating clustering and retention performance is the "some-or-none" hypothesis by Cohen (1966). That hypothesis proposes that either a large portion of the items from a given category will be recalled, or no items will be recalled from that category. Tulving and Pearlstone (1966) discussed the same issue, emphasizing the importance of gaining access to category clusters in the retrieval of categorizable items, noting that accessibility can be improved, while availability remains quite stable and more or less automatic. In a related area of investigation, Roediger and Schmidt (1980) found that the number of items recalled from a category had no effect upon output interference, while the number of categories recalled did. Their results seem to suggest another difference between the dynamics of accessibility and availability. It has been suggested that access to a cluster of stored items from a given category may be achieved through the use of retrieval cues (Tulving & Osler, 1968).

It is curious that the research into the use of cues in the recall of categorizable items has divulged so many significant factors, such as the number of items related to each cue (e.g., Earhard, 1967), closeness/remoteness of the cue-item relationship (e.g., Bender & Johnson, 1979; Hall, Murphy, Humphreys & Wilson, 1979), consistently using the same cues (e.g., Bilsky, Evans & Gilbert, 1972; Earhard, 1969), having cues present at storage as well as at recall (e.g., Bilsky, 1976; Crouse, 1968; Earhard, 1969; Glidden & Mar, 1978; Herriot, 1972a; Thompson & Tulving, 1970; Tulving & Pearlstone, 1966), letting subjects know that the same cues will be present at recall (e.g., Kobasigawa, 1975), instructing subjects to use cues during retrieval (e.g., Ashcraft & Kellas, 1974; Emmerich & Ackerman, 1978; Gerjuoy & Spitz, 1966; Glidden, 1976; Kobasigawa, 1974; Lathey, 1979; Reichhart & Borkowski, 1978) and finally, the number of trials subjects are given to learn to use the cues (e.g., Bower, Clark, Lesgold &

Winzenz, 1969; Gerow, 1970; Green, 1974), but little attention has been directed at the type of cues used. For the most part, subjects in cued recall experiments have been told verbally the categorical nature of the to-be-remembered material and the category membership of individual items. Though at least two researchers (Kobasigawa, 1974, 1975; Martin, 1975) have used pictures as cues, rather than verbal cues, extremely little research has been done to date comparing the effects of different types of cues, such as verbal, picture and object cues.

With respect to mentally retarded subjects, some authors have suggested an organizing deficit (e.g., Bilsky & Evans, 1970; Ellis, 1970; Spitz, 1966), while others discuss a similar deficit in operational intelligence (e.g., Gruen, 1973; Simpson, King & Drew, 1970), while still other theorists have proposed that mentally retarded subjects simply lack spontaneity in the application of strategies for remembering (e.g., Furth & Milgram, 1965; Griffith, Spitz & Lipman, 1959; Jensen, 1965). In order to establish the precise nature of the difficulties mentally retarded individuals experience in retrieving information, research in the area of cued recall must not only investigate the role of procedural factors, such as those mentioned above, but also compare the effectiveness of different types of cues. Some of the variance in the ability of experimental subjects, especially those who are young children or mentally retarded, in learning to use cues in recalling categorizable items could be due to the relative ineffectiveness of the types of cues typically used.

Due to the sparcity of reported research in the comparison of the effectiveness of different types of cues, a related field of endeavour, the study of the hierarchy of recall item efectiveness, will be reviewed before presenting a hypothesis for a similar hierarchy of cue effectiveness.

Words, pictures and objects as recall items. As early as 1894, Kirkpatrick reported a free recall study in which recall was higher for objects as to-be-remembered items than for the names of the objects. Four years later, Calkins (1898), in a partial replication of Kirkpatrick's study, showed that pictures of to-be-remembered items were recalled more efficiently than the names of the items. Later Moore (1919) found the recall of picture items actually fit neatly between objects as highest and verbal material as lowest in a hierarchy of recall effectiveness (number of items recalled).

Scott (1967) reported that college students given perceptual items (objects) recalled better and showed a stronger tendency to use the categorization strategy, than did students exposed to symbolic items (words). Contrasting pictures and objects as recall items with retarded subjects, faster paired associate learning (Iscoe & Semler, 1964) and greater amounts recalled in free recall (Mende, 1974) were found where objects were used. Similarly, Shotick, Ray and Addison (1976) found three-dimensional recall items gave better results on tests of memory span, short term recall and long term recall with mentally retarded subjects. Comparing the learning ability of retarded persons using abstract items, such as geometric forms, and pictures of familiar objects (Deich, 1974), or actual toys that were familiar to the subjects (Klein & Safford, 1976), pictures and objects proved superior. Thus, a consistent trend of recall superiority of objects over pictures over verbal material has been reported by those and other researchers (e.g., Bousfield, Esterson & Whitmarsh, 1957; Paivio, Rogers & Smythe, 1968; Swanson, 1977ab).

Dugas (1975) has suggested that an important factor influencing the hierarchy of objects over pictures over words may be the subject's familiarity with the items, especially in the case of retarded subjects, who tend to have more contact with concrete materials versus other symbolic items.

Cues and cuing. If any type of cue is to be of value in the recall situation, the experimental subjects must obviously be made aware of the presence of the cues (e.g., Burger, Blackman & Tan, 1980; Emmerich & Ackerman, 1978; Kobasigawa, 1974). When working with very young children or mentally retarded persons, not only must the subjects be made conscious of the cues, but they also benefit from encouragement to put them to use (e.g., Emmerich & Ackerman, 1978; Kobasigawa, 1974, 1975; Reichhart & Borkowski, 1978).

The simple presence of retrieval cues during presentation and/or recall in the free recall situation with normal subjects (e.g., Crouse, 1968; Emmerich & Ackerman, 1978; Segal, 1969; Tulving & Pearlstone, 1966) and with retarded subjects (e.g., Ashcraft & Kellas, 1974; Bilsky, 1976; Herriot, 1972a) has been demonstrated effective in increasing recall performance. Instructing subjects to use retrieval cues has also been studied. A number of researchers (e.g., Horowitz, 1969; Pollio, Richards & Lucas, 1969) have shown that subjects instructed to organize recall on a categorical basis show improvement in performance.

In an experiment with elementary school children, Kobasigawa (1974) found that the difference in free recall scores of first and third grade youngsters could be eliminated by using a directive cuing technique, that is, by instructing them to use recall cues as aids in remembering the experimental items. The 48 second and fifth graders in a cued recall study by Hall, Murphy, Humphreys and Wilson (1979) also did better on cued recall than on free recall. Hall et al. did report a different pattern of scores, compared to Kobasigawa (1974) though, in that they found that on the free recall test there was no difference due to age, but when cues were given, the fifth grade children recalled more items than those in second grade. Also, Wingard, Buchanan and Burnell (1978) found 4 and 5 year old normal children recalled significantly more items, when given semantic prompts after they had already attempted the free recall of 25 categorizable picture items. Emmerich and Ackerman (1978), working with first and fifth grade pupils, as well as college students, found that recall was significantly better for subjects given cues over those in the free recall condition. Furthermore, Emmerich and Ackerman also observed that those subjects in their "constrained" cuing condition, similar to the directive cuing technique, recalled even more items than the other two groups (free recall and cued recall). Finally, when Gerjuoy and Spitz (1966) instructed their subjects to use category cues to recall items, they found that the performance of retarded and equal mental age normal subjects was equivalent.

Mental Age Level

In a developmental study of memory, Worden and Ritchey (1979) found that the number of items children (grades 2, 4 & 6) could store per memory unit, or chunk, was three plus or minus 2, much less than their adult subjects. Whether it is the limitation of the size of the memory units or some other factor that is responsible is uncertain, but it is a fact that both amount recalled and clustering increase with increasing mental age of experimental subjects (e.g., Bousfield, Esterson & Whitmarsh, 1958; Coward & Lange, 1979; Emmerich & Ackerman, 1978; Hall, Murphy, Humphreys & Wilson, 1979; Kobasigawa, 1974; Lathey, 1979; Liben, 1979). With respect to mentally retarded subjects, if they are of equal mental age, they generally tend to recall and cluster to the same extent as normal controls (e.g., Ashcraft & Kellas, 1974; R.M. Brown, 1974; Deich, 1974; Gerjuoy & Spitz, 1966; Heal, 1970; Osborn, 1960; Palmer, 1974). But within the mentally retarded population, mental age level is still a relevant factor in the free or cued recall situation. For example, Green (1974) tested retarded adults of two vocabulary ages and found that only the high vocabulary age group evidenced an increase in recall when cues were given. Green also noted that the higher vocabulary age subjects clustered more than those of lower vocabulary age. The rate at which the high versus the low groups learned to use the cues to cluster and recall information was significantly different, suggesting that mental age is a crucial variable in determining not only memory capacity, but also the ability of mentally retarded subjects to learn and use strategies for remembering.

Recall Performance Across Trials

In 1971, Thompson and Roenker gave a total of nine four-category word lists to their undergraduate subjects in three experiments. Those experimenters reported that learning to cluster occured and was complete, that is, essentially all items were grouped by category membership, after multiple trials on a single categorizable word list. Along the same line, Rosner (1970), also studied clustering in the recall protocols of undergraduates and found that the output phase of memory experiments facilitated higher-order organization of output content. A number of other investigators have also shown that over a number of trials, subjects learn to organize output, whether the subjects be university students (e.g., Bousfield, Puff & Cowan, 1964; Donaldson, 1971; Gerow, 1970), young children (e.g., Horowitz, 1969; Moely & Shapiro, 1971) or mentally retarded persons (e.g., Evans, 1970; Gerjuoy & Winters, 1970; Gerjuoy, Winters, Pullen & Spitz, 1969; Green, 1974; Palmer, 1974).

Amount recalled has also been observed to increase over progressive trials with mentally retarded persons (e.g., Bilsky & Evans, 1970; Bilsky et. al., 1972; Evans, 1970; Fagan, 1969; Gerjuoy & Winters, 1970; Gerjuoy, Winters, Pullen & Spitz, 1969; Glidden, 1976; Green, 1974; Leicht & Johnson, 1970; McConkey & Green, 1973) and normal subjects (e.g., Coward & Lange, 1979; Emmerich & Ackerman, 1978; Donaldson, 1971; Gerow, 1970;

Horowitz, 1969; Moely & Shapiro, 1971).

The Present Study

During the presentation of the to-be-remembered items, the experimental subjects received cues informing them of the categorical nature of the material. For all experimental groups, the cued presentation was the same, except for the specific type of cues used (Cue Type). One third of the subjects received three-dimensional object cues, while the others got either picture or verbal cues (Object vs Picture vs Verbal).

The experimental groups differed with respect to the presence or absence of retrieval cues during the recall test (Recall Condition). Half of the subjects received standard free recall instructions, with no cues present at recall (Free Recall). The remainder received directive cuing, that is, the same category cues that were used during presentation were also present for the recall test, and the subjects were instructed to use them (Directive Cuing).

In addition, a single control group, free of experimental manipulation was used. The 16 control subjects received no category cues at either presentation or recall. Standard free recall instructions were given to the controls during the recall test.

Each treatment group and the controls were divided into high and low mental age groups to assess treatment effects at the two levels of mental age (Mental Age Level).

A total of three training trials, each consisting of a presentation phase and a recall phase, were used. A transfer trial, the fourth trial, with all subjects treated the same as the control group was given to test the extent of the integration of the categorization strategy into the memory processes of the experimental subjects from each treatment condition. During the transfer trial, no category cues were present at either presentation or recall.

The Hypotheses

In general, it was hypothesized that the clustering of material recalled by mentally retarded subjects would be increased through experimental manipulation and that increased clustering would result in an increased number of items recalled. The hypotheses covered three stages in the experiment: a) initial effects, recall performance on training trial one before the involvement of inter-trial learning; b) training effects, recall performance on training trials one through three, and c) transfer effects, recall performance on the transfer trial, the fourth trial, compared to the training trials.

Initial effects. A number of predictions about the effects of the various experimental conditions (Recall Condition, Cue Type, Mental Age Level) upon recall performance (clustering and number of items recalled) during the first training trial were made:

1. The presence of recall cues at presentation followed by standard free recall instructions would result in increased categorized organization of recalled items and increased amount recalled compared to non-cued controls (i.e., Recall Condition: Free Recall vs Controls).

2. The use of a directive cuing procedure would produce more organization and better recall than would the free recall method

(i.e., Recall Condition: Directive Cuing vs Free Recall).

3. With respect to the type of recall cues used, the utilization of verbal, pictorial or three-dimensional cues would result in increasing amounts of clustering of recalled items and number of items recalled, progressing in that order (i.e., Cue Type: Verbal vs Picture vs Object).

4. Regarding the mental age of the subjects, it was predicted that in general, subjects of higher mental age would evidence more organization and larger amounts recalled than those of lower mental age. Specifically, it was hypothesized that the higher mental age subjects would be influenced, with respect to categorical organization and amount recalled, more by experimental manipulation, than would subjects of lower mental age (i.e., Mental Age Level: High vs Low/ Recall Condition X Mental Age Level interaction).

Training effect. A general training effect, measured as increasing recall performance (clustering and number of items recalled) across the three training trials was predicted. The relative positions of the various experimental groups would remain as they were on the first training trial.

Transfer of training. It was hypothesized that the positive effects of the experimental manipulations, the presence of recall cues at storage and the use of a directive cuing procedure at retrieval, during the three training trials, would be transferred to the fourth trial in which no cues or special recall instructions would be given. That is, all experimental subjects would recall, (clustering and number of items recalled), at a level at least equal to their performance on the first training trial and superior to that of the control group on the transfer trial.

CHAPTER II

METHOD

Subjects

The subjects were 112 trainable mentally retarded students ranging in age from 60 to 252 months. Half of the subjects were from a rural school and the other half from an urban school. Both schools were nonresidential.

Screening. Subjects were selected at random from the registers of the two schools, with the provision that each subject had to be able to recall a minimum of four items from a 4 X 4 matrix of 16 unrelated picture items called the Basic Recall Ability Test (BRAT, see Herriot, Green & McConkey, 1973), and be able to name all recall items to be used in the experimental task. Two of the 112 subjects originally selected had to be replaced, because they were absent due to illness at the time of the experimental sessions.

Assignment to treatment groups. Grouping was done separately within each school, using identical procedures. The sample was first divided into two groups on the basis of mental age, as measured by the Peabody Picture Vocabulary Test (PPVT, see Dunn, 1965). The 56 subjects from each school were divided into high and low mental age groups using the median mental age score. Then within each school, the 28 subjects from each mental age group were further divided into seven groups of four subjects each. Due to the large number of small groups, matching was done on the basis of mean mental age. That is, within each of the two mental age groups, random combinations of four subjects each were compared for mean mental age, until seven groups with relatively equivalent mean mental ages were established. An attempt was made to keep subjects from the same classroom from being in the same group. Next the groups were matched for mean basic recall ability, as measured by the BRAT, by shifting subjects of equal mental age from one group to another, until the mean BRAT scores for all seven groups within the two mental age levels were equivalent.

Thus within each school, the 56 subjects were divided into high and low mental age groups, and then, each mental age group was subdivided into seven groups of four subjects each. The groups were matched first for mean mental age, and second for mean BRAT scores. The seven groups from each mental age level in each school were then randomly assigned to one of seven treatments (Directive Cuing-Object, -Picture, -Verbal; Free Recall-Object, -Picture, -Verbal; Control), using a table of random numbers (D'Amato, 1970).

Equivalence of group characteristics. A breakdown of the mean mental age, mean chronological age and mean BRAT score for each of the different subject groups is presented in Table 1.

Those three characteristics of the 28 sub-groups of subjects were compared using three separate orthogonal analyses of variance (Nie, Hull, Jenkins, Steinbrenner & Bent, 1975). A 7 (Treatment) X 2 (Mental Age Level) X 2 (School) design was used. The summaries of

TABLE 1

Group Means and Standard Deviations (SD) for Mental Age (MA), Chronological Age (CA), and BRAT Scores

Group	N	MA	CA	BRAT
Directive				
Total	48	78.23 (21.3)	174.5 (44.3)	6.60 (2.1)
High MA	24	95.33 (14.8)	192.2 (38.9)	6.92 (2.2)
Low MA	24	61.13 (9.9)	156.8 (42.8)	6.29 (2.0)
Object	16	78.31 (21.7)	191.7 (39.9)	6.63 (2.0)
Picture	16	78.19 (21.4)	158.1 (51.2)	6.50 (2.4)
Verbal	16	78.19 (22.2)	173.6 (36.4)	6.69 (2.1)
Free Recall				
Total	48	78.19 (21.7)	171.7 (42.1)	6.44 (1.9)
High MA	24	95.38 (15.2)	189.1 (37.3)	6.79 (1.8)
Low MA	24	61.00 (10.7)	154.0 (29.6)	6.08 (1.9)
Object	16	78.38 (21.4)	166.1 (37.8)	6.44 (2.3)
Picture	16	78.06 (22.4)	169.2 (42.1)	6.44 (1.5)
Verbal	16	78.13 (22.7)	179.8 (47.3)	6.44 (2.0)

(Continued...)

TABLE 1 -Continued

Group	N	MA	CA	BRAT
Control				
Total	16	78.00 (20.6)	184.8 (51.5)	6.69 (1.4)
High MA	8	95.00 (12.9)	206.3 (47.6)	6.88 (1.1)
Low MA	8	61.00 (9.5)	163.3 (48.7)	6.50 (1.7)
Cues				
Object	32	78.34 (21.2)	178.9 (40.4)	6.53 (2.1)
Picture	32	78.13 (21.5)	163.7 (46.4)	6.47 (2.0)
Verbal	32	78.16 (22.1)	176.7 (41.7)	6.56 (2.0)
Mental Age				
High MA	56	95.30 (14.5)	192.9 (39.2)	6.86 (1.9)
Low MA	56	61.05 (10.0)	156.6 (41.8)	6.23 (1.9)
School				
Urban				
High	28	100.39 (15.0)	192.8 (35.7)	6.32 (1.6)
Low	28	59.86 (11.0)	162.3 (41.9)	5.71 (1.5)
Rural				
High	28	90.21 (12.1)	192.9 (43.0)	7.39 (2.1)
Low	28	62.25 (9.0)	151.0 (41.7)	6.75 (2.1)

those analyses are contained in Tables 2, 3 and 4 in Appendix B.

Mental age. The mean mental ages of the six experimental groups (Directive-Object, -Picture, -Verbal; Free Recall-Object, Picture, -Verbal) and the Control did not differ significantly, nor were the mean mental ages of the two schools different. As expected, the mean mental age of the High Mental Age group was significantly higher than that of the Low Mental Age group, F (1,84) = 178.01, $p < .001$. It was also found that the difference between the High and Low mental age groups in the urban school was significantly greater than that of the rural school (i.e., Mental Age Level X School interaction), F (1,84) = 6.00, $p = .016$.

Chronological age. Similarly, the seven treatment groups did not differ significantly with respect to chronological age, nor did the two school groups differ. There was a significant difference between the mental age groups, with those subjects of higher mental age being older than those of lower mental age, F (1,84) = 21.01, $p < .001$.

Basic recall ability. With respect to the BRAT scores, the only significant difference was found between the two schools, F (1,84) = 7.15, $p = .009$. The BRAT scores of the rural school subjects were significantly higher than those of the urban group. It was learned that many of the teachers in the rural school had recently put emphasis upon improving the basic recall of their students. No one consistent method of teaching the skill of remembering was used, though the lessons appear to have been beneficial. All of the treatment groups and the two mental age groups were equivalent with respect to BRAT scores.

Sex and Down's syndrome. The groups had been matched also with respect to two other characteristics, sex and the presence of Down's syndrome (see Table 5 in Appendix B). A series of Chi square comparisons (Nie et al., 1975) of the frequency of male versus female, and Down's versus non-Down's subjects in each subject grouping was done.

The 52 male and 60 female subjects were evenly distributed among the seven treatment groups, as well as between the two mental age levels and the two schools. In fact, the two sexes were equally represented in every possible grouping, even in the Down's and non-Down's groups.

Each of the seven treatment groups had equivalent numbers of Down's syndrome subjects. The Chi square comparing the distribution of the 28 Down's syndrome children between the High and Low mental age levels was significant, $p = .0011$. There were fewer Down's syndrome pupils in the High group than among those of lower mental age. There was also a significant school difference, $p = .05$, with the syndrome being more prevalent among the urban school subjects. Due to the large number of subjects required and the limited number available, those differences were beyond the control of the selection procedure.

Thus, the six treatment groups (Directive Cuing-Object, -Picture, -Verbal; Free Recall-Object, -Picture, -Verbal) and the Control group were equivalent with respect to mean mental age, chronological age and basic recall ability, as well as sex and the presence of Down's syndrome. The higher mental age subjects were older and fewer had Down's syndrome than those of lower mental age, though the two groups were equivalent with respect to basic recall ability. The urban school had a larger difference between High and Low mental age groups, had lower BRAT scores and more Down's syndrome pupils than the rural school.

Materials

The test booklet and manual for the PPVT (Dunn, 1965) and the answer sheets for forms "a" and "b" were used. The alternate forms were used because testing had been done in the schools earlier in the year with the PPVT.

A 4 X 4 matrix display of basic recall ability test items, each represented by a laminated coloured drawing (9.5 X 10 cm), evenly spaced on a laminated sheet of yellow bristle board (45 X 47 cm) was used, with items arranged in the following order:

Chair	Comb	Clock	Candle
Pencil	Ring	Slide	Flower
Broom	Saw	Pipe	Spoon
Cow	Boat	Book	Key

The items were taken from Herriot, Green and McConkey (1973) except for the two items: "slide" and "key", which replaced the items "gun" and "kettle" from Herriot et al. due to the difficulty encountered in obtaining those two pictures to complete the set.

The 16 items for the BRAT, as used in the present study, are presented in Figure 1.

A similar set of coloured drawings was used in the experimental task, displayed on the same sheet of yellow bristle board. The 16 to-be-remembered items, four from each of four categories, for the recall task were:

VEHICLES	- bus, car, truck, motorcycle
ANIMALS	- cat, dog, rabbit, horse
TOYS	- doll, kite, drum, ball
FRUIT	- apple, orange, pear, banana

The items and categories were used previously and found to be effective with mentally retarded subjects in a series of experiments reported by Herriot, Green and McConkey (1973). See Figure 2 for details.

As category cues, a set of four cue cards (9.5 X 10 cm) with coloured drawings representing each category were used as pictorial cues. Four objects, not over 30 cm on any one dimension, were used as three-dimensional cues for each of the four categories. The pictures and objects used as cues, and the categories they represented were as follows:

FRUIT BASKET	- fruit
TOY BOX	- toys
BARN	- animals
PAVED ROAD	- vehicles

All but two of the picture cards used as to-be-remembered items and cues were taken from the picture card sets published by the

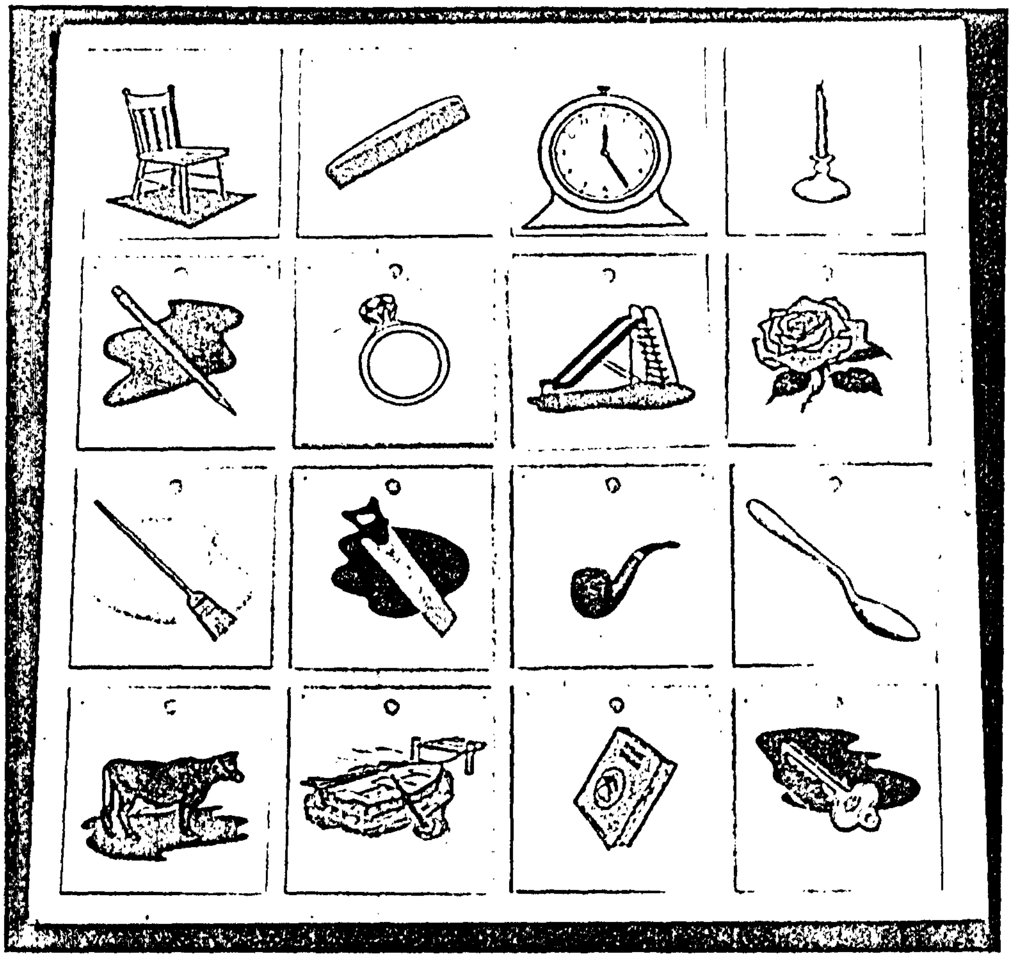

Figure 1 Basic recall ability test (BRAT) picture items.

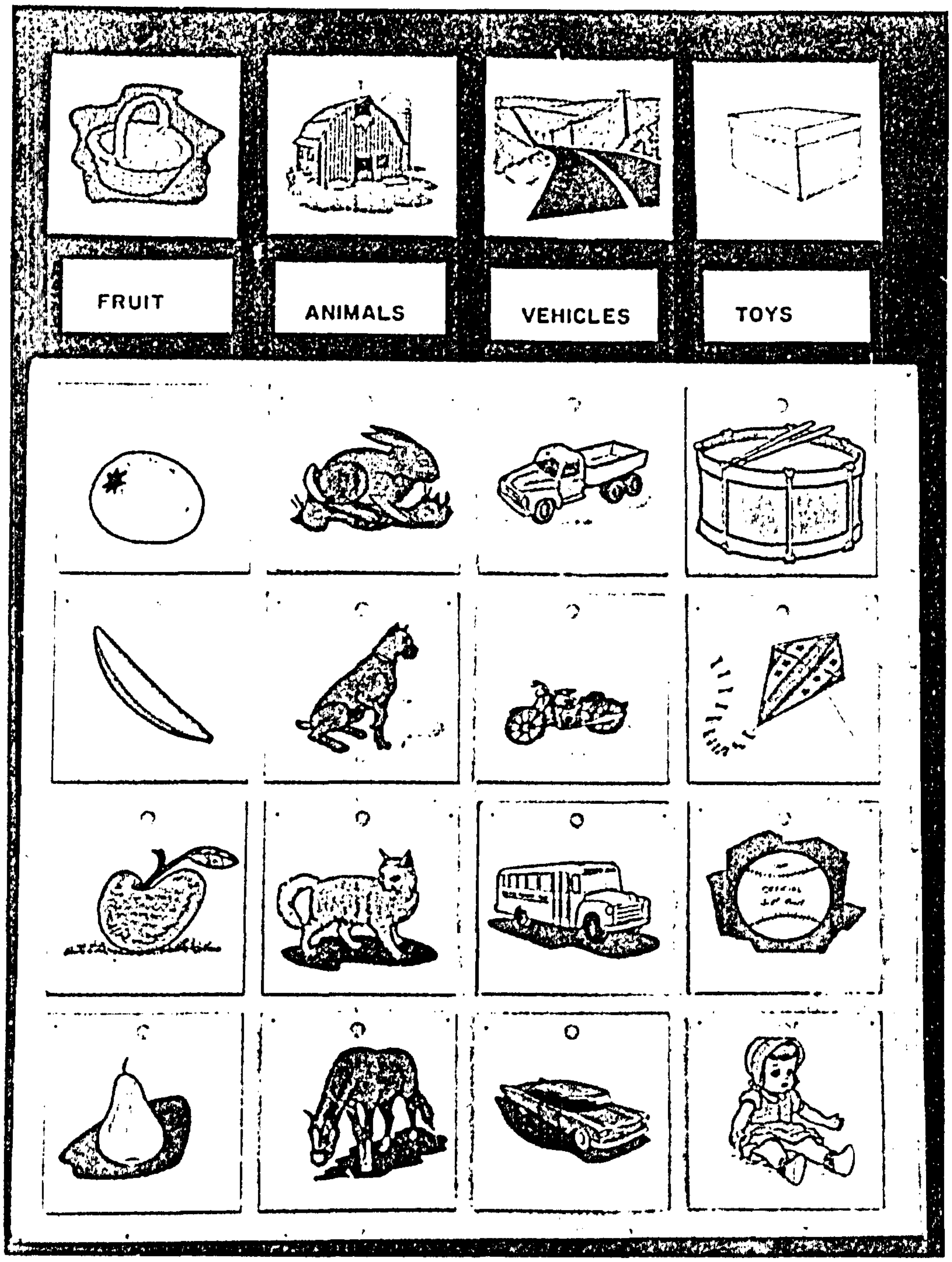

Figure 2 Recall task picture items and category labels.

Ideal School Supply Company, Illinois. The picture items, "orange" and "motorcycle" were drawn by the author, in a format as similar to that of the published set as possible. The object cues used were either individually bought (the barn and fruit basket) or constructed by the author to suit the purposes of the present study.

All time intervals were measured with a Cronus electronic stopwatch, Model 3-S.

A small, quiet, well lighted room with table and chairs was used as the experimental room in both schools.

Procedure

Once all subjects had been screened and grouped, each subject was run individually under one of the six experimental treatment conditions or as a control. The setting was the same for each subject. Subjects were taken individually from their classrooms and seated at a small table beside the experimenter. On the table, the subjects could see the yellow bristle board directly in front of them. For subjects receiving object or picture cues, the four category cues were arranged in a semicircle around the top of the yellow board, across from the subject (see Figures 3 & 4). The experimenter held the deck of picture cards in her hand, setting them down, one at a time, on the yellow sheet of bristle board. Those receiving either verbal cues or no cues at all, saw only the yellow bristle board and the 16 to-be-remembered picture items on it.

The procedure consisted of an introduction and review of the names of the to-be-remembered items, followed by four recall trials, each with a presentation and a recall test. All subjects went through

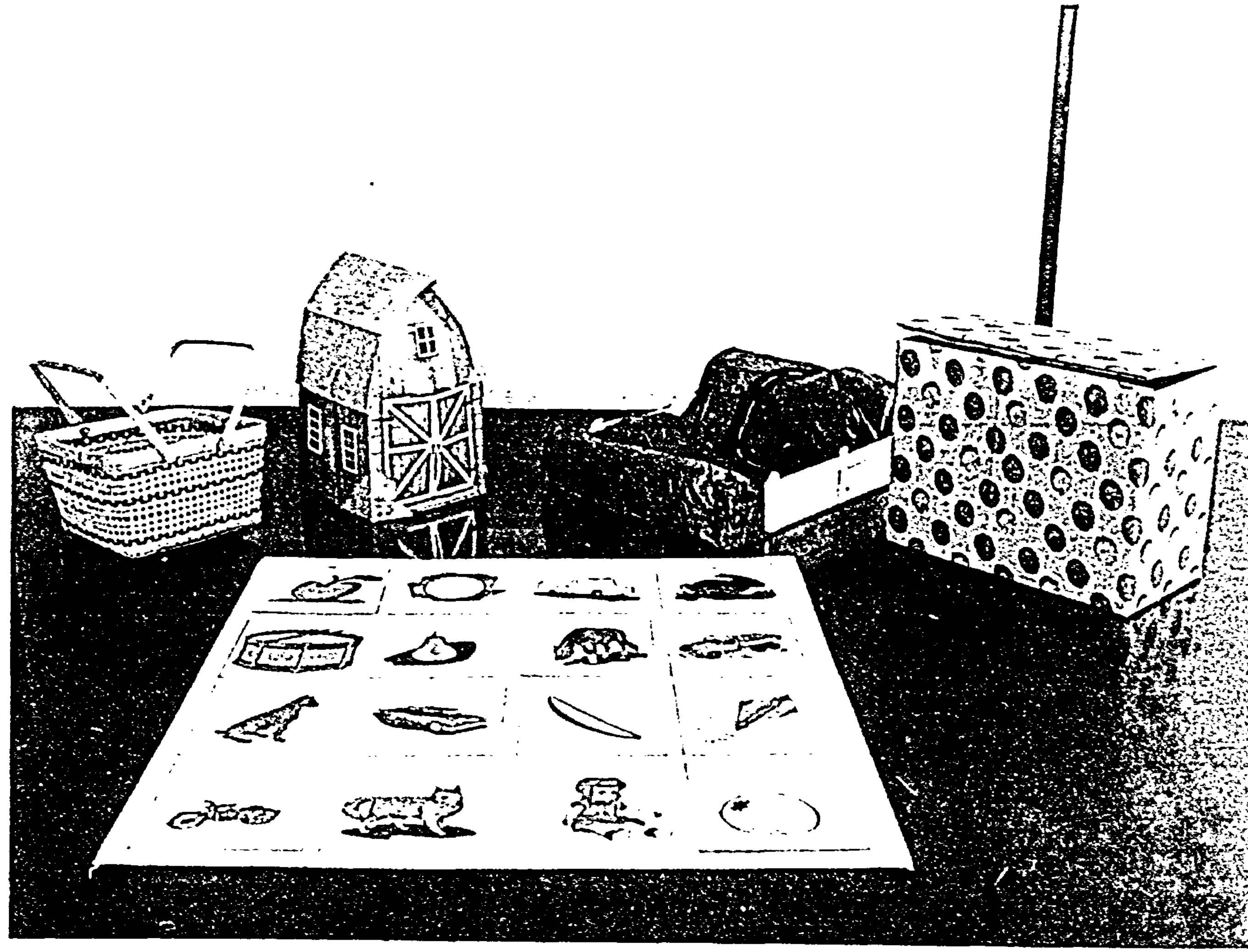

Figure 3 Recall task presentation for groups receiving object cues.

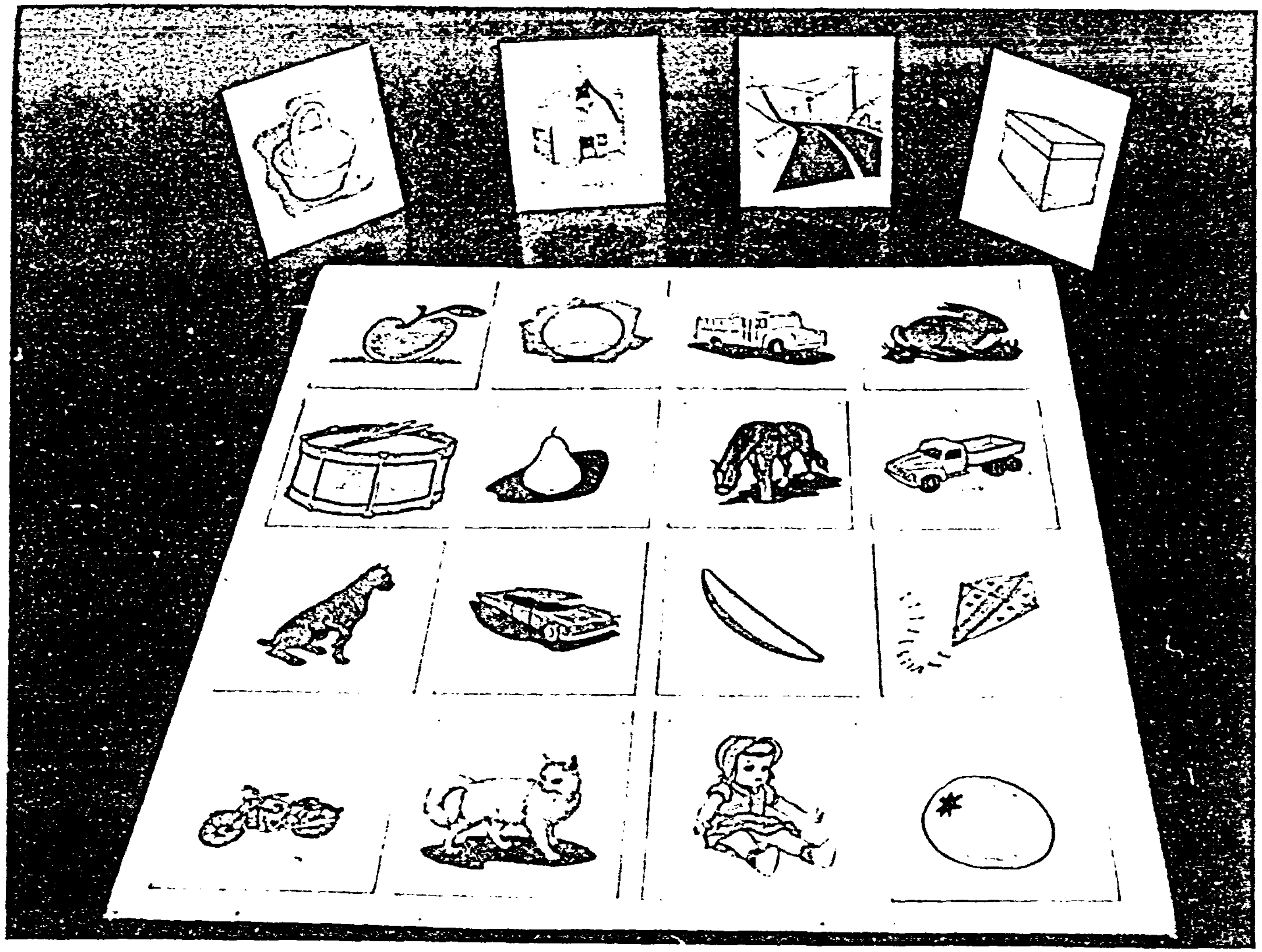

Figure 4 Recall task presentation for groups receiving picture cues.

the same sequence of activities, differing only in the presence or absence of cues at presentation and/or recall, and the type of cues and cuing used. The procedure and instructions in general for all groups were as follows, with specific differences between groups as noted:

Introduction. To all subjects:

> We are going to play a memory game, you have to remember the names of some pictures I am going to show you. Look carefully at each picture. I am going to take the pictures away and I will ask you tell me their names. Remember to look carefully at each picture and remember its name.

Naming. Prior to the first trial, each subject was required to name each item. The items were presented individually and in random order. The naming procedure took 32 sec., with subjects allowed approximately 2 sec. per item. All subjects received the naming procedure under identical conditions.

Training. Each of the three training trials consisted of a 90 sec. presentation followed immediately by a 90 sec. recall test. The items were displayed simultaneously in a 4 X 4 matrix on the yellow bristle board. They were arranged such that no two items from the same category were in the same column or row on any one trial. No two items were adjacent to one another on any two consecutive trials. Finally, the same item did not occupy the same position within the matrix on any two trials.

The presentation was experimenter-paced, with subjects being required to name the items at a rate of 5 sec. per item. The experimenter pointed to the recall items in a left to right, top to bottom fashion, with all subjects on all trials. For the experimental subjects (Directive Cuing & Free Fecall), receiving either object or picture cues, the experimenter first pointed to the individual to-be-remembered item and, when the subject had named that item, the experimenter then pointed to the appropriate cue and cued the subject. The verbal instructions during the presentation were as follows:

a) Control subjects:

> Look carefully at each picture. Remember each picture and remember its name. What is the name of this picture? ... Yes, it's a horse, and this one? ... Yes, it's a car, and this one? ... Yes, it's a ball, and this one? ..., ...

b) All experimental subjects:

> Look carefully at each picture. Remember each picture and remember its name. What is the name of this picture? ... Yes, in the barn (pointing to the barn) we find a horse, and this one? ... Yes, on the road (pointing to the road) we find a car, and this one? ..., ...

Thus for the Directive Cuing and Free Recall subjects, the to-be-remembered items were individually associated with their respective category cues. For subjects receiving either object or picture cues, the cues were associated with their respective recall items by the experimenter first pointing to the recall item and the subject naming it, then the experimenter pointing to the cue and relating the cue to the item to be remembered. Those subjects receiving verbal cues were cued in the same manner, except that the experimenter had no cues to point to.

Immediately after each presentation, a recall test was begun. Timing began with the subject's first recall response and continued for 90 sec. The 16 recall items were cleared from the table for all subjects. For the Directive Cuing subjects, the category cues were left in place, while all cues were put out of sight during the recall test for the Free Recall subjects. The subjects were instructed as follows:

a) Control and Free Recall subjects:

> Now, (subject's name), try to remember all the pictures you saw. Tell me their names, what did you see in the pictures? ... (after any pause of 10 sec. or more, the subject was prompted to try to recall more items) ... You are doing well, can you remember any more pictures? ...

b) Directive Cuing subjects:

> Now, (subject's name), look at these (pointing to the object or picture cues, or stating,"Think of the barn, the fruit basket, the road and the toy box ..." as verbal cues). Remember the pictures that go together. In the barn we find? ... (10

sec.) ... In the toy box we find? ... (10 sec.) ... On the road we find? ... (10 sec.) ... In the fruit basket we find? ... (10 sec.) ... Very good, can you remember any more pictures?

The order of cuing was counterbalanced within subjects using a random counterbalancing procedure, such that each cue preceded and followed a different cue on each of the three training trials.

Transfer. On the fourth trial, the presentation and recall phases were the same for all subjects. Recall items were presented for 90 sec., with subjects naming them at a rate of 5 sec. per item, and then tested for recall. No cues or cuing were present at either presentation or recall for any subject. In other words, all subjects were treated in a manner identical to that of the Control group.

CHAPTER III

RESULTS

The effects of the major factors (Recall Condition, Cue Type and Mental Age Level) on recall performance was analysed for two dependent variables (Clustering of recalled items and Number of items recalled). Three comparisons were made: a) initial effects (performance on first training trial); b) training effects (performance across three training trials), and c) transfer of training (performance on a transfer trial versus the training trials). For each comparison, the data of the experiomental subjects were analysed first and then a second analysis, with the control subjects included was performed. This was necessitated by the statistical complications of the empty cells in a factorial design with a single control group (Winer, 1971).

For the experimental groups, the analysis of the clustering data was a 2 (Recall Conditon) X 3 (Cue Type) X 2 (Mental Age Level) X 2 (Schools) orthogonal analysis of variance (M.B. Brown, 1977; Nie, Hull, Jenkins, Steinbrenner & Bent, 1975) with repeated measures on a fifth factor (Trials) for the (b) and (c) comparisons. Schools was included as a factor, since the subjects were obtained from two somewhat different schools (Urban vs Rural).

The analysis of the number of items recalled by the exeperimental groups was similar to that for the first dependent variable (2 X 3 X 2 X 2) except that an analysis of covariance (M.B. Brown, 1977; Nie et al., 1975) was used with Basic Recall Ability Test (BRAT) scores as a covariate, and repeated measures on a fifth factor (Trials) for the (b) and (c) comparisons. The BRAT scores correlated significantly with the number of items recalled on the first training trial, $r = 0.3439$, $p = .001$. The BRAT scores were used as a covariate in the analysis of the second dependent variable, number of items recalled, in an attempt to take into account differences in performance related to schools and basic recall ability (see Subjects section above). The BRAT scores did not correlate with the clustering measure on the first training trial, $r = 0.05333$, $p = .288$, so no covariate was used in the analysis of the clustering data.

In comparing the performance of the experimental group with that of the control subjects, the experimental group was partitioned orthogonally along the Recall Condition factor. That is, data for the Control subjects were compared first with those of the Directive Cuing group and then with the Free Recall group. Two separate 4 (Cuing Condition) X 2 (Mental Age Level) X 2 (Schools) analyses of variance were used, with repeated measures on a fourth factor (Trials) and BRAT scores as covariate with the second dependent variable, as described above. The four levels of the Cuing Condition factor were the three types of cues used (Object, Picture, Verbal) and no cues (Control). The decision to use two separate analyses to compare the experimental and control subjects was made since that method allowed the Control group to fit conveniently into the design and a complete analysis of treatment effects, without collapsing across any of the factors.

Clustering Measure

The major purpose of the present study was to investigate factors that determine the extent to which mentally retarded subjects utilize the categorization strategy in recalling categorizable material. Strategy use, amount of clustering, was measured through the computation of an Adjusted Ratio of Clustering (ARC) score (Roenker, Thompson & Brown, 1971). The ARC has been used by a number of experimenters (e.g., Bilsky, 1976; Burger, Blackman & Tan, 1980; Glidden, 1976; Glidden et al., 1979; Green, 1974; Herriot, 1972a; Lathey, 1979; McConkey & Green, 1973; McConkey & Herriot, 1974) researching the variables influencing the use of the categorization strategy by retarded persons. Various other methods of detecting and analysing the presence of clustering in the free recall of categorizable items have been described in Appendix C.

The ARC compares the observed and expected number of category repetitions, taking into account the number of items and categories recalled, and the maximum number of category repetitions:

$$1)\quad E(R) = \frac{\lfloor n_i \rfloor^2}{N} - 1$$

$$2)\quad maxR = N - k$$

$$3)\quad ARC = \frac{R - E(R)}{maxR - E(R)}$$

$E(R)$ = expected number of category repetitions

n_i = number of items recalled in category "i"

N = total number of items recalled

K = number of categories recalled

$maxR$ = maximum possible number of category repetitions

R = total number of observed category repetitions

The ARC scores can be expressed as a percentage, with 100% representing perfect clustering and zero standing for clustering at the chance level. Negative ARC scores specify clustering at a level below that expected by chance.

Clustering of Recalled Items

Initial effects. The clustering of items recalled on the first training trial is presented graphically as a function of Recall Condition and Cue Type in Figure 5. The analysis of variance of the ARC scores of the experimental subjects on the first trial produced

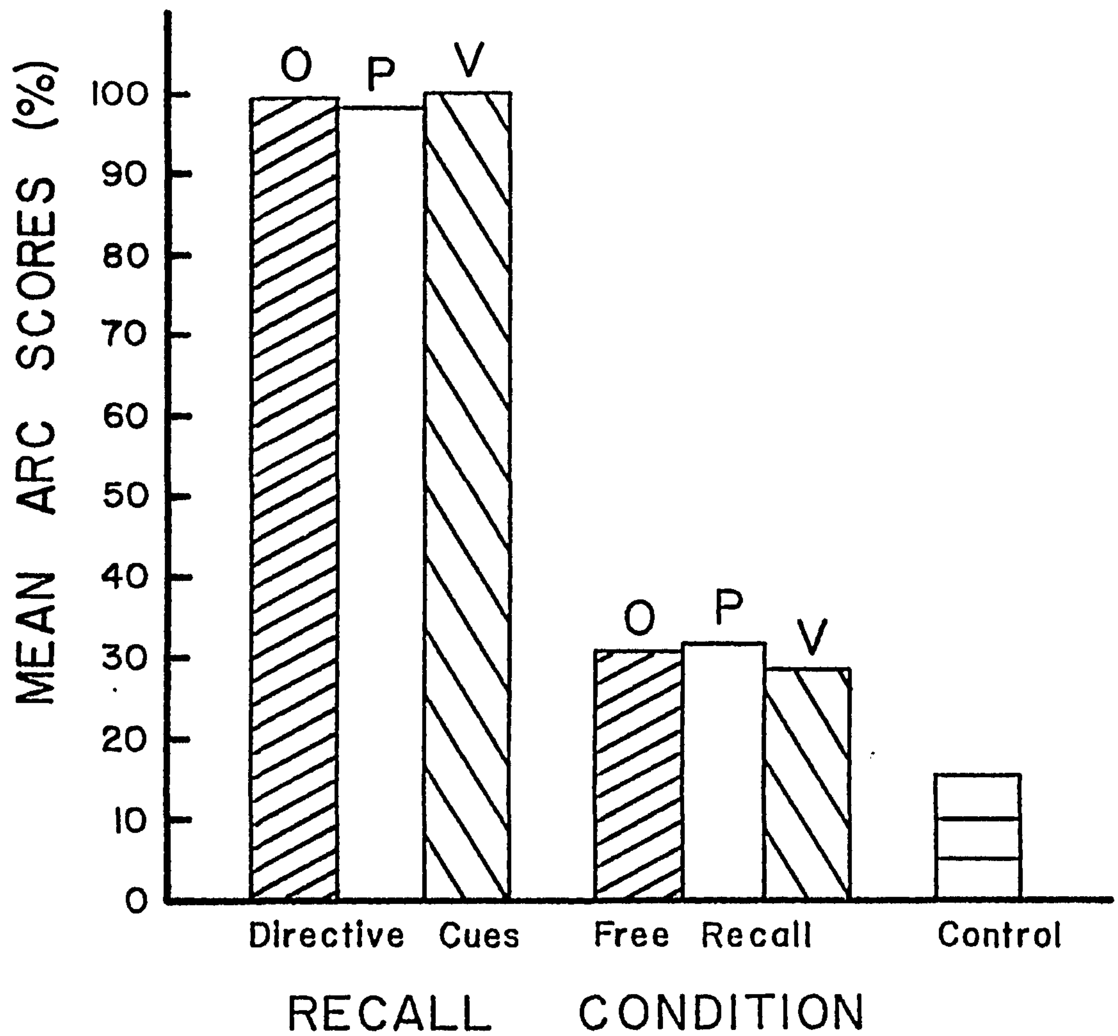

Figure 5 Mean ARC scores on the first training trial for all subjects as a function of Recall Condition and Cue Type.

a single main effect (Recall Condition, $\underline{F}$ (1,72) = 80.81, $\underline{p}$ < .001, see Table 6). As can be seen in Figure 5, subjects receiving directive cuing had significantly greater ARC scores than the Free Recall group. The same figure reveals the similarity in scores across types of cues. The mean for the Directive Cuing group was 99.25%, very near the maximum score of 100%, compared to 30.16% for the Free Recall subjects.

The Control group had a mean clustering score of 15.65%. When those data were analysed along with the results of the experimental groups (see Tables 7 & 8), the mean ARC score for the Controls was significantly smaller than that of the Directive Cuing group, $\underline{t}$ (48) = 10.55, $\underline{p}$ < .01, using the Dunnett test (Winer, 1971) for comparing all means with a control group. But, as can be seen in Table 8, there were no significant differences among the Free Recall sub-groups (Object, Picture, Verbal) and the Controls with respect to the ARC scores on the first training trial.

Regárding the hypothesis of the present study, clustering of items in recall after the initial trial was shown to be affected by only one factor, Recall Condition. Specifically, subjects given recall cues during storage (Free Recall) did not use the categorization strategy at recall more than subjects who received no recall cues (Controls). Finally, subjects who had recall cues available during both retrieval and storage, and were instructed to use them in recalling items in categories (Directive Cuing) showed near perfect clustering, significantly above the other two groups. The types of cues used and the subjects' mental age levels did not

TABLE 6

Analysis of Variance of ARC Scores for the Experimental Groups on Trial One

Source	*df*	*MS*	*F*
Recall Condition (R)	1	11.46	80.81 *
Cue Type (C)	2	0.00	0.00
Mental Age Level (M)	1	0.02	0.14
School (S)	1	0.00	0.02
R X C	2	0.00	0.03
R X M	1	0.01	0.03
R X S	1	0.00	0.01
C X M	2	0.08	0.56
C X S	2	0.01	0.04
M X S	1	0.29	2.07
R X C X M	2	0.10	0.71
R X C X S	2	0.01	0.09
R X M X S	1	0.38	2.68
C X M X S	2	0.01	0.08
R X C X M X S	2	0.02	0.14
Error	72	0.14	

* $p < .001$

TABLE 7

Analysis of Variance of ARC Scores for the Directive Cuing and Control Groups on Trial One

Source	df	MS	F
Cue Condition (C)	3	2.80	41.58 *
Mental Age Level (M)	1	0.20	0.24
School (S)	1	0.03	0.39
C X M	3	0.01	0.07
C X S	3	0.05	0.75
M X S	1	0.03	0.37
C X M X S	3	0.01	0.15
Error	48	0.07	

* $p < .001$

TABLE 8

Analysis of Variance of ARC Scores for the Free Recall and Control Groups on Trial One

Source	*df*	*MS*	*F*
Cue Condition (C)	3	0.09	0.31
Mental Age Level (M)	1	0.05	0.16
School (S)	1	0.04	0.14
C X M	3	0.12	0.43
C X S	3	0.06	0.20
M X S	1	0.36	1.28
C X M X S	3	0.14	0.51
Error	48	0.28	

have a significant effect upon the tendency to recall items by category.

Training effects. Over the three training trials, the relative positions of the groups (Directive Cuing, Free Recall, Control) did not change, as can be seen in Figure 6. With respect to the experimental groups, Recall Condition remained the sole significant factor, F (1,72) = 165.68, p < .001, (see Table 9, in Appendix B). No increment in clustering occured over the three training trials, nor was there any effect due to Cue Type or Mental Age Level.

With respect to the Control group, the situation remained the same as during the initial trial. The Free Recall subjects' ARC scores did not differ from those of the Controls, as can be seen in Table 10 in Appendix B. The comparison of the ARC scores of the Directive Cuing group and those of the Controls, over the three training trials, revealed the Directive Cuing scores to still be larger, F (3,48) = 72.83, p < .001 (see Table 11 in Appendix B). Two higher-order interactions became significant with the comparison of the Directive Cuing group and the Controls. The School X Mental Age Level X Trials and the School X Cuing Condition X Mental Age Level X Trials interactions reached significance, F (2,96) = 4.75, p = .011 and F (6,96) = 3.59, p = .003 respectively. The fluctuations in the ARC scores for the Controls from different schools and mental age levels appeared to be the cause of the interactions. This was due probably to some subtle difference between the two schools sampled.

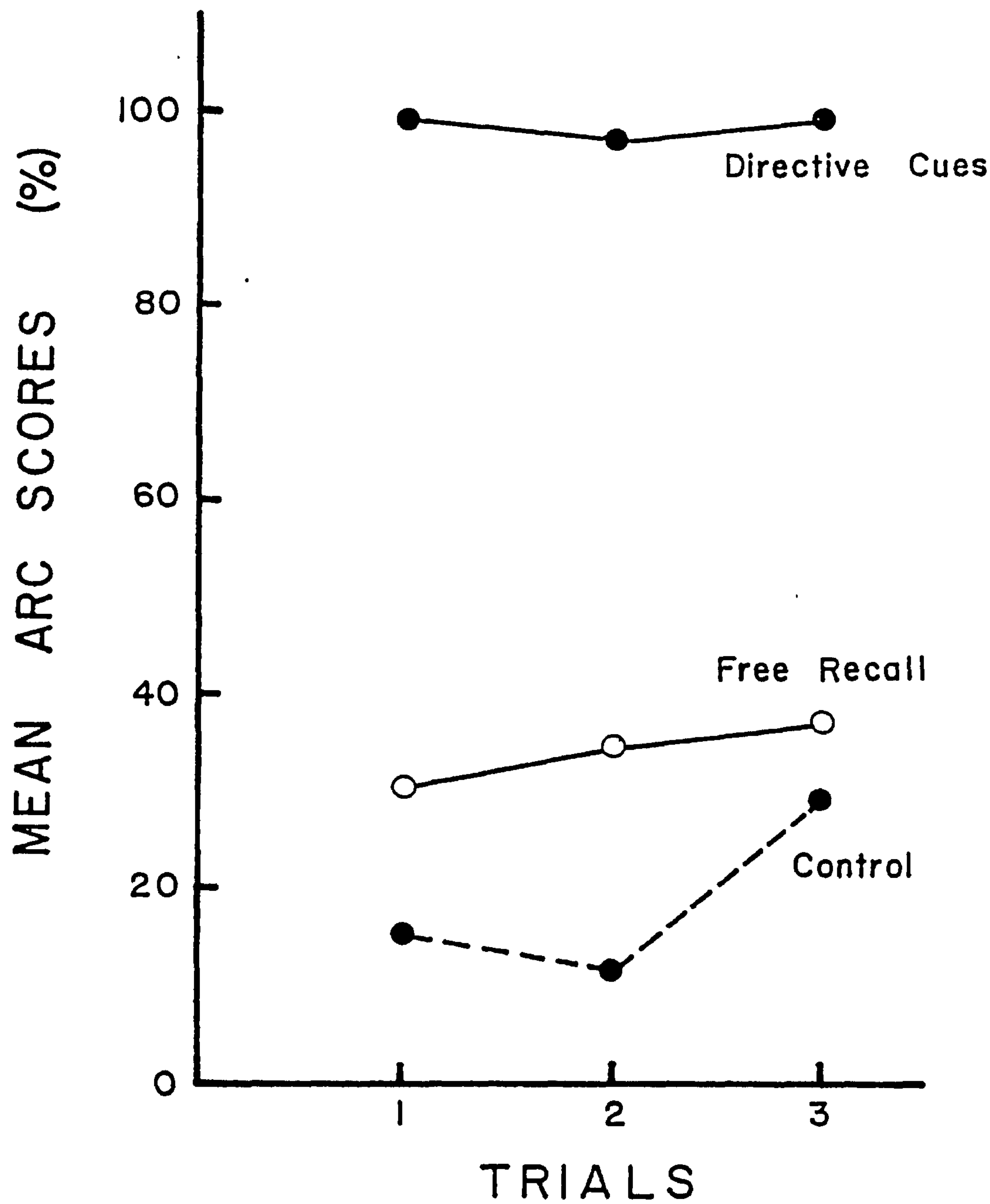

Figure 6. Mean ARC scores on the three training trials for all subjects as a function of Recall Condition.

Thus far, the results suggest that subjects required to recall categorizable material without receiving either category cues or special instructions (Controls) and those exposed to retrieval cues at storage only (Free Recall) did not differ in their tendencies to cluster. Both groups scored lower than the Directive cuing subjects, who were given recall cues at storage and retrieval, as well as receiving instructions to recall by category. No improvement in ARC scores was observed over the three training trials and, neither the subjects' mental age levels nor the types of cues used affected the probability that a group of subjects would use or learn to use the categorization strategy of remembering.

Transfer of training. The ARC scores evidenced significant changes going from the training trials to the transfer trial, as can be seen in Figures 7 and 8. Looking first at the results of the experimental groups on the transfer trial, Recall Condition, Cue Type and Mental Age Level were all significant, F (1,72) = 5.186, p = .019; F (2,72) = 3.213, p = .046; F (1,72) = 5.186, p = .026, respectively (see Table 12). The Directive Cuing group clustered significantly more than the Free Recall subjects on the transfer trial, 59.11% versus 38.28%, respectively. As Figure 9 reveals, the differences between the effects of the three types of cues were more pronounced on the fourth trial, than on the first training trial. The significant main effect of Cue Type indicates that those differences are real. Upon closer inspection, it was observed that the differences among the means for Object, Picture and Verbal cues (58.6%, 54.06%, 33.43%) did not reach statistical

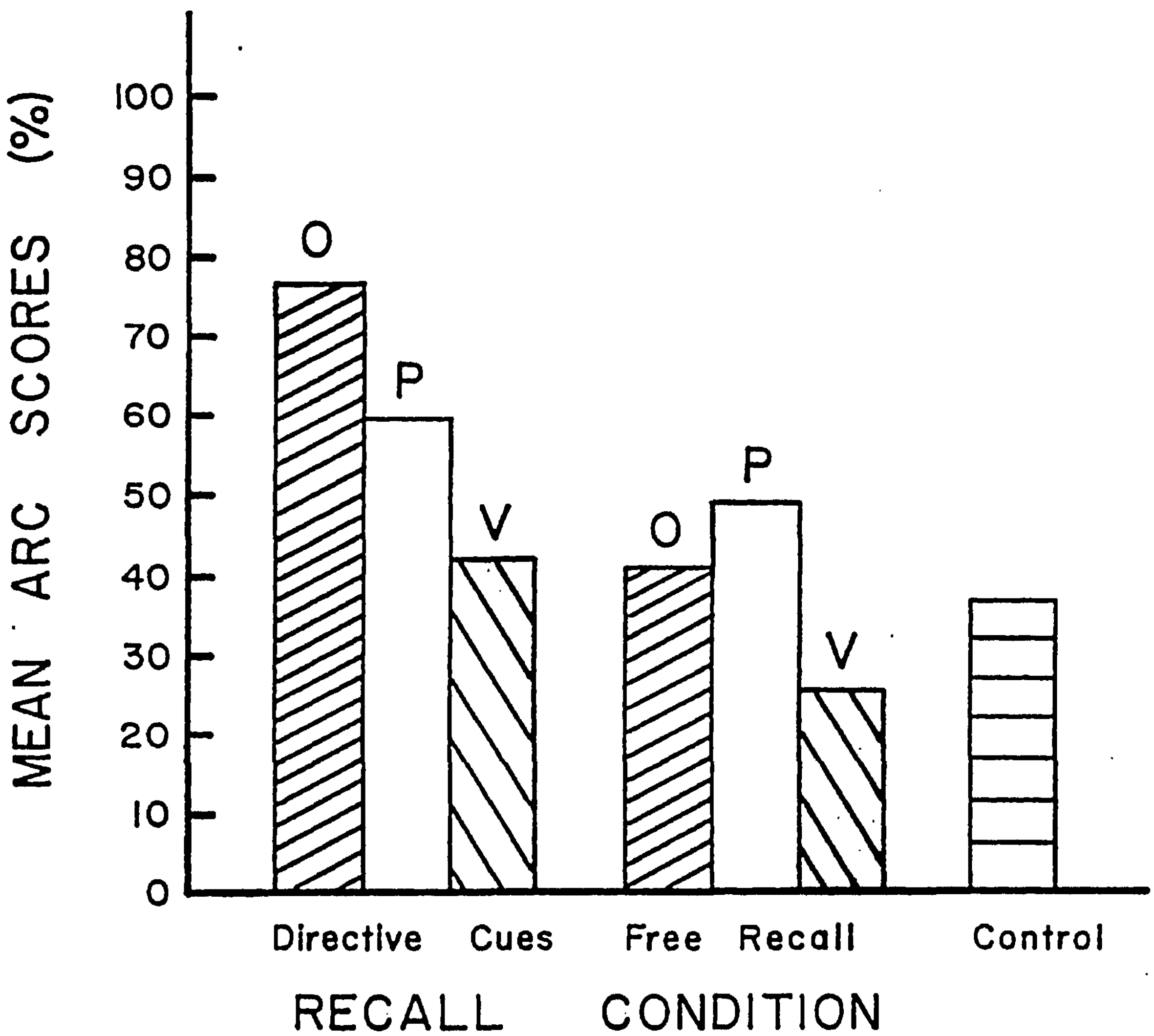

Figure 7. Mean ARC scores on the transfer trial for all subjects as a function of Recall Condition and Cue Type.

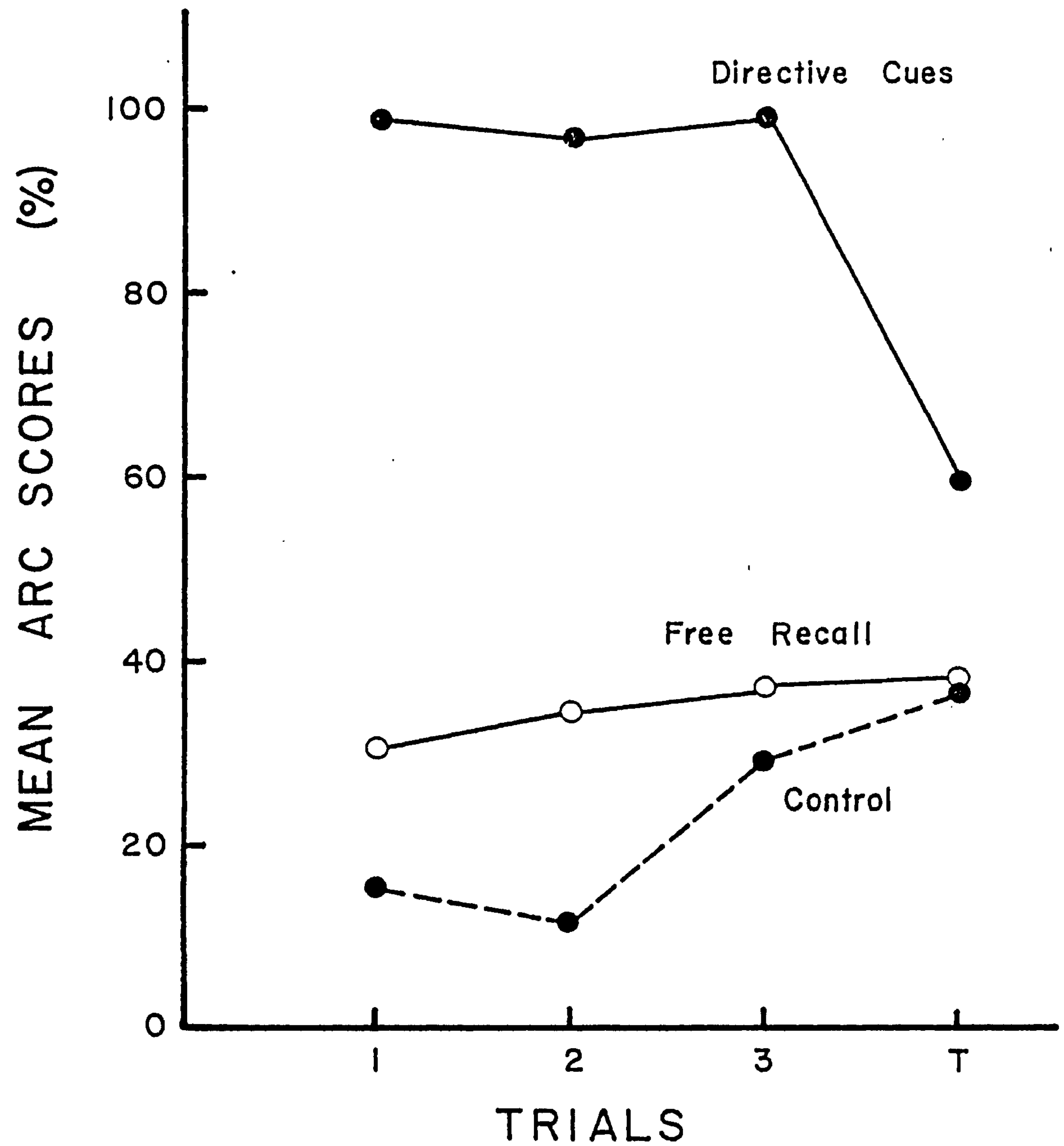

Figure 8. Mean ARC scores on all four trials for all subjects as a function of Recall Condition.

TABLE 12

Analysis of Variance of ARC Scores for the Experimental Groups on the Transfer Trial

Source	df	MS	F
Recall Condition (R)	1	1.04	5.81 *
Cue Type (C)	2	0.58	3.21 *
Mental Age Level (M)	1	0.93	5.19 *
School (S)	1	0.06	0.32
R X C	2	0.14	0.80
R X M	1	0.07	0.38
R X S	1	0.01	0.03
C X M	2	0.16	0.91
C X S	2	0.06	0.31
M X S	1	0.32	1.76
R X C X M	2	0.02	0.11
R X C X S	2	0.02	0.10
R X M X S	1	0.37	2.08
C X M X S	2	0.08	0.44
R X C X M X S	2	0.32	1.76
Error	72	0.18	

* $p < .05$

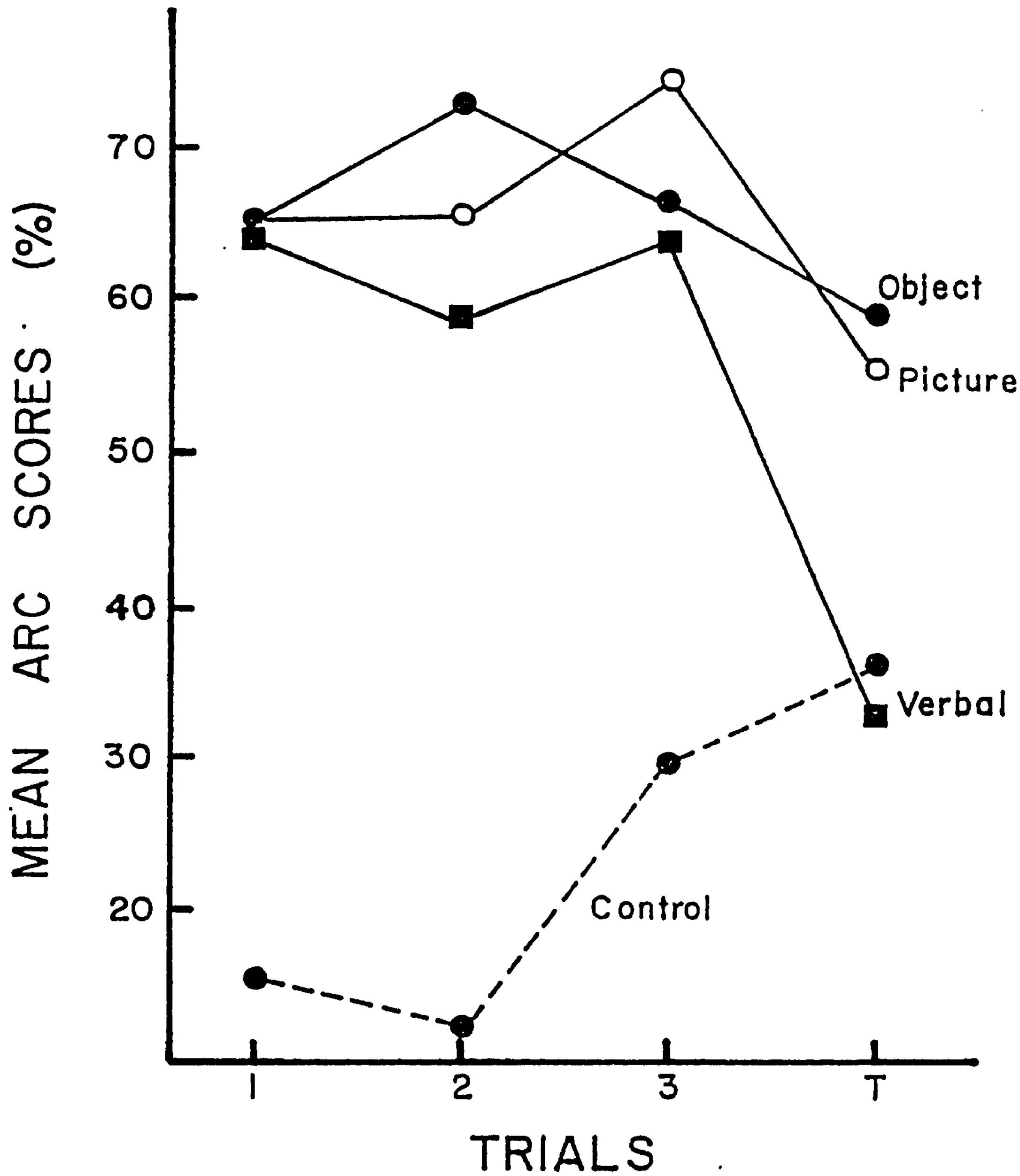

Figure 9. Mean ARC scores on all four trials for the experimental subjects as a function of Cue Type.

significance in a multiple pair-wise comparison using the Tukey hsd test (Winer, 1971), $p > .05$. There was a limited tendency for the type of cues used to have an effect upon clustering on the transfer trial.

The third main effect, Mental Age Level, produced somewhat of a surprising result (see Figure 10). The hypothesis of the present study had predicted differences in clustering performance due to mental age, but not in the direction that was obtained. On the transfer trial, the Low Mental Age subjects clustered to a significantly greater extent than the High group (58.55% vs 38.86%). Since an interaction between Recall Condition and Mental Age Level had been predicted, the Tukey hsd test was used. It was found that the Low Mental Age-Directive Cuing subjects had a mean ARC score that was significantly larger than those of the other three groups (High Mental Age-Directive, High- and Low-Free Recall), $p < .05$.

The data for the three training and one transfer trials for the experimental subjects were examined with a 2 (Recall Condition) X 3 (Cue Type) X 2 (Mental Age Level) X 2 (Schools) X 4 (Trials) analysis of variance (M.B. Brown, 1977), with repeated measures on the Trials factor, in order to compare performance on transfer with the training results (see Table 13, in Appendix B). The Recall Condition and the Trials factors were significant, F (1,72) = 117.09, $p < .001$; F (3,216) = 8.03, $p < .001$, respectively. Significant interactions of the Trials factor with the Recall Condition (F (3,216) = 10.91, $p < .001$) and Mental Age Level

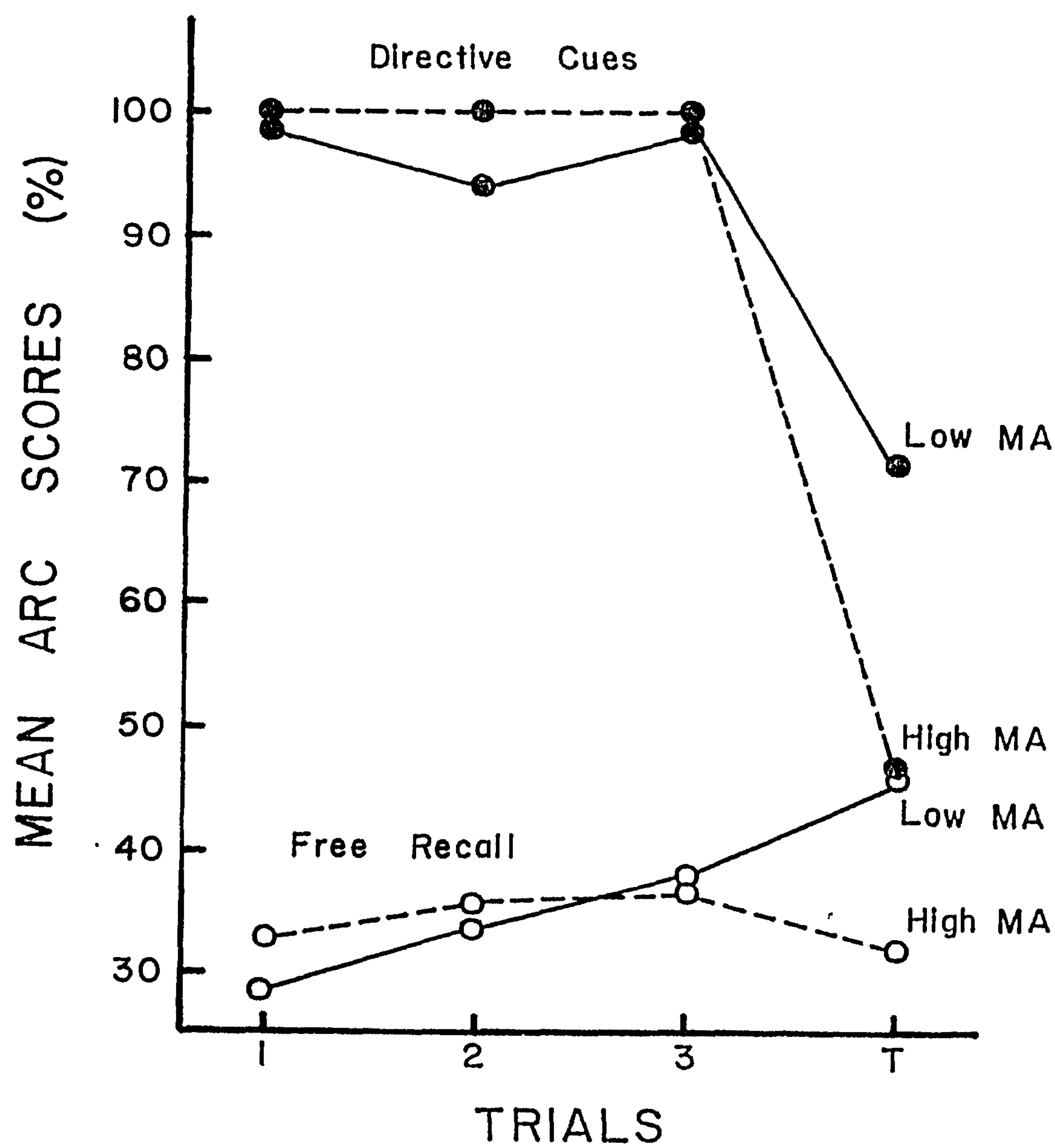

Figure 10. Mean ARC scores on all four trials foı the experimental subjects as a function of Recall Condition and Mental Age Level.

(F (3,216) = 2.70, p = .047) factors were also obtained. The examination of the interactions revealed that the differences among the experimental groups were in going from the training situation to the transfer condition.

The results of the Tukey hsd tests (Winer, 1971) on the Recall Condition X Trials interaction showed the transfer trial ARC scores of the Directive Cuing group were significantly lower than on any of the three training trials, ps < .01, while the clustering scores of the Free Recall subjects did not change significantly from the initial training trial through to the transfer trial.

With respect to the Mental Age Level X Trials interaction, the ARC scores of the higher mental age subjects dropped significantly in transfer, compared to each of the training trials (Tukey hsd, ps < .01). The clustering performance of the Low Mental Age group did not differ over the four trials.

In comparing the performance of the Controls and the experimental subjects (see Tables 14 & 15 in Appendix B) with the Dunnett test (Winer, 1971), it was found that the Directive Cuing group's mean ARC score was significantly greater than that of the Controls, t (48) = 2.06, p < .05. The Dunnett multiple comparison of the different cue groups for the Directive Cuing condition showed the Object Cue group to have a mean ARC score (76.55%) significantly greater than that of the Controls (36.02%), t (48) = 2.95, p < .01. The Picture and Verbal Cue groups did not differ from the Control subjects, with respect to ARC scores on the transfer trial.

The comparison of the Controls and the three cue types in the Free Recall group revealed no significant differences on the transfer trial.

Summary of clustering results. In conclusion, the analyses of the initial effects and subsequent training effects over the first three trials demonstrated that mentally retarded individuals require assistance in initiating and applying the categorization strategy in recalling categorizable picture items from a randomized presentation. With no assistance, they demonstrated clustering at an average level of 18.99%. Exposing the subjects to retrieval cues during storage and giving them standard non-cued free recall instructions resulted in a somewhat larger, though not statistically significantly so, average clustering score of 33.79%. Those subjects receiving the assistance of retrieval cues at both storage and recall, as well as instructions to recall by category during the retrieval stage, produced an average clustering score of 98.47% over the three training trials, significantly higher than that of the other subject groups. It was also noted that the types of cues used and the mental ages of the subjects did not have any significant effect upon their tendency to use the categorization strategy, nor did the amount of clustering change significantly over the three training trials.

The situation became more complex on the transfer trial with significant drops in ARC scores and the emergence of Mental Age Level and Cue Type as significant factors. Overall, the Directive Cuing subjects clustered less on the transfer trial than during training, but still significantly more than either the Free Recall or

Control groups. Taken individually, the Directive-Object Cues group was the only Directive Cuing sub-group to have clustering scores significantly greater than those of the Controls on the transfer trial. In general, there was a tendency for the Verbal Cue subjets to cluster less than the other two cue groups. Surprisingly, the Low Mental Age subjects clustered significantly more than the High Mental Age group, due mainly to the high scores of the Directive-Low Mental Age subjects on transfer.

Number of Items Recalled

The relationship between this second dependent variable and the amount of clustering of recalled items was substantiated by an overall positive Pearson product-moment correlation (Nie et al., 1975), $r = .5070$, $p = .001$, for the training trials. A matrix of the correlation coefficients of the two principle dependent variables (clustering and amount recalled), as well as three supplementary dependent variables (number of categories and redundant items recalled, intrusions), for each trial are presented in Table 16 in Appendix B. Figure 11 is a graphic description of the relationship of the ARC scores and the number of items recalled on each trial for the three Recall groups. The relationship is not entirely a direct one, as can be seen by the non-significant correlation between the ARC scores and the number of items recalled on the transfer trial (see Table 16 in Appendix B).

Initial effects. The recall performance on the first training trial appears in Figure 12, with the mean number of items recalled charted as a function of Recall Condition and Cue Type. A summary of

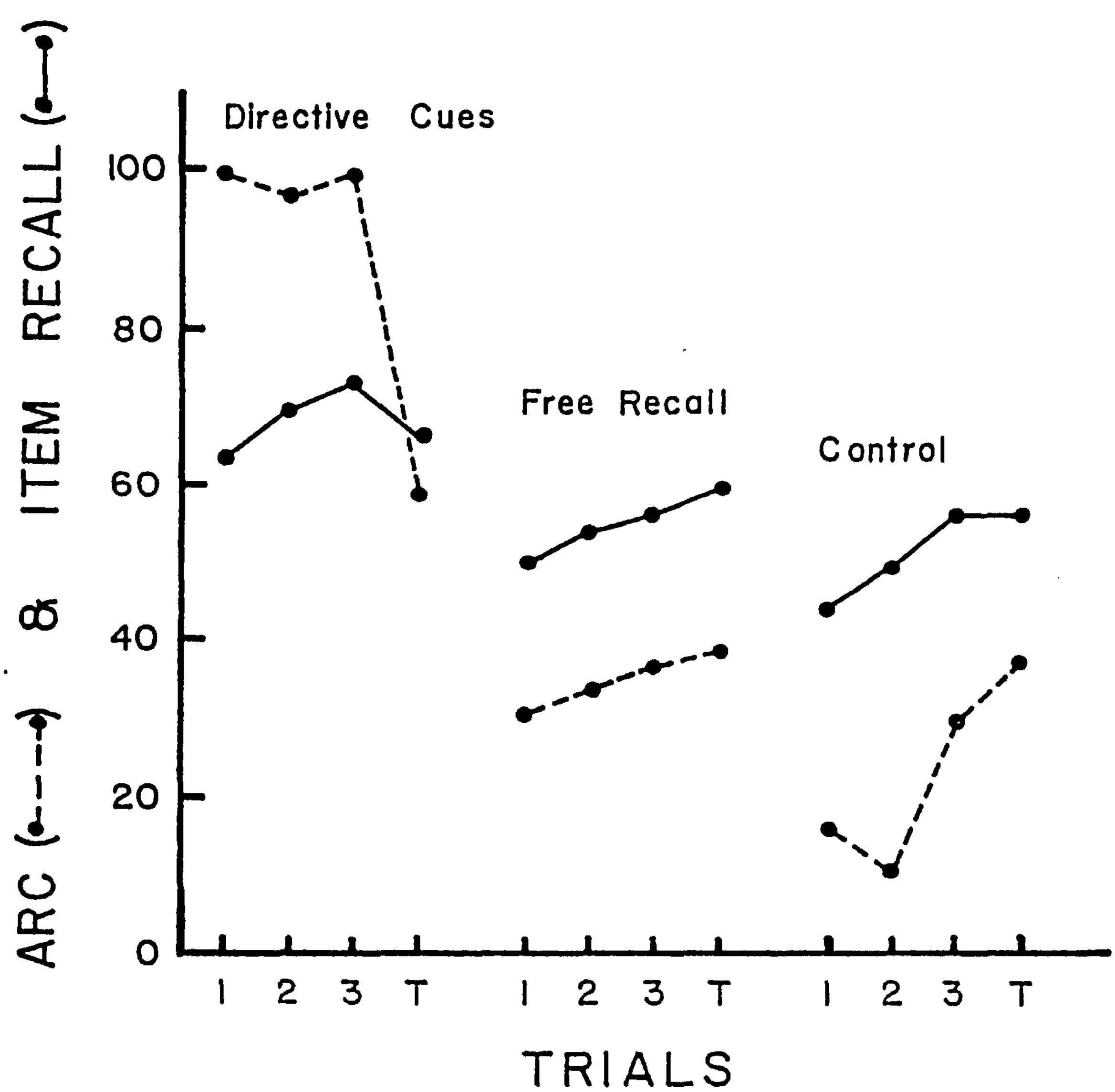

Figure 11. Mean ARC scores and percent of to-be-remembered items recalled on all four trials for all subjects as a function of Recall Condition.

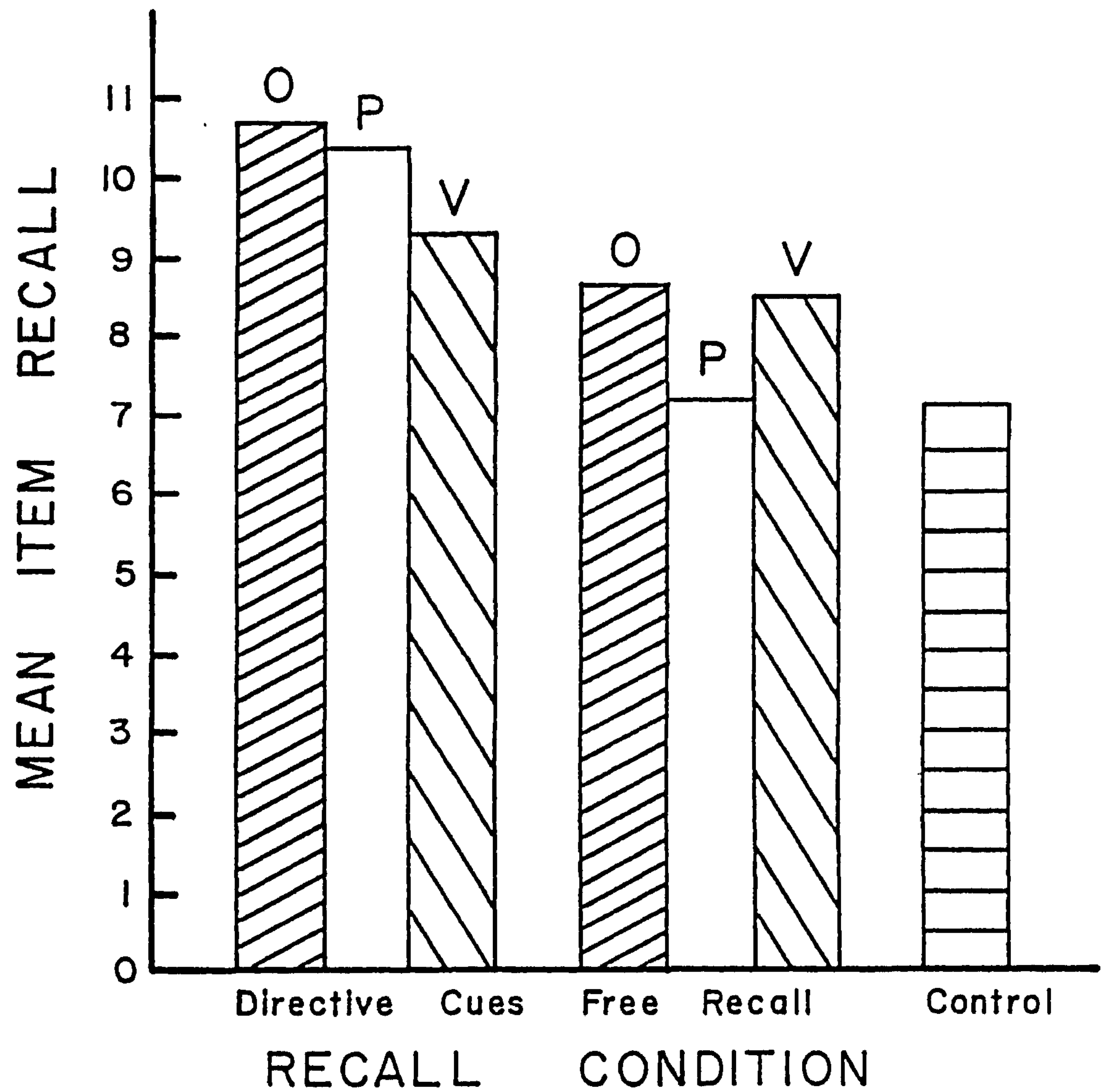

Figure 12. Mean recall scores (number of items recalled) on the first trial for all subjects as a function of Recall Condition and Cue Type.

the analysis of covariance (Nie et al., 1975) for the experimental groups is contained in Table 17. Both Recall Condition and Mental Age were observed to be significant factors, F (1,71) = 7.15, $p <$ .001 and F (1,71) = 14.09, $p <$ .001, respectively. Subjects receiving directive cuing instructions recalled more items than those under the free recall condition, as did the higher mental age group compared to the lower mental age subjects. Neither of the remaining factors (Cue Type and Schools) reached significance. Nor was the predicted Recall Condition X Mental Age Level interaction significant.

When the Control group data were compared with the results of the experimental groups, (see Tables 18 & 19 in Appendix B) the outcome was similar to that of the ARC score comparisons. The Dunnett test (Winer, 1971) indicated that the Controls recalled significantly fewer items than any of the Directive Cuing groups (Object, Picture, Verbal groups: ts (47) = 4.39, 4.16, 2.67, ps < .01, .01, .05 respectively). When the Dunnett test was used to compare each of the Free Recall groups with the Controls, it was found that there were no significant differences.

With respect to the general hypothesis of the present study, the analysis of the first training trial data suggests that the experimental manipulations were only partially effective. Exposing the subjects to retrieval cues, in storage and recall, and instructing them to use those cues in recalling the to-be-remembered items, (Directive Cuing) had a positive effect on recall performance, increasing the number of items recalled compared to both subjects

TABLE 17

Analysis of Covariance of Item Recall Scores for the Experimental Groups on Trial One

Source	df	MS	F	
Recall Condition (R)	1	90.38	17.47	*
Cue Type (C)	2	6.96	1.34	
Mental Age Level (M)	1	72.90	14.09	*
School (S)	1	12.50	2.42	
R X C	2	11.91	2.30	
R X M	1	1.33	0.26	
R X S	1	0.90	0.17	
C X M	2	1.02	0.20	
C X S	2	0.05	0.01	
M X S	1	2.25	0.44	
R X C X M	2	3.09	0.60	
R X C X S	2	6.33	1.22	
R X M X S	1	2.04	0.40	
C X M X S	2	1.90	0.37	
R X C X M X S	2	1.76	0.34	
Covariate-BRAT	1	92.37	17.85	*
Error	71	5.17		

* $p < .001$

receiving recall cues at storage only (Free Recall) and those receiving no cues or aids at all (Controls). The type of cues used (Object, Picture, Verbal) made no difference. And finally, a subject's mental age level was a significant factor in recall performance, (High MA better than Low MA). The hypothesis of the present study had predicted that subjects of higher mental age would be able to take more advantage of the benefits of the experimental manipulations than would those of lower mental age. That is, a Recall Condition X Mental Age Level interaction was predicted. This prediction was not fulfilled by the data for the first training trial.

Training effects. Across the three training trials, a number of changes occured, as can be seen in Figure 13. The analysis of covariance (M.B. Brown, 1977) of the recall performance across the three training trials for the experimental groups revealed Recall Condition, Mental Age Level and Trials to be significant factors, $F(1,71) = 33.67, p < .001$; $F(1,71) = 12.91$, $p < .001$; $F(2,144) = 25.61$, $p < .001$ respectively, (see Table 20). During the training trials, the Directive Cuing subjects continued to recall more items than the Free Recall group, as did the higher mental age subjects compared to those of lower mental age. With respect to the Trials factor, the overall performance of the experimental subjects increased steadily with a mean of 9.08, 9.83 and 10.30 items recalled on trials one through three. A Tukey hsd test (Winer, 1971) showed that significantly more items were recalled by the experimental subjects on each successive training trial ($ps < .05$).

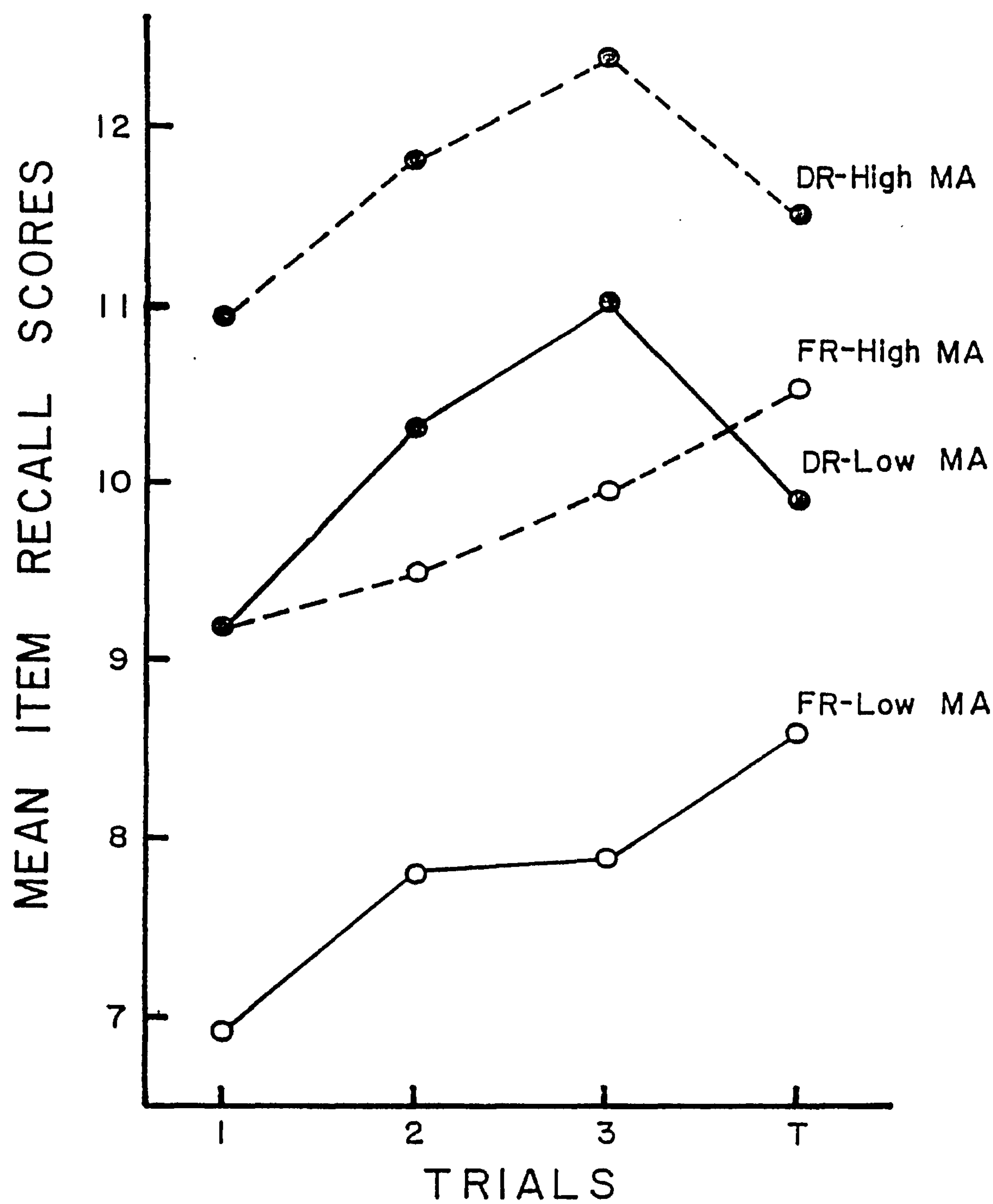

Figure 13. Mean recall scores on the three training trials for the experimental subjects as a function of Recall Condition and Mental Age Level.

TABLE 20

Analysis of Covariance of Item Recall Scores for the Experimental Groups on the Training Trials

Source	df	MS	F	
Between Ss				
Recall Condition (R)	1	391.33	33.67	*
Cue Type (C)	2	5.11	0.44	
Mental Age Level (M)	1	150.09	12.91	*
School (S)	1	41.48	3.57	
R X C	2	16.03	1.38	
R X M	1	3.61	0.31	
R X S	1	8.09	0.70	
C X M	2	2.75	0.24	
C X S	2	3.85	0.33	
M X S	1	9.29	0.80	
R X C X M	2	13.37	1.15	
R X C X S	2	11.21	0.96	
R X M X S	1	1.84	0.16	
C X M X S	2	4.78	0.41	
R X C X M X S	2	3.10	0.27	
Covariate - BRAT	1	212.52	18.28	*
Error (b)	71	11.62		

(Continued...)

TABLE 20 -Continued

Source	df	MS	F
Within Ss			
Trials (T)	2	36.28	25.61 *
T X R	2	3.61	2.55
T X C	4	1.94	1.37
T X M	2	1.07	0.76
T X S	2	2.36	1.66
T X R X C	4	1.87	1.32
T X R X M	2	0.32	0.22
T X R X S	2	2.28	1.61
T X C X M	4	1.11	0.79
T X C X S	4	0.78	0.55
T X M X S	2	0.07	0.05
T X R X C X M	4	1.32	0.93
T X R X C X S	4	1.98	1.40
T X R X M X S	2	0.63	0.44
T X C X M X S	4	0.48	0.34
T X R X C X M X S	4	0.21	0.15
Error (w)	144	1.42	

* $p < .001$

When the training data for the Controls were compared with those of the experimental groups (see Tables 21 & 22 in Appendix B), the Controls continued to recall fewer items than the Directive Cuing group and about the same number as the Free Recall subjects. With the Dunnett test (Winer, 1971) it was found that the Directive-Object, -Picture and -Verbal groups each recalled significantly more items over the three training trials than the Controls, $\underline{t}$s (47) = 5.02, 4.64, 3.57, $\underline{p}$s < .01 respectively. The analysis of the Free Recall and Control training data revealed no significant differences between the Controls and the three cue types. A Tukey hsd test (Winer, 1971) comparing the mean number of items recalled by the Controls indicated that their scores for the third trial were significantly greater than on the first trial, $\underline{p}$ < .01.

As predicted by the hypotheses of the present study, a training effect was demonstrated. The number of items recalled across the three training trials increased, though the relative positions of the groups (Directive, Free Recall, Controls) with respect to each other did not change from the first trial. Higher mental age subjects continued to recall more items than the lower mental age group. The predicted Recall Condition X Mental Age Level interaction was not significant, implying that the effects of the different recall conditions did not have a differential effect as a function of a subject's mental age, after three training trials.

Transfer of training. Figure 14 depicts the recall performance situation on the transfer trial. Most apparent is the emergence of one cue condition as the more effective cue within each recall condition, (i.e., the Directive-Object and Free Recall-Verbal groups standout). The analysis of the experimental group data (see Table 23) found the significant effects to be Recall Condition (F (1,71) = 6.13, p = .016), Mental Age Level (F (1,71) = 9.68, p = .003) and a significant Recall Condition X Cue Type interaction (F (2,71) = 3.52, p = .035). Directive Cuing subjects continued to recall more items than the Free Recall group, even in the transfer situation, as did the higher mental age subjects compared to those of lower mental age.

A Tukey hsd comparison (Winer, 1971) of the three Cue groups within the recall conditions found that the Directive-Object subjects recalled significantly more items than either of the Free Recall -Object or -Picture groups, ps < .05. No other differences were found to be significant.

The analysis of covariance with the Control group included (see Tables 24 & 25 in Appendix B) shed more light upon the differences among the cue types. The Dunnett test found the mean number of items recalled by the Directive Cuing group to be greater than that of the Controls, t (47) = 2.68, p < .01. The Dunnett t comparison of the Control versus Free Recall group as a whole was not significant. The Dunnet test comparing the Control mean with those of each of the Cue groups within the Recall conditions indicated that the only two groups who recalled more items than the

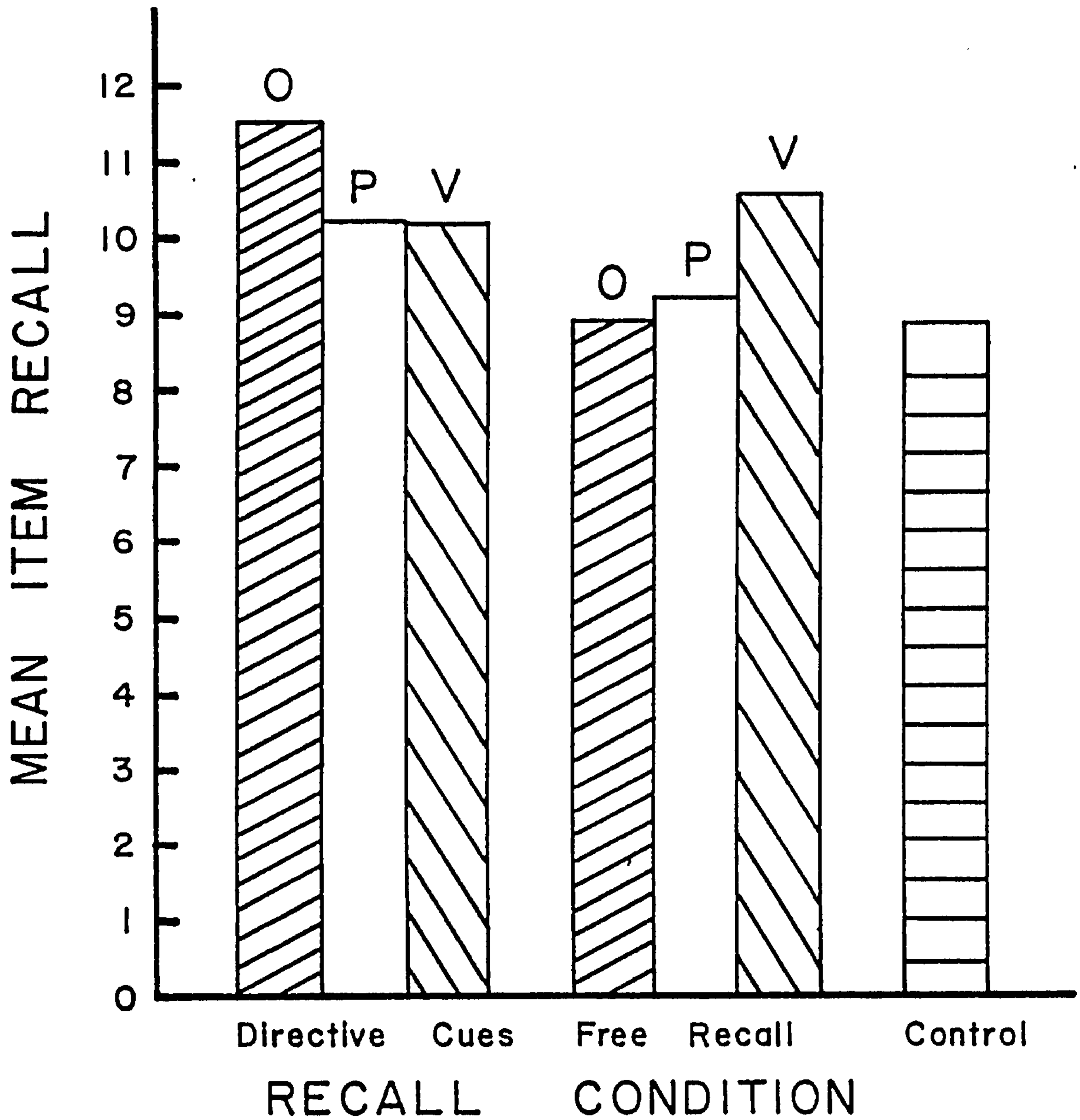

Figure 14. Mean recall scores on the transfer trial for all subjects as a function of Recall Condition and Cue Type.

TABLE 23

Analysis of Covariance of Item Recall Scores for the Experimental Groups on the Transfer Trial

Source	df	MS	F	
Recall Condition (R)	1	29.45	6.13	*
Cue Type (C)	2	3.55	0.74	
Mental Age Level (M)	1	46.55	9.68	**
School (S)	1	12.78	2.66	
R X C	2	16.91	3.52	*
R X M	1	0.38	0.08	
R X S	1	0.04	0.01	
C X M	2	4.02	0.84	
C X S	2	0.28	0.06	
M X S	1	0.16	0.03	
R X C X M	2	5.20	1.08	
R X C X S	2	0.00	0.00	
R X M X S	1	0.01	0.00	
C X M X S	2	9.04	1.88	
R X C X M X S	2	1.05	0.22	
Covariate-BRAT	1	136.42	28.38	***
Error	71	4.81		

* $p < .05$ ** $p < .005$ *** $p < .001$

Controls on the transfer trial were the Directive-Object (t (47) = 3.21, $p < .01$) and the Free Recall-Verbal (t (47) = 2.16, $p < .05$) groups.

Examination of Figures 15 and 16 reveals a number of interesting shifts in recall scores from the training trials to transfer. The analysis of covariance of the experimental group data for trials one though four, (see Table 26 in Appendix B) indicated three significant factors, (Recall Condition, F (1,71) = 26.85, $p < .001$; Mental Age Level, F (1,71) = 13.41, $p < .001$; Trials, F (3,216) = 18.09, $p < .001$) and two significant interactions (Recall Condition X Cue Type X Trials, F (6, 216) = 2.20, $p = .044$; Recall Condition X Trials, F (3,216) = 7.46, $p < .001$). The Recall Condition X Trials and the Recall Condition X Cue Type X Trials interactions are of primary interest. As Figure 15 depicts it, a steadily increasing number of items were recalled by the Free Recall group, versus an apparent drop in performance by the Directive Cuing subjects. This situation reached significance on a Tukey hsd test, the number of items recalled on the transfer trial by the Free Recall group was greater than that for the first two training trials, ps < .01, and for the Directive Cuing group, the opposite was true, the number of items recalled on the transfer trial was significantly less than on the third training trial, $p < .01$, and equal to that of the first training trial.

Looking at the recall performance as a function of Recall Condition, Cue Type and Trials, as portrayed in Figure 16, it appears that for the Directive Cuing subjects, those receiving

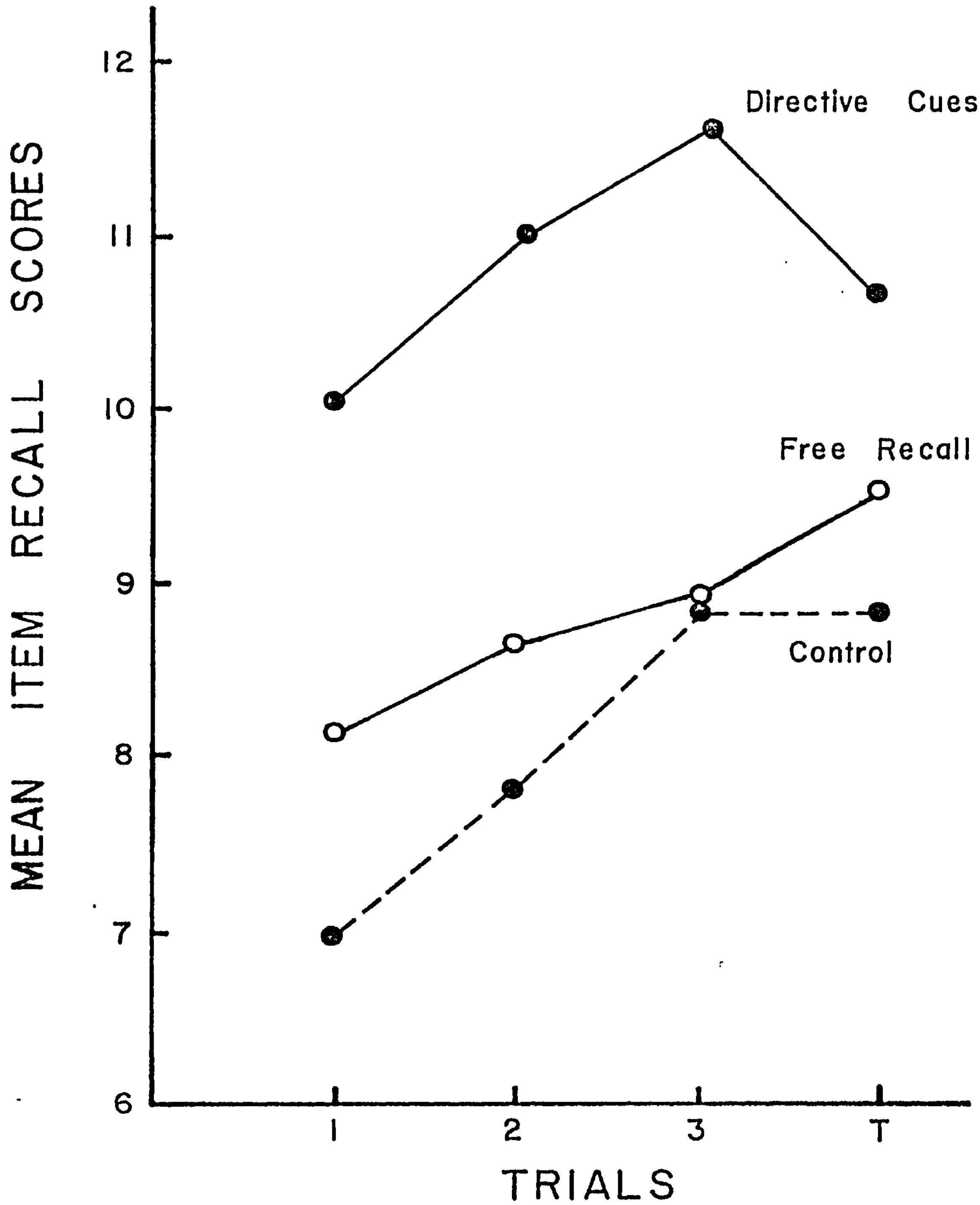

Figure 15. Mean recall scores on all four trials for all subjects as a function of Recall Condition.

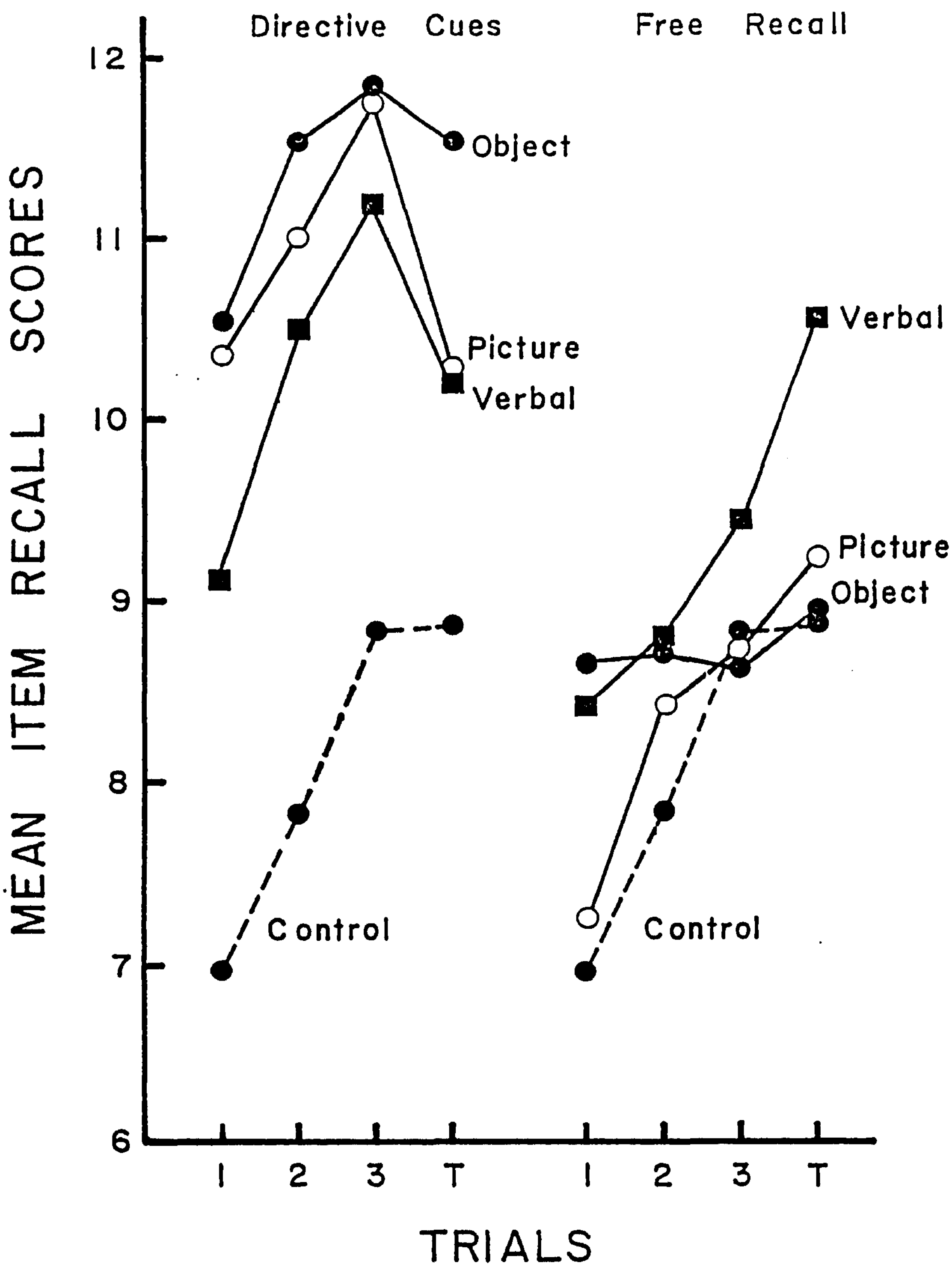

Figure 16. Mean recall scores on all four trials for the experimental subjects as a function of Recall Condition and Cue Type.

concrete-visual cues (Object or Picture) consistently tended to recall more items over the three training trials compared to those getting purely auditory cues (Verbal). And, the recall performance of the Picture and Verbal cue subjects appeared to drop to a greater extent than that of the group receiving Object cues. But, the Tukey hsd (Winer, 1971) comparison of the fourth trial mean for each of the Directive cue groups and their training performance did not determine any significant drop in scores. With respect to the Free Recall group, the Verbal and Picture cue groups appeared to continue to recall increasing numbers of items, even on the transfer trial (see Figure 16). That trend was found significant with a Tukey hsd test, with transfer performance greater for the Free Recall-Picture group compared to the first trial, $\underline{p} < .01$, and for the Verbal subjects compared to trials oe ($\underline{p} < .01$) and two ($\underline{p} < .05$).

Summary of recall results. In summary, exposing subjects to retrieval cues at storage and recall, as well as instructing them to use the cues during retrieval (Directive Cuing) produced significantly higher recall scores than the Free Recall and Control groups on the first trial. This situation continued through training and, at least partially, into the transfer situation. All groups, even the Controls, improved to some extent with the experience of successive trials. There was a trend for the Directive-Picture and -Verbal subjects' performance to drop on transfer. In contrast, the Free Recall-Picture and -Verbal groups did better on the transfer trial than on earlier training trials. Only the Directive-Object and Free Recall-Verbal subjects did better than the Controls on the transfer trial. Apparently, the type of cues used in assisting mentally retarded persons to store and recall categorizable material does not necessarily have the same effect under different recall situations. Higher mental age subjects recalled more items than those of lower mental age, throughout the experiment.

Additional Findings

Supplementary data gathered were: a) number of categories recalled; b) number of redundant items, and c) number of intrusions. Redundant items were defined as recall responses that were actually repetitions of the same item on any single trial, while intrusions were recall responses that did not exist in the original set of to-be-remembered items.

Number of categories recalled. Table 16 in Appendix B shows the relationship between the number of categories recalled and the two major dependent variables in the present study. As can be seen in Table 16, the Pearson product-moment correlation coefficients (Nie et al., 1975) show that the number of categories recalled is positively correlated with the number of items recalled on each of trials one through four, *r*s = 0.5677, 0.4563, 0.5294, 0.4720, *p*s = .001 respectively. Similarly, during the training trials, the ARC scores were positively correlated with the number of categories recalled, *r*s = 0.4508, 0.3286, 0.2288, *p*s < .01. But, on the transfer trial, the ARC scores and number of categories recalled were negatively correlated, $r = -0.1561$, $p = .05$. Thus, during training, the more categories recalled the higher the subjects' clustering scores and the more items recalled. On the transfer trial, subjects recalling more categories recalled more items, but clustered those items less than subjects recalling fewer categories. It should be noted that the number of items and categories recalled form part of the basis upon which ARC scores are calculated, but the adjustments made through the ARC formula make the scores quite independent (Roenker, Thompson & Brown, 1971).

The initial effects of the experimental procedures upon the number of categories recalled, along with the results of the training and transfer trials can be seen in Figures 17 and 18. The analyses of variance (M.B. Brown, 1977; Nie et al., 1975) for this variable are presented in Tables 29 to 37 in Appendix B. The analysis of variance of the first training trial data for the experimental groups found two significant factors, Recall Condition and Mental Age Level, $\underline{F}$ (1,72) = 17.65, $\underline{p}$ = .001; $\underline{F}$ (1,72) = 4.41, $\underline{p}$ = .039 respectively. The Directive Cuing subjects recalled more categories than the Free Recall group, as did the higher mental age subjects compared to those of lower mental age.

The Dunnett (Winer, 1971) comparison of the Controls and experimental group means found that the Controls recalled significantly fewer categories than each of the Directive-Object, -Picture and -Verbal groups, $\underline{t}$s (48) = 4.34, 4.00, 4.34, $\underline{p}$s < .01 respectively. The Controls recalled essentially the same number as the Free Recall groups.

The analysis of the data for the three training trials of the experimental subjects revealed Recall Condition and Mental Age Level to be significant factors, $\underline{F}$ (1,72) = 32.77, $\underline{p}$ < .001;

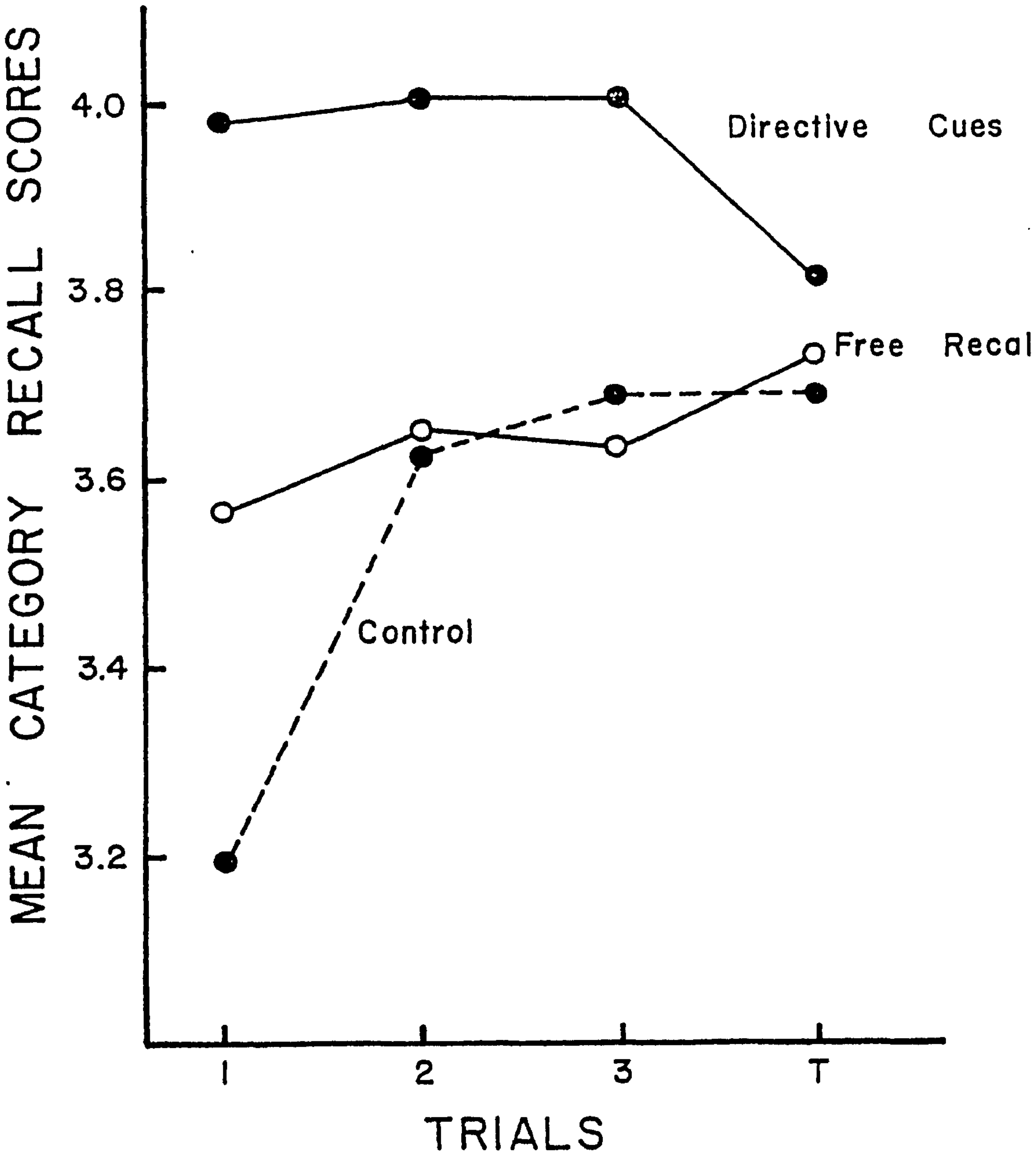

Figure 17. Mean category recall scores on all four trials for all subjects as a function of Recall Condition.

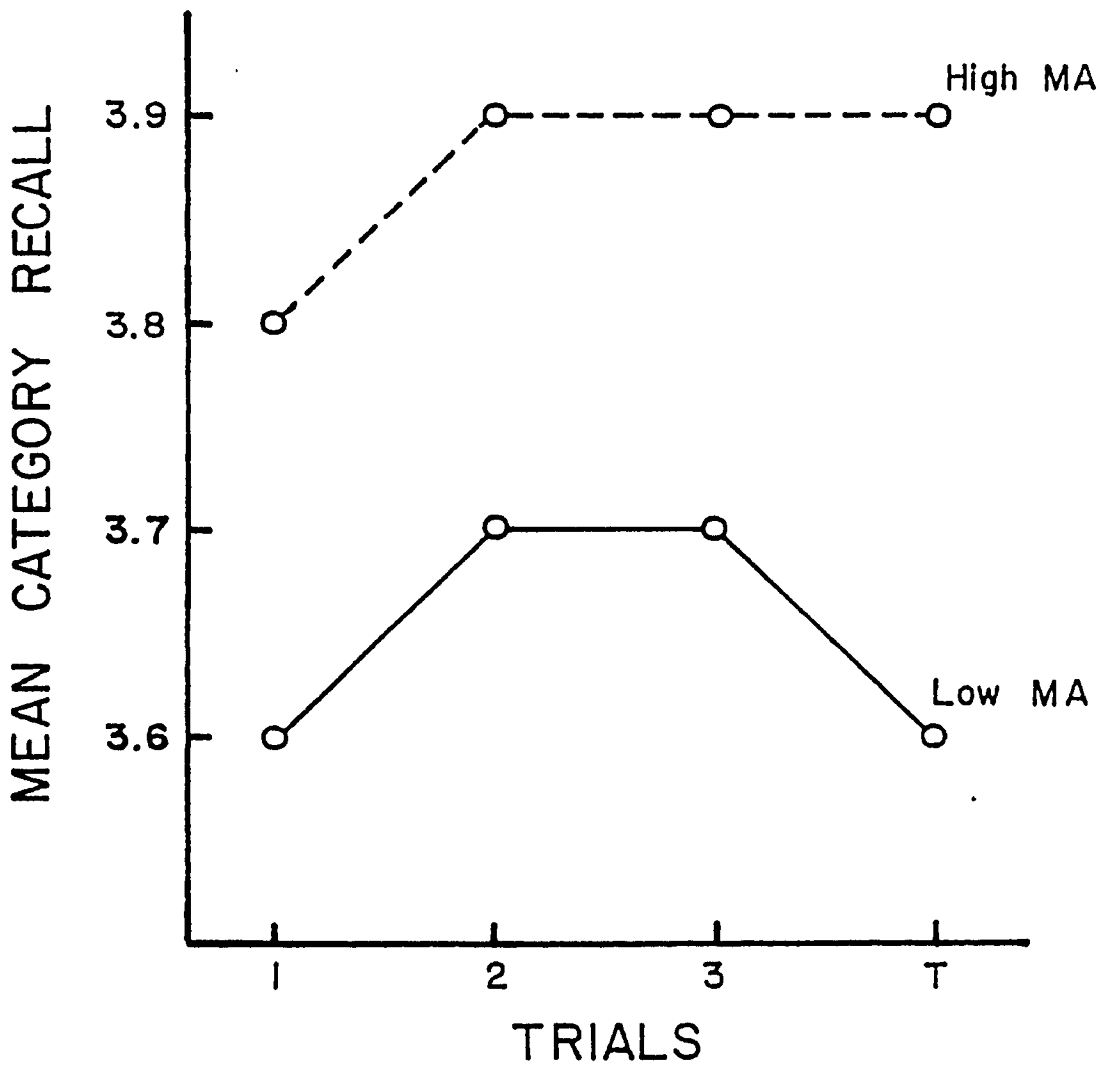

Figure 18. Mean category recall scores on all four trials for the experimental subjects as a function of Mental Age Level.

$\underline{F}$ (1,72) = 4.78, $\underline{p} < .05$ respectively. The Directive Cuing group recalled more categories than the Free Recall subjects, as did the higher mental age children over those of lower mental age.

When the Control data were analysed with each of the experimental groups a number of significant results were observed. The Controls recalled significantly fewer categories than Directive-Object, -Picture and -Verbal groups over the three training trials, with Dunnett test (Winer, 1971) $\underline{t}$s (48) = 4.80, 4.48, 4.80, $\underline{p}$s < .01 respectively. A significant interaction between Cue Type and Trials was observed ($\underline{F}$ (6,96) = 2.74, $\underline{p}$ = .017). The Tukey hsd test of the simple effects of that interaction showed that the Controls recalled more categories on trials two and three, than on trial one, $\underline{p}$s < .01. The Directive Cuing subjects recalled 3.98, 4.00 and 4.00 out of a maximum of four categories on training trials one through three respectively, obviously no room for increases. The Control versus Free Recall analysis found that for those two groups, the higher mental age subjects recalled significantly more categories than those of lower mental age, $\underline{F}$ (1,72) = 7.18, $\underline{p}$ = .01. The Control data did not differ significantlyy from the Free Recall groups.

Finally, on the transfer trial, the only significant factor was Mental Age Level, $\underline{F}$ (1,72) = 6.97, $\underline{p}$ = .01, in the analysis of variance of the experimental data. Higher mental age subjects recalled more categories on the transfer trial than those of lower mental age. The Recall Condition and Cue Type factors were not significant. Comparing the Control data with those of the experimental groups, the no significant differences were found between the Controls and any of the experimental groups.

Summary of category recall results. In general, during the training trials, subjects receiving directive cuing recalled more categories than either those getting presentation cues and free recall instructions or those receiving no cues at all. The peformance of all three groups was the same on the transfer trial. Higher mental age subjects recalled more categories than those of lower mental age.

Number of redundant items. The relationship between the number of redundant items produced on each trial and each of the principal dependent variables, clustering and number of items recalled, was examined. A matrix of the Pearson product-moment correlation coefficients (Nie et al., 1975) between those measures appears in Table 16 in Appendix B. There was a trend for the ARC scores to correlate negatively with the number of redundant items produced, with significant negative correlations on trials two and three, $rs = -0.2279, -0.3142$, $ps < .01$, respectively. The number of items recalled on each of the four trials also correlated negatively with the number of redundant items produced, reaching significance on every trial, $rs = -0.1561, -0.2304, -0.2586, -0.1741$, $ps < .05$. Thus the more the subjects repeated themselves, producing redundant items, the more inefficient their recall performance was, as measured by ARC scores and number of items recalled.

The results of the observation of redundant items in the recall profiles are graphed in Figure 19. Tables 38 to 46 in

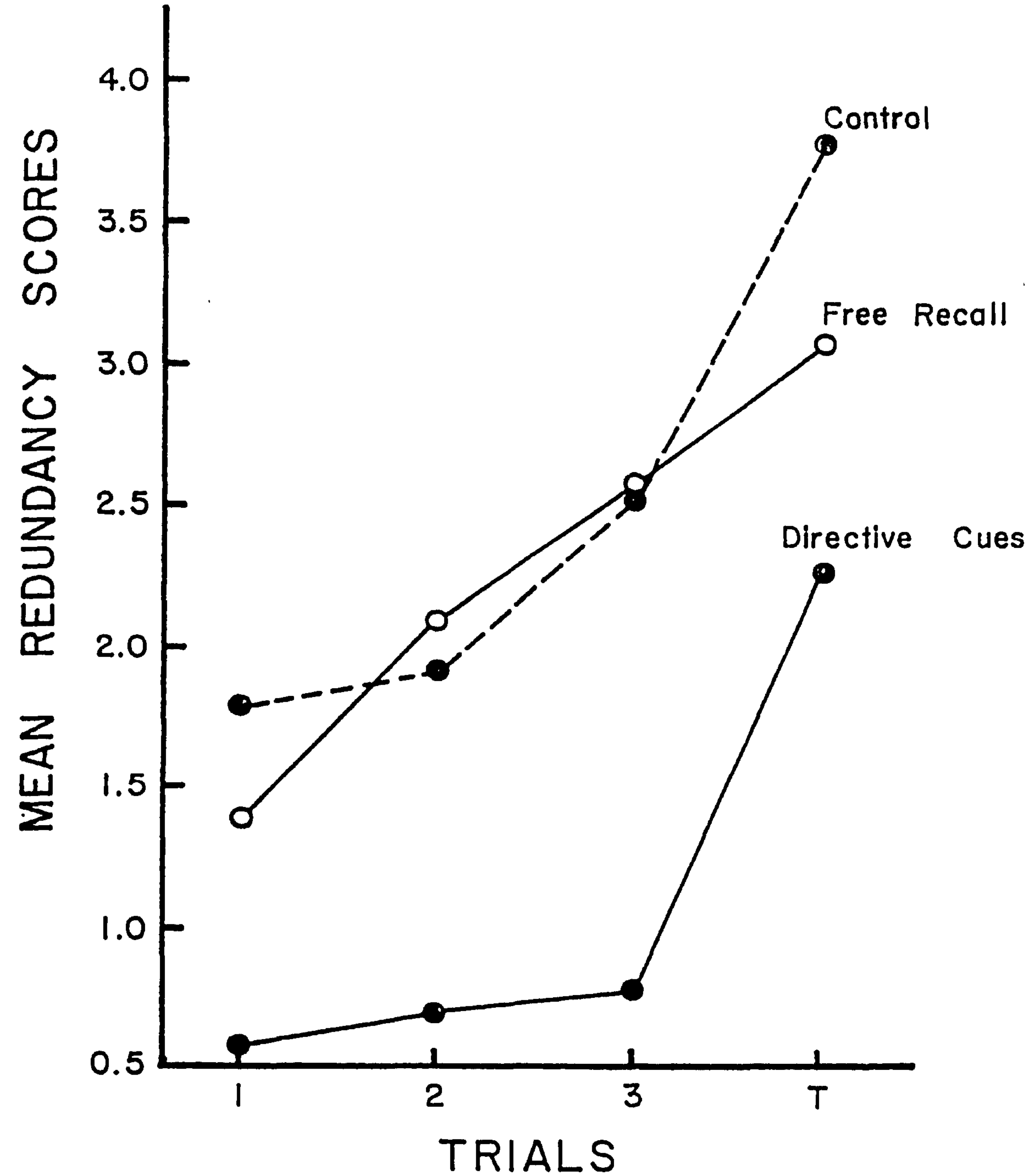

Figure 19. Mean redundancy scores (number of redundant items recalled) on all four trials for all subjects as a function of Recall Condition.

Appendix B contain summaries of the analyses for this variable. During the first training trial, the Free Recall group responded with more redundant items than did the Directive Cuing group, F (1,72) = 8.81, p = .004. A Cue Type X Mental Age Level interaction was also significant, F (2,72) = 3.59, p = .003. This interaction was due to a significant difference between the Verbal and Object cue groups within the group of higher mental age subjects. As revealed by a Tukey hsd test (Winer, 1971), the Verbal-High Mental Age group score was greater than the Object-High group's, $p < .05$. Compared with the experimental groups, using the Dunnett test (Winer, 1971), the Controls produced significantly more redundant items than the Drective Cuing subjects, (ts (48) = 3.07, 2.23, 2.51, ps < .05, Object, Picture, Verbal respectively), and about the same number as those in the Free Recall condition.

Over the three training trials, the analysis of the experimental data exposed two significant main effects, Recall Condition and Trials, and a significant Recall Condition X Trials interaction, F (1,72) = 33.27, $p < .001$; F (2,144) = 7.91, p = .001; F (2,144) = 4.82, p = .009. As can be seen in Figure 19, the number of redundant items produced by the Free Recall subjects was greater and increased more over successive trials than that of the Directive Cuing group. The analysis of variance (M.B. Brown, 1977) of the Controls versus the Directive Cuing group data found the Cuing Condition and Mental Age Level factors to be significant, F (3,48) = 4.84, p = .005; F (1,48) = 4.85, p = .033, respectively. A Dunnett test (Winer, 1971) showed that during the training, the Controls continued to produce more redundant items than each of the Directive Cuing groups (Object, Picture, Verbal), *ts* (48) = 6.02, 4.85, 5.00, *ps* < .01.

On the transfer trial, the only significant result was a Cue Type X Schools interaction, *F* (2,72) = 3.67, *p* = .03, for which a Tukey hsd test found no significant trends. In the Control comparisons, the only significant factor was Mental Age Level, *F* (1,48) = 5.93, *p* = .019; *F* (1,48) = 5.30, *p* = .026 (Controls vs Directive, Free Recall respectively). Lower mental age subjects produced more redundant items than those of higher mental age.

Summary of redundancy results. Therefore, subjects generally produced many redundant items in recall during training, unless they were given instructions to use retrieval cues and recall by category. On transfer, all recall groups were equivalent in number of redundant items observed. In general, the number of redundant items increased with decreasing mental age. The number of redundant items subjects produced correlated negatively with both their ARC scores and the number of items they recalled, revealing the habit of recalling an item more than once per trial to be detrimental to efficient recall performance.

Number of intrusions. A total of 161 intrusions were observed in the present study, with 47, 42, 41 and 31 on the first through fourth trials respectively. Only 11 of the 161 were names or descriptions of actual cues used in this study, (e.g., "box" and "barn"). The other intrusions appeared to be items from the BRAT (given a minimum of one week prior to the experimental session), categorical items (items obviously from the four categories, but not in the original set of 16 items) and some micellaneous items, all of which have been presented in Table 47 in Appendix B.

With respect to the two major dependent variables in the present study, no significant relationship was found, with a Pearson product-moment correlation test (Nie et al., 1975), between number of items recalled and number of intrusions on any one of the four trials. The situation was the same between ARC scores and intrusions during training, though a positive correlation was noted on the transfer trial, $r = 0.2112$, $p < .05$, (see Table 16).

The situation with respect to the number of intrusions observed during the four trials of the present study has been illustrated in Figures 20 and 21. The intrusion data were analysed and the summaries presented in Tables 48 to 56 in Appendix B. On trial one, Cue Type and Mental Age Level were significant factors, $F(2,72) = 9.94$, $p < .001$; $F(1,72) = 7.37$, $p = .008$. The Tukey hsd test (Winer, 1971) found subjects exposed to Picture cues produced more intrusions than either Object or Verbal cue groups, $ps < .01$. Low mental age subjects produced a larger number of intrusions than did those of higher mental age.

The Dunnett test (Winer, 1971) did not reveal any differences between the number of intrusions observed in the recall profiles of the Controls on trial one and those of the Free Recall groups. The analysis of variance of the Control and Free Recall data did reveal a significant Mental Age Level X Schools interaction, $F(1,48) = 5.83$, $p = .02$. Also, compared to the Controls, the

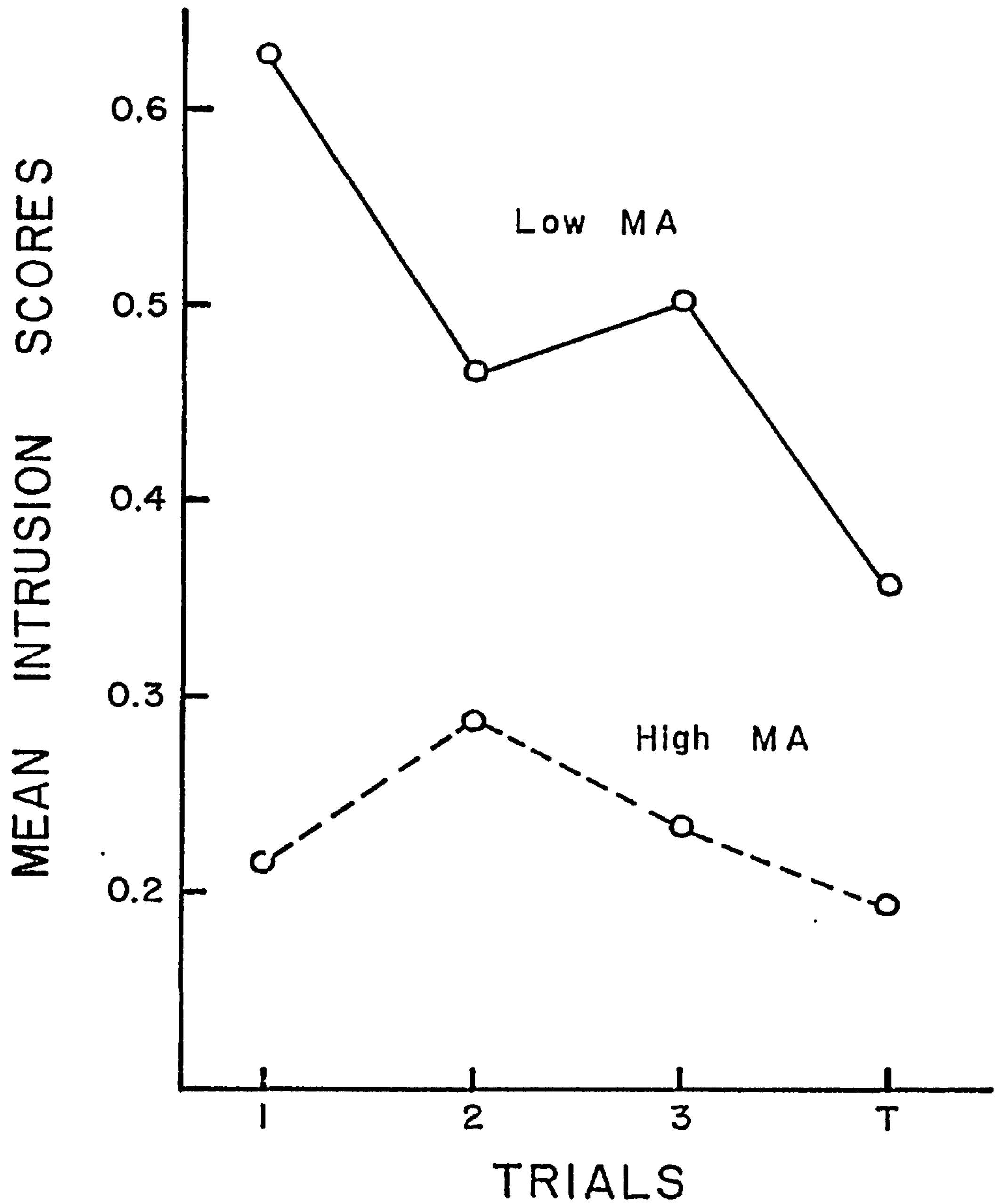

Figure 20. Mean intrusion scores (number of intrusions observed) on all four trials for the experimental subjects as a function of Mental Age Level.

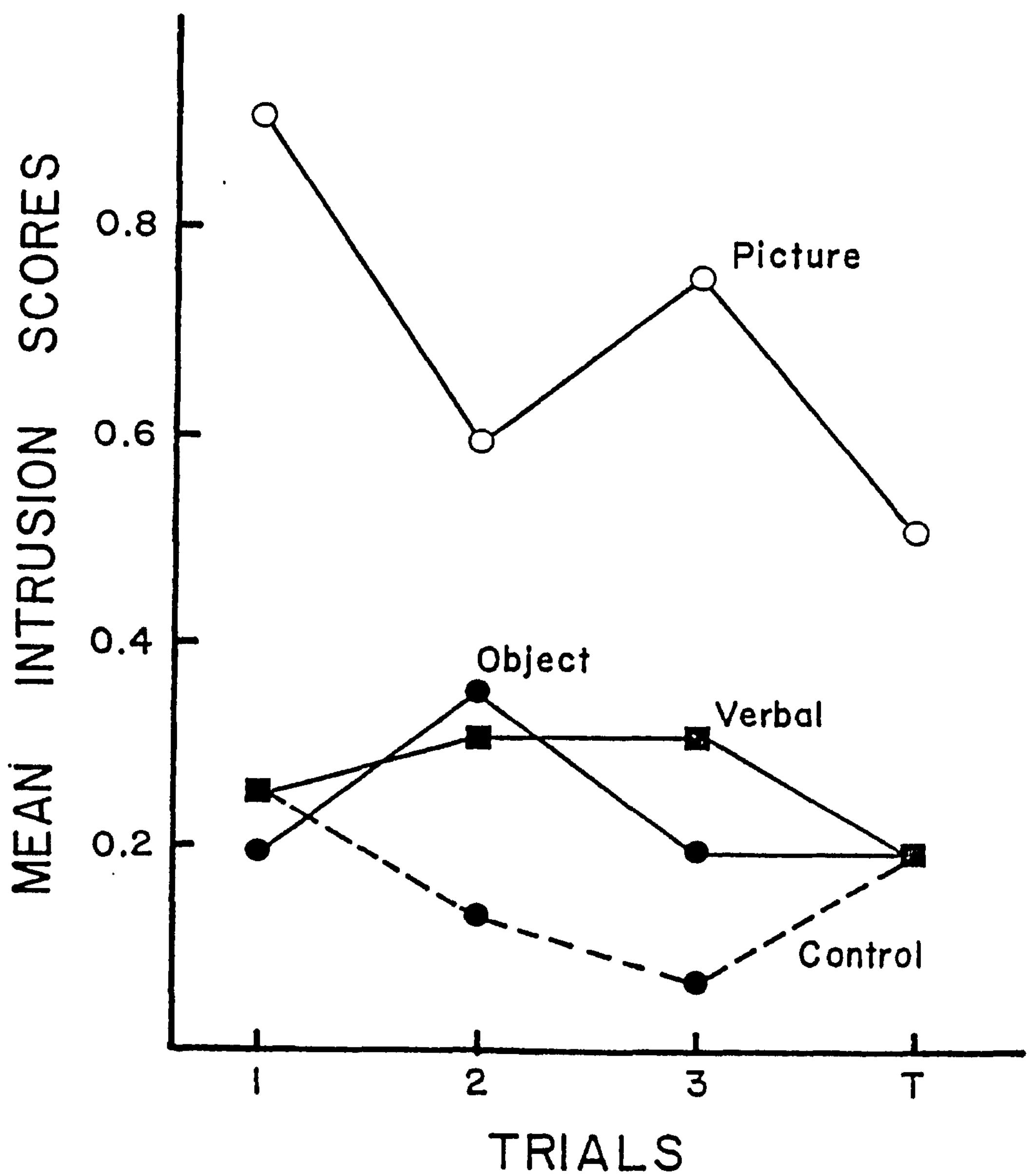

Figure 21. Mean intrusion scores on all four trials for the experimental subjects as a function of Cue Type.

Directive-Picture cue subjects produced significantly more intrusions, t (48) = 3.66, p < .01 with the Dunnett test.

Over the three training trials, the situation remained fairly stable. For the experimental groups, Cue Type and Mental Age Level were significant main effects, F (2,72) = 5.64, p = .005; F (1,72) = 4.34, p = .041 respectively. The Cue Type X Trials and Mental Age Level X Schools X Trials interactions also reached significance, F (4,144) = 2.61, p = .038; F (2,144) = 8.19, p < .001. Using the Tukey hsd test (Winer, 1971) it was noted that overall during the training trials, the Picture cue subjects produced more intrusions than either of the other two cue groups, ps < .05. The Cue Type X Trials interaction appears to be due to the fact that the Picture cue group had a greater number of intrusions than the Object or Verbal groups on trial one, ps < .01, but the three cue groups did not differ significantly on trial two, and finally, the Picture group produced more intrusions than the Object group only on the third trial, p < .05, (Tukey hsd test). The lower mental age subjects continued to make more intrusions than those of higher mental age. The Mental Age Level X Schools X Trials interaction is evidence of subtle differences in the response profiles of the groups from different schools. The Dunnett test comparison of the Controls with the experimental groups found only the Directive-Picture group to have produced significantly more intrusions than the Controls, t (48) = 6.33, p < .01 over the three training trials. In those analyses, school differences continued to be observed. The analysis of variance of the transfer data for the experimental subjects and the separate analyses comparing the experimental and Control groups found no significant differences.

Summary of intrusion results. In summary, the number of intruding items found in the recall profiles of the mentally retarded subjects in the present study during training was greater for subjects exposed to pictures as cues, versus object and verbal cues, and for lower mental age subjects. The type of recall condition used did not have a significant effect, nor did practice over three training trials. In transfer, the differences among groups disappeared. Number of intrusions and number of items recalled were not related, though the more intrusions found on the transfer trial, the more subjects clustered on that trial.

CHAPTER IV

DISCUSSION

The major purpose of the present study was to demonstrate that a hierarchy of cue effectiveness, as measured by increased organization and number of items recalled, exists for objects, pictures and words as recall cues. The discussion of the findings regarding cue effectiveness and other factors in the retrieval of categorizable picture items by mentally retarded subjects has been subdivided according to the three main stages of the study: a) initial effects; b) training effects and c) transfer of training. The major factors (Recall Condition, Cue Type, Mental Age Level, Trials) have been discussed within each stage.

Initial Effects

Recall condition. Initially on both of the principle dependent measures (clustering and amount recalled), the Directive Cuing subjects scored significantly higher than the Free Recall group and the Controls. Thus, as hypothesised, using the directive cuing procedure during recall does increase the clustering scores, as does intensive pre-training in categorical relationships (Burger, Blackman, Holmes & Zetlin, 1978; Liben, 1979; Madsen & Connor, 1968), explicit rehearsal instructions at storage (Ashcraft & Kellas, 1974), simultaneous and consistent presentation (Glidden et al., 1979), and category labels plus blocked presentation (Bilsky, 1976; Emmerich & Ackerman, 1978). The finding that giving subjects directive cuing during the recall test increased the amount recalled is not without precedent in research with mentally retarded subjects (e.g., Ashcraft & Kellas, 1974; Gerjuoy & Spitz, 1966; Green, 1974; Herriot, 1972a; Reichhart & Borkowski, 1978). Within the accessibility framework of Tulving and Pearlstone (1966), the superior number of items recalled by the Directive Cuing group would appear to be due to increased accessibility of stored material. Since both that group and the Free Recall group were treated in an identical way during storage, the amount of stored information that was available at recall can be assumed equal for both groups, but access to that information was enhanced significantly through the directive cuing procedure.

The present experimental design does not make a distinction between the two components of the directive cuing technique: a) the presence of cues at retrieval, and b) instructions to recall by category. A similar situation existed in a number of studies investigating the effects of cuing subjects during recall (e.g., Green, 1974; Herriot, 1972a; McConkey & Herriot, 1974; Reichhart & Borkowski, 1978; Wingard, Buchanan & Burnell, 1978), since the verbal cues used included implicit instructions to recall by category, (e.g., "What were the things we eat?"). One experiment in which the distinction was made between the presence of cues at recall and instructions to use them in recalling items in category clusters was reported by Kobasigawa (1974). He found that for normal, first and third grade children, the simple presence of picture cues at recall was not sufficient to increase recall with respect to non-cued controls, instructions to use cues (directive cuing) were necessary. Since the subjects in the present study and those of Kobasigawa's youngest group were of comparable mental age, it would seem logical to assume that any effects observed for the directive cuing procedure were due to the effect of both the presence of retrieval cues and the instructions to recall by category, and that the effects would probably not have been observed if the instruction component had been absent.

The fact that the performance of the Free Recall subjects and the Controls did not differ on any measure, demonstrtaed that the subjects do not spontaneously use category cues in organizing and recalling picture items, if the cues are not present at retrieval as well as at storage. Thus, the hypothesis that cues at storage alone would improve retention was rejected. A similar lack of spontenaiety on the part of mentally retarded subjects has been reported by a number of authors (e.g., Furth & Milgram, 1965; Griffith, Spitz & Lipman, 1959; Jensen, 1965). Since those subjects in the Directive Cuing group were able, with the assistance of the cuing procedure, to perform better than the Controls on all measures, mentally retarded subjects are obviously capable of learning to use the categorization strategy of remembering. The reason that the Free Recall group and the Controls did not differ in performance appears to be that simply giving subjects cues during storage is not sufficient to teach them to use the categorization strategy later on a recall test.

The Directive Cuing subjects also recalled more categories, which in turn resulted in more items from those categories being recalled, compared to the Free Recall group and the Controls. The positive correlation between the number of categories and items recalled is consistent with the "some or none" hypothesis of Cohen (1966). If subjects can be assisted in gaining access to a categorized memory unit, they will recall a significant number of items from that memory unit. The directive cuing procedure appears to be a very systematic approach to getting subjects to try to retrieve items from each memory unit in turn.

The fact that the Free Recall group and the Controls produced significantly more redundant items than the Directive Cuing subjects is additional evidence that the directive cuing procedure made recall more systematic. Under the Directive Cuing condition, subjects were required to recall items from each category in turn, thereby reducing the probability of recalling redundant items from previous categories.

Cue type. No differences in the amount of clustering or the number of items or categories recalled were observed with respect to the type of cues used. Thus the data on the first trial did not support the hypothesis that a hierarchy of cue effectiveness exists.

For the Free Recall group, where cues in general had no effect upon recall performance, compared to non-cued controls, the absence of significant differences among the three types of cues is understandable. But in the case of the Directive Cuing subjects, whose performance (clustering and amount recalled) was affected by the cuing procedure, one would have expected the hypothesised hierarchy of cue effectiveness, if one did exist, to have some effect. Taking into consideration the two components of the directive cuing procedure, it is evident that the treatment of the Directive Cuing subjects differed only in the type of cues present at storage and retrieval, and not in the instructions given to recall by category. Looking at the different recall measures used, the fact that the ARC scores and the number of categories recalled both reached their ceilings on the first trial, for the Directive Cuing subjects, due to the systematic instructions to recall items from each category in turn, left no room for evidence of differential performance due to the type of cues used. The number of items recalled appears to be the only measure that did not reach a ceiling, even with instructions to recall by category, thereby leaving room for improvement due to the type of cues used. In actual fact, a trend, in the predicted direction (objects over pictures over words), was noted in the number of items recalled for the three types of cues within the Directive Cuing group. Though the trend did not reach statistical significance, some indication of it can be seen in the different levels of significance reached in comparing the number of items recalled by each Directive Cuing sub-group and the Controls. The difference between the performance of the Controls and the mean number of items recalled by those subjects receiving either object or picture cues in the Directive Cuing group reached a higher level of significance ($p < .01$), than the comparison between the

Controls and the Directive-Verbal subjects ($p < .05$). Though that in no way justifies the unconditional acceptance of the hierarchy of cue effectiveness hypothesis, it does warrant noting the trend over the training trials.

Mental age level. As hypothesised, the higher mental age subjects recalled more items than those of lower mental age. Thus the mental age of mentally retarded subjects is a significant factor in determining the amount of information they can recall. That finding concurs with the results of research with both normal and retarded subjects (e.g., Coward & Lange, 1979; Emmerich & Ackerman, 1978; Gerguoy & Spitz, 1966; Green, 1974; Hall, Murphy, Humphreys & Wilson, 1979; Horowitz, 1969; Kobasigawa, 1974; Liben, 1979; Moely & Shapiro, 1971).

No significant difference was found between the higher and lower mental age subjects, with respect to the amount of clustering observed in their protocols on the first trial. The fact that those subjects who did cluster more than the Controls, that is the Directive Cuing group, approached the maximum valued possible for the clustering measure, irrespective of mental age, must be part of the reason why no difference was observed between the two groups. That is, since the clustering of the Directive Cuing subjects, both high and low mental age sub-groups, was consistently above 95%, a ceiling effect may be the reason for the lack of a significant mental age efect.

The predicted Mental Age Level X Recall Condition interaction was not significant, thereby offering no support for the hypothesis that subjects of higher mental age would be affected to a greater extent by the experimental manipulations, than those of lower mental age. That finding is in contrast to the results of a study by Green (1974), in which mentally retarded subjects of higher mental age recalled more items, evidenced more clustering in recall and produced a steeper performance curve over five training trials, than did those of lower mental age, when both groups of subjects were in the directive cuing condition.

The fact that 22 of the lower mental age subjects, and only six of the higher mental age group, had Down's syndrome may have had something to do with the lack of significant interaction, in the present study. As suggested by Green (see Herriot, Green & McConkey, 1973, Exp. XII), the selection criteria (the Basic Recall Ability Test scores) may have resulted in a biased sampling of the Down's syndrome population: only those who could compensate for their poor articulation skills were selected (i.e. reached criterion). The lower mental age subjects, 39% of whom had Down's syndrome, may have had more experience in compensating for poor verbal skills, compared to those of higher mental age. Thus the lower mental age subjects may have been selected with specific abilities that in part compensated for their low mental ages. The data appears to support such an explanation, in that the lower mental age subjects followed instructions as well as those of higher mental age, achieving equivalent ARC scores, and both groups improved proportionally with the application of the experimental treatment (cues and directive cuing). The fact that the lower mental age group was still unable to recall as many items or categories would be expected, since experience in compensating for verbal inadequacies would result in increased attention paid to instructions and the learning of new strategies, but not necessarily in an increased ability to retain information equal to subjects of higher mean mental age. Herriot, Green and McConkey (1973, Exp. XII) also reported that Down's syndrome subjects showed worse overall recall performance than equal mental age non-Down's subjects, but that Down's group had a greater capacity to benefit from assistance (directive cuing) or exposure to the learning situation (transfer).

Finally, the lower mental age subjects produced more intrusions than those of higher mental age, suggesting that the former group was doing more guessing. A similar interpretation was made by Gerjuoy and Spitz (1966).

Summary of initial effects. Based on the results of the first training trial, mentally retarded subjects required to recall the names of categorizable picture items will use the categorization strategy of remembering to a greater extent and recall more items, if they receive category cues at storage and directive cuing during the recall test, as compared with non-cued controls. Simply having cues present at storage followed by a standard, non-cued free recall test has no effect upon recall performance. The use of the directive cuing procedure also encourages subjects to recall more categories and produce fewer redundant items, further evidence of a more efficient memory search, compared to the other groups. The results suggested that the type of cue used makes no difference, though a trend for object and picture cues to be superior to verbal cues, with respect to the number of items recalled, was observed. The mental age of the subjects has an effect upon the amount of information recalled (number of categories and items), with higher mental age subjects recalling more information than those of lower mental age. A similar effect of mental age upon organization in recall (clustering) was not observed, most likely due to a ceiling effect, since subjects who did cluster in recall, clustered at about the 100% level, irrespective of mental age. Lower mental age subjects did appear to guess more in attempting to recall the names of the picture items, than did those of higher mental age.

Training Effects

It was hypothesised that the recall performance (clustering and number of items recalled) of all subjects would improve over the three training trials, though no change in the relative positions of the various sub-groups, with respect to each other, was expected.

Trials. As hypothesised, the number of items recalled by the experimental subjects in general increased significantly over the three training trials. A similar improvement in amount recalled over trials was reported by a number of other authors (e.g., Coward & Lange, 1979; Emmerich & Ackerman, 1978; Evans, 1970; Fagan, 1969; Gerjuoy & Winters, 1970; Horowitz, 1969; McConkey & Green, 1973; Moely & Shapiro, 1971; Palmer, 1974). The Control group's recall performance also improved, with more items being recalled on the third trial than on the first. Thus, repeated exposure to the memory task resulted in improved recall performance.

With respect to the ARC scores, no improvement was observed across the three training trials. For the Directive Cuing subjects, this was possibly due to a ceiling effect, as described earlier. With regards to the Free Recall group and the Controls, no improvement was made in the amount of clustering observed in their recall protocols. Thus, even with repeated exposure to categorizable picture items, with or without category cues at storage, the mentally retarded subjects in the present study did not spontaneously increase their use of the categorization strategy of remembering.

Recall condition. The Directive Cuing subjects continued to achieve higher recall scores (clustering and number of items and categories recalled), than either the Free Recall group or the Controls. The latter two groups did not differ, thereby demonstrating that even with repeated exposure to category cues at storage, subjects do not spontaneously use them to organize for remembering.

A positive correlation between ARC scores and both the number of items and categories recalled was observed. That correlation suggests a relationship between organization and amount recalled, consistent with that reported by other researchers (e.g., Evans, 1970; Gerjuoy & Spitz, 1966; Herriot & Cox, 1971; Puff, Murphy & Ferrara, 1977; Thompson, Hamlin & Roenker, 1972).

Though high ARC scores and the recall of a large number of categories may be artifacts of the directive cuing procedure, resulting from the systematic instructions to recall items from each category in turn, the correlation between each of those measures and the number of items recalled is not. That is, instructing subjects to recall items by category and naming each category in turn for them, would obviously result in a more structured or organized recall protocol, and would most likely result in more categories being recalled, but it would not necessarily result in more items being recalled, unless the type of memory search it encouraged was more effective than that normally used by the subjects. Thus, instructing mentally retarded subjects to use category cues in recalling picture items does result in a more organized recall protocol and in more items being recalled.

The number of redundant items produced by the Free Recall group and the Controls increased over the three training trials, while that of the Directive Cuing group remained significantly lower. Thus, subjects given the structure of the directive cuing procedure continued to recall efficiently, while the other groups became more and more repetitive. In general, the number of redundant items observed was negatively correlated with clustering and number of items recalled, indicating that redundancy was related to poor recall performance.

Cue type. Even over the three training trials, no significant differences were found in amount of clustering or number of items recalled with respect to the three types of cues used. However, on all three training trials, those subjects receiving picture cues produced significantly more intrusions than those exposed to either object or verbal cues. Though Gerjuoy and Spitz (1966) interpreted intrusions as an indication of the amount of guessing being done by subjects on the recall test, the situation does not appear to be as straightforward in the present case. For the Free Recall subjects, the Picture cue group produced 10 intrusions that were actual names or descriptions of the picture cues used. Only one other intrusion of that type was observed in all the recall protocols of the other two groups of Free Recall subjects, and not one was produced by subjects from the other recall conditions. Since the names (or descriptions) of cues made up 42% of the intrusions produced by the Free Recall-Picture group, it appears that for those subjects there was some confusion as to which pictures they were to recall (i.e., cues or to-be-remembered items), thereby explaining in part the large number of intrusions that that group produced. For the Directive Cuing-Picture subjects, evidence of the same confusion was not found, which was to be expected, since those subjects had the picture cues present during the recall test. Exactly why the Directive Cuing-Picture group produced more intrusions than the Directive Cuing-Object or -Verbal groups is not clear. One possible explanation may be that since both the to-be-remembered items and the category cues were pictures, when subjects are exposed to picture cues at retrieval and required to recall all pictures seen, the picture cues may have been responsible for a certain amount of retroactive inhibition. That is, of the 20 pictures (cues and items) the subjects were exposed to during the presentation, four were present during the recall test and the other 16 were to be recalled. The situation was essentially the same as that reported by other authors (e.g., Roediger, 1978; Roediger, Stellon & Tulving, 1977) in which it was found that part-list cues or context words exert an inhibitting effect by competing with target words at retrieval. In the case of object and verbal cues, the difference between the format of the cues and the to-be-remembered items would be great enough to significantly lower the probability of a similar inhibitting effect. Since the Picture cue subjects did not differ from the other two cue groups, with respect to clustering and number of items recalled, and neither of those measures correlated with the number of intrusions produced, the significant Cue Type effect for intrusions may indicate that, though the type of cue used was not sufficient to produce significant differences in the two principle dependent variables, there is a less conspicuous underlying effect.

Mental age level. Over the three training trials, the higher mental age subjects continued to recall more items and more categories than those of lower mental age. No differences were observed on the clustering measure. Those who did cluster (Directive Cuing) did so at a near perfect level, leaving no room for differences between mental age groups. Thus, mental age continued to be a significant factor in determining the amount of information recalled, though any potential differences in organization continued to be concealed by a ceiling effect.

Summary of training effects. It was demonstrated that over repeated trials the number of items being recalled increased. Though all groups improved over the three training trials, their relative positions remained the same as on the initial trial, with the directive cuing procedure producing superior results, compared to the other two groups, and similarly, higher mental age subjects recalled more items than those of lower mental age.

The directive cuing procedure continued to produce near perfect clustering in recall, while the level of clustering observed in the protocols of the other groups remained significantly lower and did not increase over trials. Apparently mentally retarded subjects do not spontaneously learn to use the categorization strategy of remembering.

The type of cues used continued to have no significant effect upon either organization or amount recalled. But, significant differences in the number of intrusions produced by the different cue groups did suggest the existence of a complex underlying effect due to the type of cue used.

Transfer of Training

Jakobovits (1969) proposed that transfer is perhaps the single most important concept in the theory and practice of education. If training methods are to be of any practical use, the ability of the trainees to generalize from their training to a new situation is paramount. In the present study, it was hypothesised that positive transfer effects would be observed as a result of the various experimental manipulations.

Recall condition. The Directive Cuing subjects produced a greater amount of clustering and recalled more items on the transfer trial, than either the Free Recall group or the Controls. Thus as hypothesised, a positive transfer effect was observed for the directive cuing procedure. The Free Recall subjects and the Controls did not differ from each other either in the amount of clustering or the number of items recalled on the transfer trial, thereby not supporting the hypothesis that all of the experimental subjects would show positive transfer effects. Since their scores on both dependent measures were low and did not differ throughout training, a significant difference between the scores of the Free Recall group and the Controls would not be expected.

The fact that the Directive Cuing group had a significant drop in clustering and number of items recalled, comparing transfer and training scores, suggests that the transfer effect was not complete, and could perhaps improve with further transfer trials. The significant increase in the number of redundant items produced by the Directive Cuing subjects on the transfer trial emphasizes the importance of their low redundancy scores during training and the efficiency of the directive cuing procedure, in keeping the recall process systematic.

Cue type. There was a significant Cue Type effect on the transfer trial. Subjects trained with object cues tended to cluster more on the transfer trial, than did those trained with verbal cues, with the group exposed to picture cues scoring in between the other two groups. Further evidence of differential training effects on transfer due to the type of cue used was observed in the comparison of the performance of the Directive Cuing subjects and the Controls. The Directive-Object group recalled more items and clustered more on the transfer trial than the Controls, while the Directive-Picture and -Verbal subjects' performance was not significantly different from that of the Controls on either measure. In this context, Green

(1974) has reported that her subjects trained with directive-verbal cues did no better (clustering or number of items recalled) than her non-cued controls on a series of five transfer trials. Thus the results of the present study indicate that the type of cue used with the directive cuing procedure does have an effect upon organization and amount recalled on a transfer trial, with object cues being definitely superior to both picture and verbal cues.

The situation within the Free Recall group was somewhat different and unexpected. Since that group did not differ in clustering or amount recalled during training, compared to the Controls, no differences were expected on the transfer trial. But, the Free Recall subjects trained with verbal cues recalled more items than the Controls on the transfer trial. The most probable explanation for that situation appears to be the fact that the Free Recall-Verbal subjects produced significantly more redundant items during the three training trials, thus they had actually verbalized and rehearsed some of the to-be-remembered items more often than the other Free Recall subjects and the Controls.

Mental age level. On the transfer trial, the higher mental age subjects (mean MA = 7.94 yr.) continued to recall more items and categories than those of lower mental age (mean MA = 5.09 yr.), thereby confirming the hypothesis that mental age is a significant factor affecting the amount of information a subject can recall. Green (1974), with high and low mental age retarded adults (mean MA = 7.95 vs 5.75 yr. respectively), reported similar transfer results for amount recalled.

A puzzling finding in the transfer data is that the lower mental age subjects had higher ARC scores than those of higher mental age. In fact, the clustering of the higher mental age subjects actually dropped significantly on transfer, while that of the lower mental age group remained the same as during training. The analysis of the predicted interaction of Mental Age Level and Recall Conditon revealed that the lower mental age subjects given directive cuing training clustered more than those of higher mental age and given the same training. The other sub-groups within the Free Recall and Control conditions did not differ significantly. Since the higher mental age subjects trained with the directive cuing procedure recalled more information (items and categories), but clustered less than those of lower mental age, the merits of the categorization strategy of remembering are put into question. In otherwords, since the correlation between ARC scores and number of items recalled by all subjects on the transfer trial was almost nil ($r = .0053$), the statistics suggest that there was no relationship between the amount subjects clustered on the transfer trial and how many items they remembered, thereby implying that the categorization strategy of remembering was not that beneficial.

Before actually rejecting the hypothesis that the categorization strategy of remembering is a significant method of increasing the amount of information subjects can recall, the raw data was re-examined. Looking at the recall protocols, a pattern of responding seemed to be present. Specifically, all of the Directive Cuing subjects tended to recall in clusters. Once they had gone through the four categories, one at a time, they often recalled a few more items in a non-clustered fashion. The difference between the higher mental age subjects and those of lower mental age was seen in the second stage, where the additional, non-clustered items were recalled. The higher mental age subjects recalled more items on the second time around, compared to those of lower mental age. That apparent trend was supported by the significant differences in the number of items recalled by the two mental age groups. The unexpected ARC score difference between the higher and lower mental age groups is also consistent with the response pattern that appeared to emerge. For example, two subjects who recall a pair of items from each of three categories would each have identical ARC scores. But if one of them, subject "A", went on to recall three more items from categories already recalled and one item from the fourth category, subject A's ARC score would decrease, since the overall clustering would no longer be perfect. At the same time, A's other scores (number of items and categories recalled) would have increased. Thus, theoretically, a situation may exist in which at one point during the recall test, all subjects could have identical scores and depending on whether they continued to attempt to recall more items (as the higher mental age subjects seemed to do), their final scores would or would not remain equal. Since the Adjusted Ratio of Clustering is independent of the number of items or categories recalled (Roenker, Thompson & Brown, 1971), it is quite possible for ARC scores to decrease while the number of items and/or categories recalled increases.

A second factor that may be related to the unexpected difference between the clustering scores of the two mental age groups is their interpretation of the objective of the memory game they were involved in: to recall a large number of items versus to recall items by category. Though the experimenter initially explained that the objective was to recall as many items as possible, the Directive Cuing subjects received further instructions to recall items from one category at a time, implying a second objective. Therefore, under the directive cuing procedure, subjects could perceive the objective to be: a) to cluster; b) to recall many items, or c) both. It is possible that the perception of the task by the two mental age groups could have been different.

Summary of transfer of training. Training mentally retarded subjects with the directive cuing technique resulted in positive transfer of training effects, as also has been found with blocked presentation (e.g., Bilsky & Evans, 1970; Bilsky, Evans & Gilbert, 1972) and imagery (e.g., Burger & Blackman, 1976; Zupnick & Meyer, 1975) variables. Simply exposing subjects to category cues during training, followed by a standard non-cued free recall test had no differential effect on transfer performance, as compared to non-cued presentation and free recall format.

The type of cue used is a significant factor, when the directive cuing procedure is being used. Object cues proved to be superior to picture or verbal cues in amount recalled and clustering on the transfer trial.

Finally, the mental age of a subject is a significant variable in the determination of a subject's ability to recall the names of items. With respect to clustering, the findings were not straightforward. It appears that the tendency of higher mental age subjects to recall more items than those of lower mental age, that is, their trend towards a more exhaustive memory search, may paradoxically result in lower clustering scores. It is apparent that the use of the categorization strategy of remembering in the transfer situation may assist the subject to a certain point, after which it is dropped and a less systematic memory search continues.

Conclusions and Applications

The present study demonstrated that mentally retarded subjects can learn to use the categorization strategy of remembering, though they do not use it spontaneously. A number of factors proved to be relevant to the acquisition of that strategy and increased amount recalled: a) a subject's mental age; b) the type of training given; c) the type of cue used. High mental age was related to greater recall of items during both training and transfer. The directive cuing procedure resulted in increased clustering and amount recalled in all phases of the experiment. In the case of the type of cues used, a definite difference in effects was observed only on the transfer trial, where object cues proved superior to picture and verbal cues within the directive cuing procedure.

The objectives of the present study did not include the development of teaching strategies to be used with mentally retarded students, but some suggestions may be made. The memory deficits of retarded persons have a handicapping effect upon many aspects of their personal development and progress towards independence, ranging from reading comprehension to doing the weekly shopping. The results of the present study demonstrated that the directive cuing technique is a effective method of training mentally retarded persons to use the categorization strategy of remembering, thereby improving their recall performance. It was also shown that when using the directive cuing technique, object cues are better than picture or verbal cues, in promoting transfer of learning.

Teachers must be cognisant of the numerous factors affecting the progress and generalizability of training when working with mentally retarded students. The scope of the present paper was limited to the exposure of some of the more relevant factors related to improving recall. The application of those factors to the training of retarded pupils is left to those more competent in that domain.

APPENDIX A

REVIEW OF THE LITERATURE

REVIEW OF THE LITERATURE

A number of authors (e.g., Fagan, 1969; Moely, Olson, Halwes & Flavell, 1969; Simpson, King & Drew, 1970) have suggested that much of the difficulty experienced by mentally retarded persons in reading and other educational activities is the result of either a deficiency or a developmental lag in their memory processes.

For the purposes of the present study, the literature relating memory processes, the retention difficulties of the mentally retarded and the resolution of their difficulties has been reviewed under the following headings: organizing for remembering, comparing normal and retarded subjects, memory deficits in retarded subjects, and the variables affecting organization in the memory process.

Organizing for Remembering

Remembering, the recall information evolving from past experience, is central to man's ability to think and reason. Often only rather small amounts of information, from the vast store of past experience, need be remembered at a specific time, thereby requiring a very well organized warehouse of information and an efficient method of searching through it.

If information is to be retrieved efficiently, Atkinson and Shiffrin (1968) have suggested that some method or strategy must be applied to the memorization process. The need for a memorization strategy was also stressed by other authories (e.g., Burger, Blackman & Tan, 1980; Earhard, 1969; Thompson, Hamlin & Roenker, 1972; Wortman & Greenberg, 1971).

Memorization Strategies

A number of strategies for the recall of information have been reported in the professional literature, some of them are described briefly below:

Chunking. This strategy, used to bypass the normal limitation of immediate memory, was observed by Miller (1956). He found that subjects could store up to seven plus or minus two units in immediate memory, but that if they grouped the items in chunks, each chunk would take up only as much storage space as each item had originally. Thus, while the number of items in memory remained constant, the amount of information stored increased. For example, if a subject were presented with the following series of 16 x's and o's: XXOXOOOXOXOOXXXO

it would probably be quite difficult to simply remember the x's and o's in proper sequence. But if the chunking strategy were used, the task would become very much simpler. Each run of x's and o's could be converted to a numeral and memorized as five two-digit numbers: 21[XXO] ,13[XOOO] , 11[XO], 12[XOO], 31[XXXO].

Thus, rather than storing 16 separate items, only five items need be stored, each item containing a chunk of coded information. Futhermore, Warden and Ritchey (1979) have reported that the amount of information children can store per memory unit, or chunk, has an upper limit of three plus or minus two items, much more limited than in the case of adults.

Subjective organization. Tulving (1962, 1966) noted the consistent sequencing of unrelated items in the recall protocols of experimental subjects. The order appeared to be established by each subject individually.

Rehearsal. Verbally repeating the to-be-remembered material until retrieval is required is called rehearsal. Flavell, Beach and Chinsky (1966) observed subjects using verbal rehearsal in a nonverbal serial recall task as a successful method of aiding themselves in recalling information.

Imagery. A strategy in which mental images are used to recall items actually represented by the images, or related to them, for example, to remember the following series of words: house, show, dog, kite, table, cow, banana, a subject may create an image consisting of a house shaped like a shoe, with a dog out front flying a kite, while a cow sits at a table eating a banana. The more humorous the image, the better. The use of imagery has been extensively researched by Paivio (1968). In a study comparing the effects of imagery upon the recall of categorizable and unrelated lists, Ritchey and Beal (1980) found that increased imagery improved recall of only the lists of unrelated items. That research suggests that different strategies of remembering may work best with different types of material, at least in the case of imagery as a strategy. Some success with that strategy with mentally retarded subjects has been reported (e.g., Lebrato & Ellis, 1974; Taylor, Josberger & Knowlton, 1972).

Of the many strategies available, organizational strategies have been suggested as being superior (e.g., Stoff & Eagle, 1971), with the categorization strategy being best when categorizable material is used (e.g., Herriot & Cox, 1971; Marshall, 1967). Since the focus of the present study is on the utilization of the categorization strategy, the research regarding that strategy will be reviewed in detail.

The Categorization Strategy. This strategy was noted by Bousfield (1953) and Mathews (1954), who found that their experimental subjects regrouped to-be-remembered information into small groups of inter-related items, such as fruit, animals, occupations and furniture. Thus the strategy was termed the categorization strategy, because subjects regrouped items by category membership, and recalled them in those groupings. The presence of such a strategy was measured by the amount of categorical clustering in the recall protocols, that is, the amount subjects consistently recalled items in recognizable category grouping as opposed to a purely random manner. Obviously, both the application and the observation of such a strategy are facilitated by the use of categorizable material.

This strategy appears to follow a developmental trend, in that the tendency to use it increases with the age of the individual. In 1958, Bousfield, Esterson and Whitmarsh studied developmental changes in conceptual and perceptual clustering using third and fourth graders along with college students. Bousfield et al. noted that clustering on the basis of meaning tended to increase with the age of the subjects. Discusing the issue, Nelson (1969) suggested that "young children are passive receivers of information and that, with age, they learn to organize information actively and efficiently" (p. 284).

Working with children from the grades: 1, 3, 5, 7 and 9, Lange and Hultsch (1970) found that younger children did not group large numbers of items together, but grouped them in pairs, as compared to the older children, who grouped the items in larger, category groupings. Lange and Hultsch found that the amount recalled increased with age, as did the use of the categorization strategy. Similar results were reported by Moely and Shapiro (1971), studying the organization of recalled material with preschool and primary age children. Also working with primary grade children, other experimenters (e.g., Coward & Lange, 1979; Emmerich & Ackerman, 1978; Kobasigawa, 1974, 1975; Steinmetz & Battig, 1969; Westman & Youssef, 1976) observed that older youngsters utilized the categorization strategy more readily and thus, generally recalled more efficiently.

The categorization strategy has also been studied using older subject populations. Marshall (1967) reported a set of three experiments with a total of 246 introductory psychology students, noting that lists of items that appeared unrelated were recalled according to a subjective organization, while category clustering was observed in the recall of lists of items in which category relationships were more obvious. A similar switch from the use of subjective organization to categorization was witnessed by Herriot and Cox (1971) with retarded subjects. When older subjects do use the categorization strategy, recall tends to increase (e.g., Gerow, 1970; Thompson, Hamlin & Roenker, 1972) as it does with younger subjects.

One reason the utilization of the categorization strategy tends to be related to higher recall performance may be that the strategy gives subjects a systematic retrieval plan, as noted by Wortman and Greenberg (1971). Similarly, Bower, Clark, Lesgold and Winzenz (1969), reporting the results of a series of five experiments on hierarchical retrieval strategies, suggested that recall improved as subjects stored items in category groupings and retrieved the items using the same strategy. In fact, Bower et al. reported that when the items were organized by category for the subjects during the presentation by the experimenter, subjects recalled two or three times better. As noted by Tulving and Pearlstone (1966), if a systematic organization is used as the basis of a retrieval strategy, memory units become more accessible. Tulving and Pearlstone also suggested that once access to a memory unit was achieved, the contents were automatically available. Thus, the categorization strategy may be conceptualized as a method in which items are stored in a systematic manner and may be retrieved in the same manner. The efficient use of the strategy would therefore depend on the subject's ability or tendency to use the strategy at both storage and retrieval.

The major focus of the present paper will be on increasing the tendency of mentally retarded subjects to use the categorization strategy, rather than on the question of which part of the memory process is the strategy most vital to.

Comparing Normal and Retarded Subjects

Grouping subjects scoring 70 or below on an intelligence test and classifying them as retarded does not mean they will differ from those scoring above 70, the "normal" subjects, on all other tasks. For example, R.M. Brown (1974) noted no significant difference in recall between 10 mentally retarded children and 10 normal children, matched for mental age. In a free recall task with categorizable material, Gerjuoy and Spitz (1966) found the performance of retarded subjects and equal mental age normals to be equivalent, though normal subjects of comparable chronological age were superior. Similar results were reported by Palmer (1974), with both clustering and the amount recalled being the same for mentally retarded individuals and their equal mental age normal controls.

Measuring intentional and incidental learning in familial and organic mentally retarded subjects and their equal mental age controls, Hetherington and Banta (1962) observed similarities in the performance of all three groups on most tasks requiring incidental learning and all tasks with intentional learning. The normal controls and the familial mentally retarded children were equal on all tasks, and superior to the organic mentally retarded pupils only on immediate free recall of incidental learning and on a recognition test of incidental learning after a delay of 48 hours.

A number of investigators, however, have found specific differences between the performance of mentally retarded subjects and their normal controls. Belmont and Butterfield (1971), using a memory probe, noted equality of recency effects, but superiority of primacy effects for normal subjects over retarded persons matched for mental age. Comparable findings were reported by Dugas (1975). Gallagher (1969) matched 25 mentally retarded subjects with 25 normal children and found no differences in the amount of subjective organization exhibited in the free recall of a list of 12 unrelated words. But, the children of average intelligence did recall significantly more words.

Furthermore, Madsen and Connor (1968) reported that categorization and information reduction take place with both retarded and non-retarded subjects, but exactly which areas of the memory process are equivalent in retarded persons and their normal IQ controls is not completely clear. For a further review of the differences and similarities between retarded and normal subjects, and the difficulties inherent in comparative studies, the reader is referred to an article by Baumeister (1967). For the purposes of the present research, reference has been made to studies using normal and/or retarded subjects, but the empirical investigation remained uniquely concerned with mentally retarded subjects.

Memory Deficits in Retarded Subjects

Blount (1968) has reviewed extensively most of the early research with retarded subjects in the area of concept usage, including studies focused on organizational strategies of memorization. Two further reviews of memory organization experiments with the mentally retarded may be found in Herriot, Green and

McConkey (1973) and Spitz (1966).

In explaining the difference between the retention performance of retarded persons and normal controls, the tendency has been to hypothesize deficits of one type or another.

Item familiarity. To detect the categorical nature of recall items, the individual must be familiar with at least some aspect of the material. Dugas (1975) argued that lack of familiarity appears to be part of the retarded subject's deficiency. Though Dugas used a serial memory task, his suggestion would appear applicable to the free recall situation as well. Though the subjects were not retarded, the issue was somewhat similar in a study by Gerow (1970), where words of high frequency of common usuage, therefore more familiar to the subjects, were recalled more efficiently and clustered in recall to a greater extent, than were words of low frequency.

Using a "pointing" recognition task, Smith and Kaufman (1972) found differences between normal and retarded subjects, with differences increasing as stimulus information increased. As with Dugas (1975), Smith and Kaufman found retarded subjects deficient in their ability to familiarize themselves with the experimental materials within the restricted time of an experimental session. Winschel and Lawrence (1975) observed that retarded subjects tend to be deficient in the labeling of objects and the generation of names for unconventional or unnamed items, as well as in their ability to notice, without prompting, more than one dimension of a relevant stimulus.

Production deficit. Studying normal children from kindergarten, first, third and fifth grades, Moely, Olson, Halwes and Flavell (1969) noticed a gap between basic capacity and spontaneous production of concepts. That is, younger children were able to use the concepts, but did not produce them on their own, as did the older students. Though Moely et al. worked with children of normal intelligence, similar deficiencies in the spontaneous use of concepts in retarded subjects has been noted. The spontaneous utilization of the categorical nature of recall lists has been found lacking in mentally retarded persons by a number of experimenters (e.g., Furth & Milgram, 1965; Griffith, Spitz & Limpman, 1959; Jensen, 1965).

Channel capacity deficit. Working with normal subjects, Miller (1956) measured the limit of immediate memory as being the "magical number seven plus or minus two" items. Spitz (1973) reported the data of a number of studies which implied that for educable mentally retarded persons, the immediate memory span was four plus or minus one, if the subjects had not had any practice on the task before. The limit rose to five plus or minus two for more practiced subjects. Thus a channel capacity deficit was suggested, that is, only a limited amount of information may be processed into storage at any one time, and that for retarded persons, the flow of information is even more restricted than for normal subjects.

A channel capacity deficit in retarded subjects has also been noted by Gallagher (1969), and Smith and Kaufman (1972) in comparing the retention performance of normal and retarded subjects. Similarly, Fagan (1969) reported an immediate memory deficiency in his educable mentally retarded subjects, as compared to equal mental age normal controls.

Organizational deficit. Simpson, King and Drew (1970) reported the inability of retarded individuals to codify recall material. In their free recall experiments, mentally retarded subjects recalled significantly better, when given material that was already organized by category, than when they were presented with material which they had to reorganize themselves. Gruen (1973) noted the same deficiencies in organizing material to be remembered, noting that even with a memory aid, retarded subjects failed to show improvement on a Piagetian transitivity task, while equal mental age normals did, though both groups performed equally poorly without the memory aid.

Spitz (1966) emphasized that the question of whether or not retarded subjects do group or organize material is not as important as the resolution of the querry about the conditions, the fashion and how effectively retarded individuals can exhibit that capacity. For educators and learning theorists alike, it would appear more productive to establish the conditions under which mentally deficient subjects overcome their memory deficits, rather than merely identifying those deficits in extreme detail. Such was the focus of the present study.

Variables in the Organization of Memory Processes

A number of variables appear to have a significant effect on the initiation of organization in memory processes. For the purpose of the present paper, the relevant variables were grouped under the headings: a) recall items; b) cues, c) presentation variables, and d) subject variables.

Recall Items

In assessing the factors affecting the memorization of material, probably the most obvious variable to look at is the material itself.

Type of items. Recall items may be of many different forms, three of which are: words, given verbally or written, pictures and objects. Reporting the results of a free recall experiment, using 90 introductory psychology students, Scott (1967) concluded that a greater number of cues are provided by objects, than by symbolic items, such as words. Scott's subjects both recalled and clustered to a greater extent for the objects as items condition, than the symbolic items treatment group. Dugas (1975) suggested that retarded subjects perform better with familiar materials. Similar results, were reported by Iscoe and Semler (1964), in a paired associate task and by Mende (1974) in a free recall situation.

Shotick, Ray and Addison (1976), comparing the performance of retarded children using objects or photographic slides of objects, found performance to be superior with three-dimensional items on tests of memory span, short term recall (10 sec.) and long term recall (48 hr.).

Finally, on an incidental learning task with 18 kindergarten children and an equal number of mentally retarded adolescents of equal mental age, Deich (1974) found the retarded subjects performed well on tests of recall with pictures, and on tests of recall and recognition using cues learned incidentally.

The research so far suggests that the more concrete or similar to real life objects the items are, the more effective is the recall of both normal and mentally handicapped subjects.

Categorizability. Not only has the physical structure of test stimuli been found relevant in facilitating the organization of memory, but the inter-item associations have also been shown to be important variables. A number of experimenters (e.g., Cohen, 1963; Puff, 1970b, 1970c; Roberts & Smith, 1966) have studied the free recall of university undergraduates and in every case, associatively related words were recalled more proficiently than unrelated words. With children, aged three to seven years, Moely and Shapiro (1971) have reported superior recall for lists of concept pairs over similar lists of unrelated items.

With mentally retarded adults, the British experimenters, McConkey and Herriot (1974, Exp. II), have compared the recall performance of subjects given categorizable items to those given unrelated items. They found recall of categorizable material to be superior. Other experimenters (e.g., Baumeister & Guffin, 1967; Glidden, 1977a; Herriot & Cox, 1971) also confirmed the advantages of using lists of conceptually related items in memory experiments with mentally retarded subjects. The importance of being aware of categories present in the to-be-remembered items list was also noted by Winschel and Lawrence (1975) in a comparative review of research with mentally retarded subjects and the use of memorization strategies.

Inter-item association strength. Other authors (e.g., Bahrick, 1971; Cofer, Bruce & Reicher, 1966; Lathey, 1979; Marshall, 1967) have suggested that not only does a general within category relationship between items facilitate organization for memorization, but the strength of that relationship is also relevant.

In a free recall study with university undergraduates, Cohen (1963) reported that inter-item associative strength correlated positively with the number of words recalled, but not with the number of categories recalled. Associative strength was derived from a table of word association norms (not specified).

Similarly, Hom (1967) worked with 30 institutionalized retarded males and found inter-item association strength to be positively related to the learning of a paired associate task, using picture pairs.

Also working with retarded subjects, Reiss (1968) used a repeated measures design, having his subjects recall items from three different 20-word lists, one with associative categories, one with rhyming categories and the third mixed. Reiss found that performance on the list containing items related by associative categories was superior in amount of clustering, as well as amount recalled.

It appears to be evident that the stronger, or more obvious the relationship between items of a category, the more likely is it that all items from that category will be recalled.

Type of category. Stedman (1963) showed that intellectually normal adults categorized items on the basis of different categories than do retarded subjects. The normal individuals used the semantic categories: action-of, synonym and supraordinate most often. The retarded subjects used the categories: contrast and coordinate, most often. Notably, the categories used most often by the mentally handicapped adults were those used least by the normal controls.

Cues and Recall

Hints, whether verbal in the form of words, or non-verbal in the form of pictures, objects or other signs, given during either presentation or recall, or both, which inform the subject about the categorical nature of the material, are called cues. Having cues present during the storage phase as well as during the retrieval stage could only enhance their facilitative effect. Thompson and Tulving (1970), in a series of three free recall experiments with university undergraduates, noted that even strong cues were not effective if not present during learning, when the to-be-remembered items were stored. Crouse (1968) also suggested that the appropriate pairing of storage cues with items is important for retrieval cues to be effective.

In a complex experiment, using a variety of sequential memory tasks, Derevensky (1967) compared the performance of pupils from kindergarten and grades two and four, under different cue conditions.

He reported that verbal cues, in combination with non-verbal cues, facilitated retention in all groups. Similarly, Tulving and Pearlstone (1966) tested a total of 929 high school students and reported that the presence of recall cues significantly facilitated recall. Finally, Segal (1969) gave 144 first year psychology students a free recall test, using words of either high or low frequency from various categories. He found that the presence of category names, cues, aided category clustering of words from both levels of frequency. Segal also noted that subjects not given cues tended to recall first a category name, then the members of that category, and then another category name.

With second and fifth grade pupils, Hall, Murphy, Humphreys and Wilson (1979) found that cues with strong cue-item associative strength resulted in better recall, than cues of more moderate strength. Similarly, with 54 educably mentally retarded children, Bender and Johnson (1979) noted that their picture items were recalled much better when cues closely related to the items were used, compared to when more remotely related cues were used.

Various experimenters (e.g., Ashcraft & Kellas, 1974; Bilsky, 1976; Bilsky, Evans & Gilbert, 1972; Brown, 1974; Glidden, 1978; Green, 1974; Herriot, 1972a) have studied the effect of cues on organizational strategies and recall in retarded subjects with results similar to those of experiments with normal subjects.

Herriot (1972a) reported that only when cues were present at both presentation and recall did recall performance improve, though cues at presentation and/or recall increased clustering in recall output. Green (1974) noted that cues affected the recall performance of high and low vocabulary retarded adults differentially, with only the high vocabulary group showing an increased recall with cues. Comparing mentally retarded adolescents and equal mental age normal controls, Ashcraft and Kellas (1974) reported similar results for both types of subjects, with recall cues significantly increasing both the amount recalled in a free recall task, as well as the number of categories recalled.

Cue to item ratio. Earhard (1967) used a wide range of item to cue ratios with medical students, and noted that the rate of acquisition varied with the number of items per cue: the more items per cue, the less effective were the subjects in free recall. Earhard suggested that cues can act for only a limited number of items, with the most efficient grouping being a compromise between the number of cues used and the number of items assigned to each cue.

Dallet (1964) reported that, with normal subjects, cues helped more with larger numbers of categories. Combining the results reported by Dallet (1964) and Earhard (1967), it would appear that as the amount of to-be-remembered information increases, cues become more effective, as long as the number of items assigned to each cue is kept relatively small.

Presentation Variables

Modality. Experimenters often have a choice of modes of presentation, such as visual, auditory or both. Horowitz (1969) found the visual and the auditory-visual modes to be superior to the auditory mode in producing clustering in free recall, as well as in increasing the amount recalled, with school children as subjects.

McConkey and Green (1973) reported that mentally retarded adults recalled more with visual presentation than with auditory, though no difference was exhibited in the amount of clustering. Gerjuoy and Winters (1970), using institutionalized educable mentally retarded adolescents, found bimodal presentation to be superior to unimodal presentation in amount recalled. Similar results were reported by Evans (1970), and Glidden et al. (1979) also with mentally retarded subjects. Apparently, mentally retarded individuals remember visual items better than auditory stimuli, though a bimodal presentation gives the best results.

Duration. Also studying methods of presentation, Winters and Goettler (1973) compared the recall, recognition and matching performance of retarded children and their equal mental age normal controls, varying exposure time during presentation. Winters and Goettler witnessed an overall improvement in performance as exposure time increased.

Instructions. When subjects were instructed to organize free recall material and to recall it in their choosen sequence, Puff (1970a) found that undergraduate university students evidenced an increase in output organization, though no increase occured in the amount recalled. Using 25 words from five categories, on a memory drum, Pollio, Richards and Lucas (1969) reported similar results, except that their subjects showed an increase in the amount recalled as well. Horowitz (1969) also found instructions to organize to improve recall performance with children. Emmerich and Ackerman (1978) reported an increase in recall for subjects from grades one and five, and from college, when they were given instructions to recall items from each category in turn.

Kobasigawa (1975) reported that each type of instruction, or pre-information, prepared the subjects differently. That is, children who were first informed that they could be given a free recall test, did equally well later on, on either free or cued recall tests, while those students given cued recall pre-information performed significantly better on cued recall as compared to free recall. Kobasigawa found that the effect of cued recall pre-information was larger for sixth grade pupils, than for third graders.

Studying the spontaneous sorting behaviour of mentally retarded adults, McConkey and Herriot (1974, Exp. III) compared the effects of five levels of instructions, ranging from no instructions to very specific ones. They noted that only the more specific instructions were related to sorting performance. In addition, they found that the subjects who had sorted more efficiently, later also recalled more items. Burger, Blackman, Holmes and Zetlin (1978) instructed 60 educable mentally retarded children and 60 normal controls to sort items by category during pre-training, they found those instructions resulted in increased recall and clustering on a recall test that followed the pre-training session, compared to the controls, who simply practised recalling the items. Finally, Ashcraft and Kellas (1974) and Gerjuoy and Spitz (1966) also worked with mentally retarded subjects and found free recall scores improved with instructions to cluster in recall.

Clustered presentation. Instructions to cluster can be implicitly incorporated into the material by physically arranging the recall items in groups or clusters at presentation. In discussing the harmonic flow found in natural systems, Spitz (1966) stated that organization will be preferred over disorganization, when the organism is given the choice. Spitz contended that organizing material prior to input, helps alleviate noise in the system and thus, appreciably improves the retarded subjects' performance.

Three to seven year olds demonstrated the importance of stimulus configuration, both clustering and recalling more with blocked presentation, that is, with items physically grouped by category, than with random presentation in a study by Moely and Shapiro (1971).
Similarly, Bower, Clark, Lesgold and Winzenz (1969), reported a series of five experiments. They found that recall was as much as two to three times better with an organized presentation, versus a random one. Concurring results with presentation organization increasing amount of clustering have been reported by other reseachers (e.g., Bahrick, 1971; Cofer, Bruce & Reicher, 1966; Emmerich & Ackerman, 1978; Puff, 1966; Shapiro & Bell, 1971).

The advantages of organized presentation have also been demonstrated with many different groups of retarded subjects. Either recall has been improved (e.g., Gerjuoy & Alvarez, 1969; Gerjuoy & Spitz, 1966; Glidden, 1977a; Herriot, 1972b), or clustering was shown to increase (e.g., Bilsky & Evans, 1970; Bilsky, Evans &

Gilbert, 1973; Gerjuoy & Winters, 1970; Glidden, 1976; Madsen & Connor, 1968), or both were augmented (e.g., Bilsky, 1976; Gerjuoy, Winters, Pullen & Spitz, 1969; Glidden et al., 1979; McConkey & Herriot, 1974) by organizing the items by category during presentation.

Subject Variables

Bousfield, Esterson and Whitmarsh (1958) noted that organizational strategies do not depend solely upon recall item variables or strategies available, but also on the sets or attitudes operating within the organism at the time. A number of subject variables must be taken into account.

Chronological age. Sykes (1976) studied the performance of 108 normal school children, ranging in age from eight to twelve years. He suggested that developmental differences are not due to memory capacity, but to the use of organization skills, Sykes found organizational skills to vary between age groups, with the more effective skills being exhibited by older subjects. Other investigators (e.g., Coward & Lange, 1979; Derevensky, 1976; Emmerich & Ackerman, 1978; Hall, Murphy, Humphreys & Wilson, 1979; Horowitz, 1969; Kobasigawa, 1974, 1975; Moely & Shapiro, 1971; Steinmetz & Battig, 1969; Worden & Ritchey, 1979) have generally found performance on memory tasks to improve with age, usually for the same reasons noted by Sykes (1967). Moely, Olson, Halwes and Flavell (1969) have also noted that there exists a gap between a child having the basic capacity and the spontaneous production of an organizational strategy by that child.

Mental age. Working with retarded adults of two vocabulary age levels, Green (1974) reported that cues increased the recall of high vocabulary age subjects only. Green also found that group to have a significantly steeper learning curve. The high vocabulary age group also clustered more when given cues. Thus, not only do normal subjects of higher mental age perform better on recall tasks, as compared to mentally retarded subjects, as noted earlier in the present review, but even within the retarded population, mental age differences influence retrieval efficiency. In fact, even though the main difference between the high and low vocabulary age groups in the Green study was only 2.2 years (5.75 to 7.95), the difference was large enough to have a significant effect.

APPENDIX B

ANALYSIS OF VARIANCE SUMMARY TABLES

AND OTHER TABLES

TABLE 2

Analysis of Variance of Mental Age Scores for the Seven Treatment Conditions

Source	df	MS	F	
School (S)	1	424.32	2.30	
Mental Age Level (M)	1	32845.75	178.01	**
Condition (C)	6	0.28	0.00	
S X M	1	1106.29	6.00	*
S X C	6	0.24	0.00	
M X C	6	0.13	0.00	
S X M X C	6	0.37	0.00	
Error	84	184.52		

* $p < .05$ ** $p < .001$

TABLE 3

Analysis of Variance of Chrological Ages for the Seven Treatment Conditions

Source	*df*	*MS*	*F*
School (S)	1	874.72	0.50
Mental Age Level (M)	1	36757.51	21.01 *
Condition (C)	6	2124.59	1.21
S X M	1	897.22	0.51
S X C	6	1477.93	0.85
M X C	6	206.26	0.12
S X M X C	6	1486.52	0.85
Error	84	1749.72	

* $p < .001$

TABLE 4

Analysis of Variance of Basic Recall Ability Test (BRAT)

Scores for the Seven Treatment Conditions

Source	df	MS	F
School (S)	1	31.08	7.15 *
Mental Age Level (M)	1	10.94	2.52
Condition (C)	6	0.22	0.05
S X M	1	0.01	0.00
S X C	6	0.29	0.07
M X C	6	0.10	0.02
S X M X C	6	0.13	0.03
Error	84	4.35	

* $p < .01$

TABLE 5

Group Composition with Respect to Sex

and Down's Syndrome

Group	Sex		Down's Syndrome (28)	
	Male	Female	Yes	No
Directive (48)	18	30	12	36
Free Recall (48)	28	20	11	37
Control (16)	6	10	5	11
Object Cues (32)	14	18	7	25
Picture Cues (32)	17	15	7	25
Verbal Cues (32)	15	17	9	23
High MA (56)	27	29	6	50
Low MA (56)	25	31	22	34
Rural School (56)	28	28	9	47
Urban School (56)	24	32	19	37
Male (52)	--	--	11	41
Female (60)	--	--	17	43

TABLE 9

Analysis of Variance of ARC Scores for the Experimental Groups on the Training Trials

Source	df	MS	F	
Between Ss				
Recall Condition (R)	1	28.84	165.68	*
Cue Type (C)	2	0.05	0.26	
Mental Age Level (M)	1	0.01	0.04	
School (S)	1	0.01	0.06	
R X C	2	0.06	0.32	
R X M	1	0.03	0.18	
R X S	1	0.01	0.04	
C X M	2	0.11	0.63	
C X S	2	0.03	0.14	
M X S	1	0.00	0.00	
R X C X M	2	0.10	0.58	
R X C X S	2	0.02	0.09	
R X M X S	1	0.02	0.14	
C X M X S	2	0.08	0.46	
R X C X M X S	2	0.06	0.35	
Error (b)	72	0.17		

(Continued...)

TABLE 9 -Continued

Source	df	MS	F
Within Ss			
Trials (T)	2	0.01	0.17
T X R	2	0.00	0.06
T X C	4	0.12	1.39
T X M	2	0.02	0.21
T X S	2	0.03	0.32
T X R X C	4	0.08	0.92
T X R X M	2	0.00	0.01
T X R X S	2	0.05	0.62
T X C X M	4	0.07	0.87
T X C X S	4	0.09	1.07
T X M X S	2	0.12	1.39
T X R X C X M	4	0.04	0.43
T X R X C X S	4	0.13	1.46
T X R X M X S	2	0.08	0.93
T X C X M X S	4	0.04	0.52
T X R X C X M X S	4	0.07	0.85
Error (w)	144	0.09	

* $P < .001$

TABLE 10

Analysis of Variance of ARC Scores for the Free Recall and Control Groups on the Training Trials

Source	df	MS	F
Between Ss			
Cue Type (C)	3	0.24	0.68
Mental Age Level (M)	1	0.01	0.02
School (S)	1	0.00	0.01
C X M	3	0.14	0.39
C X S	3	0.03	0.09
M X S	1	0.12	0.35
C X M X S	3	0.15	0.44
Error (b)	48	0.35	
Within Ss			
Trials (T)	2	0.05	0.32
T X C	6	0.14	0.94
T X M	2	0.00	0.00
T X S	2	0.01	0.08
T X C X M	6	0.09	0.57
T X C X S	6	0.23	1.52
T X M X S	2	0.16	1.05
T X C X M X S	6	0.25	1.61
Error (w)	96	0.15	

TABLE 11

Analysis of Variance of ARC Scores for the

Directive Cuing and Control Groups on the Training Trials

Source	df	MS	F	
Between Ss				
Cue Type (C)	3	6.81	72.83	***
Mental Age Level (M)	1	0.02	0.19	
School (S)	1	0.00	0.02	
C X M	3	0.01	0.11	
C X S	3	0.01	0.13	
M X S	1	0.03	0.28	
C X M X S	3	0.10	1.06	
Error (b)	48	0.09		
Within Ss				
Trials (T)	2	0.02	0.76	
T X C	6	0.02	0.77	
T X M	2	0.00	0.01	
T X S	2	0.08	2.70	
T X C X M	6	0.02	0.50	
T X C X S	6	0.05	1.43	
T X M X S	2	0.15	4.75	*
T X C X M X S	6	0.11	3.59	**
Error (w)	96	0.03		

* $P < .05$ ** $P < .005$ *** $P < .001$

TABLE 13

Analysis of Variance of ARC Scores for the Experimental Groups on All Four Trials

Source	df	MS	F	
Between Ss				
Recall Condition (R)	1	26.64	117.09	**
Cue Type (C)	2	0.31	1.37	
Mental Age Level (M)	1	0.17	0.74	
School (S)	1	0.04	0.19	
R X C	2	0.10	0.44	
R X M	1	0.00	0.00	
R X S	1	0.00	0.00	
C X M	2	0.11	0.47	
C X S	2	0.05	0.20	
M X S	1	0.09	0.41	
R X C X M	2	0.12	0.52	
R X C X S	2	0.00	0.01	
R X M X S	1	0.03	0.13	
C X M X S	2	0.06	0.27	
R X C X M X S	2	0.06	0.28	
Error (b)	72	0.23		

(Continued...)

TABLE 13 -Continued

Source	df	MS	F	
Within Ss				
Trials (T)	3	0.80	8.03	**
T X R	3	1.09	10.91	**
T X C	6	0.18	1.84	
T X M	3	0.27	2.70	*
T X S	3	0.03	0.27	
T X R X C	6	0.09	0.86	
T X R X M	3	0.03	0.34	
T X R X S	3	0.04	0.40	
T X C X M	6	0.11	1.06	
T X C X S	6	0.07	0.74	
T X M X S	3	0.15	1.55	
T X R X C X M	6	0.03	026	
T X R X C X S	6	0.09	0.94	
T X R X M X S	3	0.18	1.77	
T X C X M X S	6	0.06	0.62	
T X R X C X M X S	6	0.15	1.54	
Error (w)	216	0.10		

* $p < .05$ ** $p < .001$

TABLE 14

Analysis of Variance of ARC Scores for the Directive Cuing and Control Groups on the Transfer Trial

Source	df	MS	F
Cue Condition (C)	3	0.54	3.59 *
Mental Age Level (M)	1	0.68	4.51 *
School (S)	1	0.03	0.18
C X M	3	0.07	0.49
C X S	3	0.03	0.23
M X S	1	0.01	0.04
C X M X S	3	0.04	0.26
Error	48	0.15	

* $p < .05$

TABLE 15

Analysis of Variance of ARC Scores for the Free Recall and Control Groups on the Transfer Trial

Source	df	MS	F
Cue Condition (C)	3	0.15	0.89
Mental Age Level (M)	1	0.25	1.48
School (S)	1	0.07	0.39
C X M	3	0.08	0.49
C X S	3	0.02	0.09
M X S	1	0.68	3.93
C X M X S	3	0.25	1.48
Error	48	0.17	

TABLE 16

Correlation Matrix for Clustering (ARC), Item Recall (N), Category Recall (CAT), Redundancy (RED) and Intrusion (INT) Scores

	Trial	N	CAT	RED	INT
ARC	1	0.36***	0.45***	-0.12	0.04
	2	0.49***	0.33***	-0.23**	0.11
	3	0.44***	0.23**	-0.31***	0.12
	T	0.01	-0.16*	-0.08	0.21*
N	1		0.57***	-0.16*	-0.13
	2		0.46***	-0.23**	-0.06
	3		0.53***	-0.26**	-0.07
	T		0.47***	-0.17*	-0.15
CAT	1			-0.14	-0.04
	2			-0.34***	-0.06
	3			-0.30***	0.17*
	T			-0.23**	-0.07
RED	1				0.08
	2				0.08
	3				-0.01
	T				0.01

* $p < .05$ ** $p < .01$ *** $p < .001$

TABLE 18

Analysis of Covariance of Item Recall Scores for the Directive Cuing and Control Groups on Trial One

Source	df	MS	F	
Cue Condition (C)	3	43.12	8.05	**
Mental Age Level (M)	1	28.83	5.38	*
School (S)	1	6.07	1.13	
C X M	3	1.21	0.23	
C X S	3	4.38	0.82	
M X S	1	4.52	0.84	
C X M X S	3	1.73	0.32	
Covariate-BRAT	1	35.79	6.68	*
Error	47	5.36		

* $p < .05$ ** $p < .001$

TABLE 19

Analysis of Covariance of Item Recall Scores for the Free Recall and Control Groups on Trial One

Source	df	MS	F
Cue Condition (C)	3	11.80	2.22
Mental Age Level (M)	1	38.48	7.24 *
School (S)	1	0.25	0.05
C X M	3	3.53	0.66
C X S	3	2.76	0.52
M X S	1	0.14	0.03
C X M X S	3	0.76	0.14
Covariate-BRAT	1	71.40	13.43 **
Error	47	5.32	

* $p < .01$ ** $p < .001$

TABLE 21

Analysis of Covariance of Item Recall Scores for the Directive Cuing and Control Groups on the Training Trials

Source	df	MS	F	
Between Ss				
Cue Type (C)	3	119.44	10.47	***
Mental Age Level (M)	1	78.18	6.85	*
School (S)	1	31.72	2.78	
C X M	3	1.95	0.17	
C X S	3	13.25	1.34	
M X S	1	13.55	1.19	
C X M X S	3	3.12	0.27	
Covariate - BRAT	1	98.75	8.65	**
Error (b)	47	11.41		
Within Ss				
Trials (T)	2	44.15	44.53	***
T X C	6	0.77	0.78	
T X M	2	0.15	0.15	
T X S	2	1.27	1.28	
T X C X M	6	1.85	1.87	
T X C X S	6	0.94	0.95	
T X M X S	2	0.00	0.00	
T X C X M X S	6	0.39	0.39	
Error (w)	96	0.99		

* $p < .05$ ** $p < .005$ *** $p < .001$

TABLE 22

Analysis of Covariance of Item Recall Scores for the Free Recall and Control Groups on the Training Trials

Source	df	MS	F
Between Ss			
Cue Type (C)	3	11.95	1.07
Mental Age Level (M)	1	104.86	9.39 *
School (S)	1	0.81	0.07
C X M	3	8.87	0.79
C X S	3	2.17	0.19
M X S	1	4.08	0.37
C X M X S	3	2.31	0.21
Covariate - BRAT	1	184.16	16.50 **
Error (b)	47	11.16	

(Continued...)

TABLE 22 -Continued

Source	df	MS	F	
Within Ss				
Trials (T)	2	18.66	12.51	**
T X C	6	2.92	1.96	
T X M	2	0.11	0.07	
T X S	2	1.47	0.99	
T X C X M	6	0.99	0.66	
T X C X S	6	2.33	1.56	
T X M X S	2	0.94	0.63	
T X C X M X S	6	0.29	0.19	
Error (w)	96	1.49		

* $p < .005$ ** $p < .001$

TABLE 24

Analysis of Covariance of Item Recall Scores for the Directive Cuing and Control Groups on the Transfer Trial

Source	df	MS	F	
Cue Condition (C)	3	18.89	3.45	*
Mental Age Level (M)	1	25.75	4.71	*
School (S)	1	0.26	0.05	
C X M	3	2.67	0.49	
C X S	3	4.05	0.74	
M X S	1	1.89	0.35	
C X M X S	3	5.01	0.92	
Covariate-BRAT	1	87.69	16.03	**
Error	47	5.23		

* $p < .05$ ** $p < .001$

TABLE 25

Analysis of Covariance of Item Recall Scores for the Free Recall and Control Groups on the Transfer Trial

Source	df	MS	F	
Cue Condition (C)	3	9.89	2.08	
Mental Age Level (M)	1	35.58	7.47	*
School (S)	1	1.13	0.24	
C X M	3	3.47	0.73	
C X S	3	4.46	0.94	
M X S	1	1.56	0.33	
C X M X S	3	3.62	0.76	
Covariate-BRAT	1	62.72	13.17	**
Error	47	4.76		

* $p < .01$ ** $p < .001$

TABLE 26

Analysis of Covariance of Item Recall Scores for the Experimental Groups on All Four Trials

Source	df	MS	F	
Between Ss				
Recall Condition (R)	1	393.85	26.85	**
Cue Type (C)	2	5.82	0.40	
Mental Age Level (M)	1	196.70	13.41	**
School (S)	1	54.33	3.70	
R X C	2	26.60	1.81	
R X M	1	3.82	0.26	
R X S	1	5.59	0.38	
C X M	2	3.33	0.23	
C X S	2	3.79	0.26	
M X S	1	8.07	0.55	
R X C X M	2	17.55	1.20	
R X C X S	2	8.41	0.57	
R X M X S	1	1.50	0.10	
C X M X S	2	5.97	0.41	
R X C X M X S	2	2.31	0.16	
Covariate - BRAT	1	287.41	19.59	**
Error (b)	71	14.67		

(Continued...)

TABLE 26 -Continued

Source	df	MS	F	
Within Ss				
Trials (T)	3	27.56	18.09	**
T X R	3	11.37	7.46	**
T X C	6	2.24	1.47	
T X M	3	0.73	0.48	
T X S	3	1.57	1.03	
T X R X C	6	3.36	2.20	*
T X R X M	3	0.27	0.18	
T X R X S	3	2.36	1.55	
T X C X M	6	1.89	1.24	
T X C X S	6	0.64	0.42	
T X M X S	3	0.51	0.33	
T X R X C X M	6	1.22	0.80	
T X R X C X S	6	2.25	1.48	
T X R X M X S	3	0.53	0.35	
T X C X M X S	6	2.93	1.93	
T X R X C X M X S	6	0.75	0.49	
Error (w)	216	1.52		

* $p < .05$ ** $p < .001$

TABLE 27

Analysis of Covariance of Item Recall Scores for the Directive Cuing and Control Groups on All Four Trials

Source	*df*	*MS*	*F*	
Between *Ss*				
Cue Type (C)	3	131.79	8.74	***
Mental Age Level (M)	1	104.24	6.92	*
School (S)	1	26.62	1.77	
C X M	3	1.96	0.13	
C X S	3	17.43	1.16	
M X S	1	15.02	1.00	
C X M X S	3	2.73	0.18	
Covariate-BRAT	1	157.87	10.47	**
Error (b)	47	15.07		

(Continued...)

TABLE 27 -Continued

Source	df	MS	F	
Within Ss				
Trials (T)	3	29.52	23.15	***
T X C	9	2.76	2.16	*
T X M	3	0.12	0.10	
T X S	3	2.02	1.58	
T X C X M	9	2.15	1.69	
T X C X S	9	1.25	0.98	
T X M X S	3	0.14	0.11	
T X C X M X S	9	2.07	1.62	
Error (w)	144	1.28		

* $p < .05$ ** $p < .01$ *** $p < .001$

TABLE 28

Analysis of Covariance of Item Recall Scores for the Free Recall and Control Groups on All Four Trials

Source	df	MS	F	
Between Ss				
Cue Type (C)	3	17.84	1.22	
Mental Age Level (M)	1	140.74	9.64	**
School (S)	1	1.78	0.12	
C X M	3	12.03	0.82	
C X S	3	4.76	0.33	
M X S	1	5.64	0.39	
C X M X S	3	4.06	0.28	
Covariate-BRAT	1	219.02	15.00	***
Error (b)	47	14.61		

(Continued...)

TABLE 28 -Continued

Source	df	MS	F	
Within Ss				
Trials (T)	3	28.11	19.51	***
T X C	9	3.27	2.27	*
T X M	3	0.09	0.68	
T X S	3	0.98	0.68	
T X C X M	9	0.77	0.53	
T X C X S	9	2.18	1.51	
T X M X S	3	0.63	0.44	
T X C X M X S	9	0.84	0.58	
Error (w)	144	1.44		

* $p < .05$ ** $p < .005$ *** $p < .001$

TABLE 29

Analysis of Variance of Category Recall Scores for the Experimental Groups on Trial One

Source	df	MS	F	
Recall Condition (R)	1	4.17	17.65	**
Cue Type (C)	2	0.54	2.29	
Mental Age Level (M)	1	1.04	4.41	*
School (S)	1	0.17	0.71	
R X C	2	0.29	1.24	
R X M	1	0.67	2.82	
R X S	1	0.04	0.18	
C X M	2	0.04	0.18	
C X S	2	0.29	1.24	
M X S	1	0.17	0.71	
R X C X M	2	0.04	0.18	
R X C X S	2	0.17	0.71	
R X M X S	1	0.04	0.18	
C X M X S	2	0.29	1.24	
R X C X M X S	2	0.17	0.71	
Error	72	0.24		

* $p < .05$ ** $p < .001$

TABLE 30

Analysis of Variance of Category Recall Scores for the Directive Cuing and Control Groups on Trial One

Source	df	MS	F
Cue Condition (C)	3	2.52	8.96 *
Mental Age Level (M)	1	0.56	2.00
School (S)	1	0.06	0.22
C X M	3	0.35	1.26
C X S	3	0.02	0.07
M X S	1	0.06	0.22
C X M X S	3	0.02	0.07
Error	48	0.36	

* $p < .001$

TABLE 31

Analysis of Variance of Category Recall Scores for the Free Recall and Control Groups on Trial One

Source	df	MS	F	
Cue Condition (C)	3	1.10	1.83	
Mental Age Level (M)	1	3.06	5.07	*
School (S)	1	0.25	0.41	
C X M	3	0.10	0.17	
C X S	3	0.29	0.48	
M X S	1	0.25	0.41	
C X M X S	3	0.29	0.48	
Error	48	0.60		

* $p < .05$

TABLE 32 -Continued

Source	df	MS	F
Within Ss			
Trials (T)	2	0.07	0.63
T X R	2	0.02	0.21
T X C	4	0.18	1.53
T X M	2	0.07	0.63
T X S	2	0.32	2.73
T X R X C	4	0.12	1.02
T X R X M	2	0.02	0.21
T X R X S	2	0.34	2.91
T X C X M	4	0.10	0.90
T X C X S	4	0.23	2.01
T X M X S	2	0.02	0.21
T X R X C X M	4	0.13	1.11
T X R X C X S	4	0.22	1.92
T X R X M X S	2	0.05	0.39
T X C X M X S	4	0.03	0.30
T X R X C X M X S	4	0.02	0.21
Error (w)	144	0.12	

* $p < .05$ ** $p < .001$

TABLE 33

Analysis of Variance of Category Recall Scores for the Directive Cuing and Control Groups on the Training Trials

Source	df	MS	F	
Between Ss				
Cue Type (C)	3	2.92	10.72	**
Mental Age Level (M)	1	0.88	3.23	
School (S)	1	0.01	0.02	
C X M	3	0.71	2.62	
C X S	3	0.03	0.12	
M X S	1	0.05	0.17	
C X M X S	3	0.02	0.07	
Error (b)	48	0.27		
Within Ss				
Trials (T)	2	0.38	3.78	*
T X C	6	0.28	2.74	*
T X M	2	0.04	0.36	
T X S	2	0.07	0.67	
T X C X M	6	0.02	0.16	
T X C X S	6	0.04	0.33	
T X M X S	2	0.02	0.16	
T X C X M X S	6	0.01	0.09	
Error (w)	96	0.10		

* $p < .05$ ** $p < .001$

TABLE 34

Analysis of Variance of Category Recall Scores for the Free Recall and Control Groups on the Training Trials

Source	df	MS	F
Between Ss			
Cue Type (C)	3	0.65	0.88
Mental Age Level (M)	1	5.33	7.18 *
School (S)	1	0.52	0.70
C X M	3	0.49	0.65
C X S	3	0.45	0.61
M X S	1	1.02	1.37
C X M X S	3	0.45	0.61
Error (b)	48	0.74	
Within Ss			
Trials (T)	2	0.63	2.39
T X C	6	0.41	1.55
T X M	2	0.13	0.49
T X S	2	0.57	2.15
T X C X M	6	0.16	0.60
T X C X S	6	0.37	1.41
T X M X S	2	0.07	0.26
T X C X M X S	6	0.04	0.15
Error (w)	96	0.26	

* $P < .01$

TABLE 35

Analysis of Variance of Category Recall Scores for the Experimental Groups on the Transfer Trial

Source	df	MS	F
Recall Condition (R)	1	0.39	0.77
Cue Type (C)	2	0.14	0.63
Mental Age Level (M)	1	1.50	6.97 *
School (S)	1	0.00	0.00
R X C	2	0.14	0.63
R X M	1	0.04	0.19
R X S	1	0.04	0.19
C X M	2	0.03	0.15
C X S	2	0.59	2.76
M X S	1	0.04	0.19
R X C X M	2	0.07	0.34
R X C X S	2	0.39	1.79
R X M X S	1	0.17	0.77
C X M X S	2	0.07	0.34
R X C X M X S	2	0.32	1.50
Error	72	0.22	

* $p < .01$

TABLE 36

Analysis of Variance of Category Recall Scores for the Directive Cuing and Control Groups on the Transfer Trial

Source	df	MS	F
Cue Condition (C)	3	0.06	0.32
Mental Age Level (M)	1	1.00	5.05 *
School (S)	1	0.06	0.32
C X M	3	0.08	0.42
C X S	3	0.40	2.00
M X S	1	0.00	0.00
C X M X S	3	0.25	1.26
Error	48	0.20	

* $p < .05$

TABLE 37

Analysis of Variance of Category Recall Scores for the Free Recall and Control Groups on the Transfer Trial

Source	*df*	*MS*	*F*
Cue Condition (C)	3	0.19	0.78
Mental Age Level (M)	1	1.56	6.52 *
School (S)	1	0.00	0.00
C X M	3	0.02	0.09
C X S	3	0.29	1.22
M X S	1	0.25	1.04
C X M X S	3	0.04	0.17
Error	48	0.24	

* $p < .05$

TABLE 38

Analysis of Variance of Redundancy Scores for the Experimental Groups on Trial One

Source	df	MS	F
Recall Condition (R)	1	15.04	8.81 **
Cue Type (C)	2	2.32	1.36
Mental Age Level (M)	1	0.67	0.39
School (S)	1	3.38	1.98
R X C	2	0.95	0.56
R X M	1	1.50	0.88
R X S	1	0.04	0.02
C X M	2	6.14	3.59
C X S	2	2.28	1.34
M X S	1	0.67	0.39
R X C X M	2	4.34	2.54
R X C X S	2	1.07	0.63
R X M X S	1	1.50	0.88
C X M X S	2	1.89	1.10
R X C X M X S	2	2.09	1.23
Error	72	1.71	

* $p < .05$ ** $p < .005$

TABLE 39

Analysis of Variance of Redundancy Scores for the Directive Cuing and Control Groups on Trial One

Source	df	MS	F
Cue Condition (C)	3	5.83	3.64 *
Mental Age Level (M)	1	4.00	2.49
School (S)	1	0.06	0.04
C X M	3	0.17	0.10
C X S	3	1.56	0.97
M X S	1	3.06	1.91
C X M X S	3	0.73	0.46
Error	48	1.60	

* $p < .05$

TABLE 40

Analysis of Variance of Redundancy Scores for the Free Recall and Control Groups on Trial One

Source	*df*	*MS*	*F*
Cue Condition (C)	3	2.35	0.85
Mental Age Level (M)	1	0.25	0.09
School (S)	1	0.25	0.09
C X M	3	7.63	2.75
C X S	3	3.21	1.16
M X S	1	0.06	0.02
C X M X S	3	2.27	0.82
Error	48	2.77	

TABLE 41

Analysis of Variance of Redundancy Scores for the Experimental Groups on the Training Trials

Source	df	MS	F	
Between Ss				
Recall Condition (R)	1	128.00	33.27	**
Cue Type (C)	2	10.90	2.83	
Mental Age Level (M)	1	1.68	0.44	
School (S)	1	3.12	0.81	
R X C	2	7.16	1.86	
R X M	1	2.35	0.61	
R X S	1	0.35	0.09	
C X M	2	10.32	2.68	
C X S	2	4.82	1.25	
M X S	1	2.00	0.52	
R X C X M	2	9.21	2.39	
R X C X S	2	8.77	2.28	
R X M X S	1	0.06	0.01	
C X M X S	2	3.66	0.95	
R X C X M X S	2	1.19	0.31	
Error (b)	72	3.85		

(Continued...)

TABLE 41 -Continued

Source	df	MS	F	
Within Ss				
Trials (T)	2	10.38	7.91	**
T X R	2	6.32	4.82	*
T X C	4	1.61	1.22	
T X M	2	0.38	0.29	
T X S	2	0.76	0.58	
T X R X C	4	1.26	0.96	
T X R X M	2	0.13	0.10	
T X R X S	2	0.73	0.56	
T X C X M	4	0.70	0.53	
T X C X S	4	0.21	0.16	
T X M X S	2	1.26	0.96	
T X R X C X M	4	0.43	0.33	
T X R X C X S	4	1.66	1.26	
T X R X M X S	2	2.23	1.70	
T X C X M X S	4	2.14	1.63	
T X R X C X M X S	4	2.15	1.64	
Error (w)	144	1.31		

* $p < .01$ ** $p < .001$

TABLE 42

Analysis of Variance of Redundancy Scores for the Directive Cuing and Control Groups on the Training Trials

Source	df	MS	F	
Between Ss				
Cue Type (C)	3	24.77	4.84	**
Mental Age Level (M)	1	24.80	4.85	*
School (S)	1	0.05	0.01	
C X M	3	7.14	1.40	
C X S	3	3.23	0.63	
M X S	1	1.88	0.37	
C X M X S	3	0.87	0.17	
Error (b)	48	5.12		
Within Ss				
Trials (T)	2	1.47	1.66	
T X C	6	1.55	1.75	
T X M	2	0.61	0.69	
T X S	2	0.20	0.23	
T X C X M	6	1.52	1.71	
T X C X S	6	0.99	1.11	
T X M X S	2	1.01	1.13	
T X C X M X S	6	0.43	0.48	
Error (w)	96	0.89		

* $p < .05$ ** $p < .005$

TABLE 43

Analysis of Variance of Redundancy Scores for the Free Recall and Control Groups on the Training Trials

Source	df	MS	F	
Between Ss				
Cue Type (C)	3	11.19	1.32	
Mental Age Level (M)	1	9.63	1.14	
School (S)	1	0.26	0.03	
C X M	3	23.87	2.82	*
C X S	3	10.91	1.29	
M X S	1	2.76	0.33	
C X M X S	3	2.63	0.31	
Error (b)	48	8.47		
Within Ss				
Trials (T)	2	18.07	8.89	**
T X C	6	1.04	0.51	
T X M	2	1.26	0.62	
T X S	2	0.66	0.33	
T X C X M	6	1.54	0.77	
T X C X S	6	0.73	0.36	
T X M X S	2	3.22	1.59	
T X C X M X S	6	2.73	1.34	
Error (w)	96	2.03		

* $p < .05$ ** $p < .001$

TABLE 44

Analysis of Variance of Redundancy Scores for the Experimental Groups on the Transfer Trial

Source	df	MS	F
Recall Condition (R)	1	15.04	2.41
Cue Type (C)	2	2.32	0.37
Mental Age Level (M)	1	22.04	3.53
School (S)	1	1.04	0.17
R X C	2	2.82	0.45
R X M	1	0.04	0.01
R X S	1	15.04	2.41
C X M	2	3.20	0.51
C X S	2	22.95	3.67 *
M X S	1	12.04	1.93
R X C X M	2	0.82	0.13
R X C X S	2	0.95	0.15
R X M X S	1	0.38	0.06
C X M X S	2	9.45	1.51
R X C X M X S	2	5.66	0.91
Error	72	6.25	

* $p < .05$

TABLE 45

Analysis of Variance of Redundancy Scores for the Directive Cuing and Control Groups on the Transfer Trial

Source	*df*	*MS*	*F*
Cue Condition (C)	3	9.67	1.59
Mental Age Level (M)	1	36.00	5.93 *
School (S)	1	2.25	0.37
C X M	3	7.83	1.29
C X S	3	12.75	2.10
M X S	1	2.25	0.37
C X M X S	3	10.08	1.66
Error	48	6.07	

* $p < .05$

TABLE 46

Analysis of Variance of Redundancy Scores for the Free Recall and Control Groups on the Transfer Trial

Source	df	MS	F
Cue Condition (C)	3	4.77	0.65
Mental Age Level (M)	1	39.06	5.30 *
School (S)	1	10.56	1.43
C X M	3	5.35	0.73
C X S	3	19.22	1.40
M X S	1	5.06	0.69
C X M X S	3	1.85	0.25
Error	48	7.37	

* $p < .05$

TABLE 47

Intruding Responses by Classification

and Frequency

Categorical Intrusions			
Animals:	cow (45)	pig (7)	rooster (4)
donkey (2)	rat (2)	sheep (1)	hen (1)
bear (1)	deer (1)	mouse (1)	dinosaur (1)
Fruit:	plum (9)	peach (9)	grape (7)
corn (3)	tomato (2)	lemon (1)	cherry (1)
Vehicles:	airplane (4)	ambulance (1)	van (1)
Toys:	bat (4)	wagon (1)	balloon (1)
Cues			
barn (8)	box (2)	bucket (1)	
BRAT items			
saw (3)	book (2)	clock (2)	boat (2)
pencil (1)	rose (1)	ring (1)	
Miscellaneous			
bird (4)	house (6)	boy (3)	hammer (2)
ribbons (2)	cookie (2)	girl (1)	dishes (1)
crib (1)	crayons (1)	onion (1)	ladder (1)
pool (1)	leaf (1)	cake (1)	

TABLE 48

Analysis of Variance of Intrusion Scores for the Experimental Groups on Trial One

Source	df	MS	F	
Recall Condition (R)	1	0.26	0.51	
Cue Type (C)	2	5.07	9.94	**
Mental Age Level (M)	1	3.76	7.37	*
School (S)	1	0.26	0.51	
R X C	2	0.70	1.37	
R X M	1	0.51	1.00	
R X S	1	0.26	0.51	
C X M	2	0.64	1.25	
C X S	2	0.01	0.02	
M X S	1	1.76	3.45	
R X C X M	2	0.14	0.27	
R X C X S	2	0.26	0.51	
R X M X S	1	0.84	1.65	
C X M X S	2	0.45	0.88	
R X C X M X S	2	0.41	0.80	
Error	72	0.51		

* $p < .01$ ** $p < .001$

TABLE 49

Analysis of Variance of Intrusion Scores for the Directive Cuing and Control Groups on Trial One

Source	df	MS	F
Cue Condition (C)	3	3.38	7.36 *
Mental Age Level (M)	1	1.56	3.41
School (S)	1	0.06	0.14
C X M	3	0.19	0.41
C X S	3	0.19	0.41
M X S	1	0.25	0.55
C X M X S	3	0.21	0.46
Error	48	0.46	

* $p < .001$

TABLE 50

Analysis of Variance of Intrusion Scores for the Free Recall and Control Groups on Trial One

Source	df	MS	F	
Cue Condition (C)	3	0.81	1.78	
Mental Age Level (M)	1	4.52	9.97	**
School (S)	1	0.77	1.69	
C X M	3	0.39	0.86	
C X S	3	0.06	0.13	
M X S	1	2.64	5.83	*
C X M X S	3	0.43	0.95	
Error	48	0.45		

* $p < .05$ ** $p < .005$

TABLE 51

Analysis of Variance of Intrusion Scores for the Experimental Groups on the Training Trials

Source	df	MS	F	
Between Ss				
Recall Condition (R)	1	2.17	1.61	
Cue Type (C)	2	7.57	5.64	**
Mental Age Level (M)	1	5.84	4.34	*
School (S)	1	0.03	0.02	
R X C	2	2.36	1.75	
R X M	1	2.92	2.17	
R X S	1	0.59	0.44	
C X M	2	2.52	1.88	
C X S	2	0.45	0.33	
M X S	1	0.00	0.00	
R X C X M	2	1.25	0.93	
R X C X S	2	1.32	0.98	
R X M X S	1	1.84	1.37	
C X M X S	2	0.73	0.55	
R X C X M X S	2	1.63	1.21	
Error (b)	72	1.34		

(Continued...)

TABLE 51 -Continued

Source	df	MS	F	
Within Ss				
Trials (T)	2	0.03	0.16	
T X R	2	0.13	0.64	
T X C	4	0.53	2.61	*
T X M	2	0.32	1.57	
T X S	2	0.32	1.60	
T X R X C	4	0.27	1.34	
T X R X M	2	0.07	0.33	
T X R X S	2	0.38	1.88	
T X C X M	4	0.11	0.56	
T X C X S	4	0.19	0.96	
T X M X S	2	1.65	8.19	***
T X R X C X M	4	0.19	0.97	
T X R X C X S	4	0.44	2.16	
T X R X M X S	2	0.27	1.36	
T X C X M X S	4	0.05	0.25	
T X R X C X M X S	4	0.05	0.25	
Error (w)	144	0.20		

* $p < .05$ ** $p < .005$ *** $p < .001$

TABLE 52

Analysis of Variance of Intrusion Scores for the Directive Cuing and Control Groups on the Training Trials

Source	*df*	*MS*	*F*	
Between *S*s				
Cue Type (C)	3	7.35	5.61	**
Mental Age Level (M)	1	0.88	0.67	
School (S)	1	0.13	0.10	
C X M	3	1.23	0.94	
C X S	3	1.14	0.87	
M X S	1	0.42	0.32	
C X M X S	3	1.10	0.84	
Error (b)	48	1.31		
Within *S*s				
Trials (T)	2	0.05	0.25	
T X C	6	0.39	2.00	
T X M	2	0.41	2.15	
T X S	2	0.16	0.85	
T X C X M	6	0.13	0.70	
T X C X S	6	0.43	2.23	*
T X M X S	2	1.23	6.46	**
T X C X M X S	6	0.04	0.21	
Error (w)	96	0.19		

* $p < .05$ ** $p < .005$

TABLE 53

Analysis of Variance of Intrusion Scores for the Free Recall and Control Groups on the Training Trials

Source	df	MS	F	
Between Ss				
Cue Type (C)	3	1.35	1.55	
Mental Age Level (M)	1	9.19	10.58	**
School (S)	1	0.33	0.38	
C X M	3	1.53	1.77	
C X S	3	0.21	0.24	
M X S	1	1.02	1.18	
C X M X S	3	0.73	0.84	
Error (b)	48	0.87		
Within Ss				
Trials (T)	2	0.22	1.24	
T X C	6	0.20	1.09	
T X M	2	0.11	0.61	
T X S	2	0.69	3.84	*
T X C X M	6	0.12	0.68	
T X C X S	6	0.07	0.37	
T X M X S	2	0.85	4.70	*
T X C X M X S	6	0.10	0.55	
Error (w)	96	0.18		

* $p < .05$ ** $p < .01$

TABLE 54

Analysis of Variance of Intrusion Scores for the Experimental Groups on the Transfer Trial

Source	df	MS	F
Recall Condition (R)	1	0.17	0.34
Cue Type (C)	2	1.04	2.14
Mental Age Level (M)	1	0.38	0.77
School (S)	1	0.38	0.77
R X C	2	0.17	0.34
R X M	1	0.38	0.77
R X S	1	0.04	0.09
C X M	2	0.88	1.80
C X S	2	0.50	1.03
M X S	1	0.17	0.34
R X C·X M	2	0.38	0.77
R X C X S	2	0.29	0.60
R X M X S	1	0.17	0.34
C X M X S	2	0.04	0.09
R X C X M X S	2	0.29	0.60
Error	72	0.49	

TABLE 55

Analysis of Variance of Intrusion Scores for the Directive Cuing and Control Groups on the Transfer Trial

Source	*df*	*MS*	*F*
Cue Condition (C)	3	0.35	0.79
Mental Age Level (M)	1	0.14	0.32
School (S)	1	0.77	1.73
C X M	3	0.43	0.98
C X S	3	0.47	1.07
M X S	1	0.02	0.04
C X M X S	3	0.47	1.07
Error	48	0.44	

TABLE 56

Analysis of Variance of Intrusion Scores for the Free Recall and Control Groups on the Transfer Trial

Source	*df*	*MS*	*F*
Cue Condition (C)	3	0.56	1.39
Mental Age Level (M)	1	1.27	3.16
School (S)	1	0.39	0.97
C X M	3	0.56	1.39
C X S	3	0.18	0.46
M X S	1	0.14	0.35
C X M X S	3	0.18	0.46
Error	48	0.40	

APPENDIX C

STATISTICAL MEASUREMENT OF CLUSTERING

STATISTICAL MEASUREMENT OF CLUSTERING

Once Bousfield (1953) had reported the occurance of clustering in recall, a sound statistical method had to be devised to accurately measure the clustering of items. A number of authors (e.g., Bousfield & Bousfield, 1966; Colle, 1972; Cohen, Sakoda & Bousfield, 1954; Dalrymple-Alford, 1970, 1971; Frankel & Cole, 1971; Hubert & Levin, 1976; Mandler, 1969; Moely, Olson, Halwes & Flavell, 1969; Roenker, Thompson & Brown, 1971) have suggested a variety of statistical models to handle the problem. A number of factors must be considered in selecting any one method. Pellegrino (1971) noted that measurement of organization in recall is rendered difficult by the fact that in the free recall situation, output varies in size from one trial to the next within each subject, as well as between subjects on each trial. The ideal measure, therefore, must take into account the number of items recalled, as well as the amount of clustering observed, and give a score that can be compared to that of the same or different subject, on another trial with a different amount recalled. In short, the difficulty lies in keeping the clustering measure independent of amount recalled and comparable within and between subjects on different trials.

Bousfield and Bousfield (1966) have suggested a simple method of measuring clustering, their formula being: $\lfloor O - E \rfloor$ The expected by chance (E) number of category repetitions is subtracted from the observed (O) number. That measure has an upper limit imposed on it by the amount recalled. Recall and clustering are therefore not kept completely independent.

An alternate method was developed by Frankel and Cole (1971) using Z-scores and a "runs test". Their method is more complex, with mean number of runs, observed number of runs, list length, variance and category composition compared. The resultant score is converted to a Z-score to make the results comparable.

The use of a ratio measure has been sugested by Roenker, Thompson and Brown (1971). They proposed the Adjusted Ratio of Clustering (ARC) score in which chance clustering has a score of zero and perfect clustering a score of one. The score may be converted to a percentage for easier interpretation. Besides comparing the observed and expected number of category repetitions, as did the formula by Bousfield and Bousfield (1966), the ARC score takes into account the number of items recalled, the number of categories recalled, and the maximum possible number of category repetitions.

The ARC method was selected as the statistical measure of clustering to be used in the present study, because it keeps amount recalled and the clustering score relatively independent and gives scores that may be compared within and between subjects. A further reason for using the ARC is that it has been used by a number of experimenters researching the categorization strategy as used by retarded subjects (e.g., Bilsky, 1976; Burger, Blackman & Tan, 1980;

Glidden, 1976; Glidden et al., 1979; Green, 1974; McConkey & Herriot, 1974) and therefore facilitates the comparison of the results of the present study and those of other experiments.

For a more elaborate review of the current measures of clustering, the reader is referred to the articles by Colle (1972), Dalrymple-Alford (1970, 1971) and Hubert and Levin (1976, 1980).

APPENDIX D

SUMMARY DATA

Summary of Subject (Case) Information Including Experimental Condition (COND), Mental Age Level (MAGR), School (SCH), Sex, Chronological Age (CA), Mental Age (MA), BRAT Score and Down's Syndrome

Key

COND: 1-Free Recall Picture
2- " " Object
3- " " Verbal
4-Directive Picture
5- " Object
6- " Verbal
7-Control

MAGR: 1-High MA
2-Low MA

SCH: 1-Urban
2-Rural

SEX: 1-Male
2-Female

DS: 1-Not Down's
2-Down's

Case	COND	MAGR	SCH	SEX	CA	MA	BRAT	DS
1	1	1	1	1	235	101	7	1
2	1	1	1	1	162	122	5	1
3	1	1	1	2	220	92	5	1

Summary of Subject Information - Continued

Case	COND	MAGR	SCH	SEX	CA	MA	BRAT	DS
4	1	1	1	2	214	87	8	1
5	1	1	2	2	143	78	5	1
6	1	1	2	1	104	90	7	1
7	1	1	2	1	214	114	9	1
8	1	1	2	1	193	78	8	1
9	1	2	1	2	143	49	5	2
10	1	2	1	1	192	48	6	2
11	1	2	1	2	181	71	7	1
12	1	2	1	1	139	71	4	1
13	1	2	2	1	139	45	6	1
14	1	2	2	1	144	67	6	1
15	1	2	2	2	191	75	9	1
16	1	2	2	1	93	61	6	1
17	2	1	1	1	177	92	4	1
18	2	1	1	1	154	80	4	1
19	2	1	1	2	234	110	9	1
20	2	1	1	1	212	120	9	1
21	2	1	2	2	157	87	5	1
22	2	1	2	1	195	78	7	1
23	2	1	2	2	180	94	6	1

Summary of Subject Information - Continued

Case	COND	MAGR	SCH	SEX	CA	MA	BRAT	DS
24	2	1	2	2	167	103	10	1
25	2	2	1	1	114	48	6	2
26	2	2	1	2	93	56	9	1
27	2	2	1	1	189	73	4	2
28	2	2	1	1	176	65	4	1
29	2	2	2	1	152	59	6	1
30	2	2	2	2	102	64	5	2
31	2	2	2	1	186	50	5	1
32	2	2	2	2	169	75	10	1
33	3	1	1	1	158	103	5	2
34	3	1	1	1	239	122	6	1
35	3	1	1	1	222	97	8	1
36	3	1	1	2	126	80	5	1
37	3	1	2	1	211	78	10	1
38	3	1	2	1	238	116	6	1
39	3	1	2	1	175	82	8	1
40	3	1	2	2	208	85	7	1
41	3	2	1	2	138	75	4	2
42	3	2	1	2	130	53	7	2
43	3	2	1	1	89	42	5	1

Summary of Subject Information - Continued

Case	COND	MAGR	SCH	SEX	CA	MA	BRAT	DS
44	3	2	1	1	225	69	6	1
45	3	2	2	2	164	70	6	2
46	3	2	2	1	148	56	11	2
47	3	2	2	2	165	52	4	2
48	3	2	2	2	241	70	5	1
49	4	1	1	1	191	125	5	1
50	4	1	1	2	204	101	8	2
51	4	1	1	2	192	90	8	1
52	4	1	1	1	129	85	4	2
53	4	1	2	2	230	97	5	1
54	4	1	2	1	200	102	13	1
55	4	1	2	2	175	80	6	1
56	4	1	2	2	137	82	5	1
57	4	2	1	2	110	56	4	1
58	4	2	1	2	225	75	7	2
59	4	2	1	2	171	62	6	1
60	4	2	1	2	128	46	6	2
61	4	2	2	1	111	71	10	1
62	4	2	2	1	82	57	6	1
63	4	2	2	1	186	69	7	2

Summary of Subject Information - Continued

Case	COND	MAGR	SCH	SEX	CA	MA	BRAT	DS
64	4	2	2	1	59	53	4	1
65	5	1	1	1	246	85	5	2
66	5	1	1	1	161	92	6	2
67	5	1	1	2	187	101	7	1
68	5	1	1	1	157	124	8	1
69	5	1	2	2	247	82	7	1
70	5	1	2	1	184	96	4	1
71	5	1	2	2	221	78	10	1
72	5	1	2	2	245	105	9	1
73	5	2	1	2	198	69	4	1
74	5	2	1	2	228	65	5	1
75	5	2	1	2	213	65	5	1
76	5	2	1	2	131	41	9	2
77	5	2	2	1	149	50	8	1
78	5	2	2	2	150	65	7	1
79	5	2	2	2	209	76	4	2
80	5	2	2	2	141	59	8	1
81	6	1	1	2	172	78	5	1
82	6	1	1	2	133	90	6	2
83	6	1	1	2	235	120	9	1
84	6	1	1	2	225	113	5	1

Summary of Subject Information - Continued

Case	COND	MAGR	SCH	SEX	CA	MA	BRAT	DS
85	6	1	2	2	176	82	8	1
86	6	1	2	2	254	92	10	1
87	6	1	2	1	140	78	7	1
88	6	1	2	2	171	110	6	1
89	6	2	1	1	155	65	4	1
90	6	2	1	2	145	48	6	1
91	6	2	1	1	163	73	4	2
92	6	2	1	2	170	53	9	1
93	6	2	2	1	195	56	6	1
94	6	2	2	1	165	66	6	1
95	6	2	2	2	137	52	5	2
96	6	2	2	1	141	75	11	1
97	7	1	1	2	204	94	7	1
98	7	1	1	2	228	97	7	1
99	7	1	1	2	207	90	6	1
100	7	1	1	1	175	120	6	1
101	7	1	2	1	122	91	5	1
102	7	1	2	2	194	85	8	1
103	7	1	2	1	286	105	8	1

Summary of Subject Information - Continued

Case	COND	MAGR	SCH	SEX	CA	MA	BRAT	DS
104	7	1	2	1	234	78	8	1
105	7	2	1	1	246	67	6	2
106	7	2	1	2	130	55	6	2
107	7	2	1	2	179	71	6	2
108	7	2	1	2	142	45	6	1
109	7	2	2	1	90	59	5	1
110	7	2	2	2	189	62	10	1
111	7	2	2	2	134	55	8	2
112	7	2	2	2	196	74	5	2

Summary Data for Number of Items Recalled (N)

and ARC Scores for all Four Trials

for each Subject (Case)

Case	N1	N2	N3	N4	ARC1	ARC2	ARC3	ARC4
1	9	9	13	11	-16	45	8	-16
2	7	11	10	10	46	14	32	25
3	6	7	8	9	0	-40	64	-29
4	9	9	8	9	100	100	100	67
5	9	10	11	11	47	25	42	-20
6	5	5	6	7	-25	-25	-50	46
7	11	11	11	12	23	100	80	83
8	11	10	11	10	4	78	81	100
9	5	6	5	7	-25	0	17	100
10	4	7	5	7	0	13	100	100
11	6	10	9	9	25	32	45	100
12	4	6	6	7	100	25	100	100
13	4	8	7	9	100	69	46	71
14	9	6	6	8	67	100	100	20
15	10	13	13	13	76	10	25	-5

Summary Data - Continued

Case	N1	N2	N3	N4	ARC1	ARC2	ARC3	ARC4
16	6	6	10	8	-20	40	5	38
17	10	9	6	6	77	18	-50	100
18	5	5	5	5	100	-67	17	-67
19	15	14	15	12	100	100	100	82
20	6	9	9	10	-80	42	42	55
21	10	6	11	11	52	100	42	62
22	9	9	7	8	-25	21	56	-9
23	10	11	8	13	32	58	38	70
24	9	9	12	10	18	-9	-20	32
25	6	7	7	6	-20	100	100	100
26	10	10	9	9	52	5	45	45
27	8	9	8	10	11	100	20	29
28	7	7	7	8	0	46	-8	-23
29	8	7	7	7	60	7	7	7
30	6	7	7	6	100	100	100	100
31	11	10	9	9	23	25	18	18
32	8	10	11	12	-9	75	4	50
33	6	5	6	9	25	-67	-20	-16
34	11	13	11	15	20	24	38	-10
35	14	13	15	14	60	54	100	87

Summary Data - Continued

Case	N1	N2	N3	N4	ARC1	ARC2	ARC3	ARC4
36	7	8	7	8	100	100	-8	-9
37	13	12	14	13	-7	12	33	8
38	8	9	10	11	64	100	25	61
39	12	14	13	14	49	23	39	6
40	9	9	12	13	13	40	83	39
41	6	6	7	7	-100	25	-17	22
42	6	7	7	7	40	22	50	100
43	7	8	5	8	100	43	-67	0
44	9	7	8	10	13	7	64	55
45	8	10	9	10	-33	5	-16	9
46	7	6	11	9	-8	-20	57	45
47	8	7	10	13	20	-8	55	40
48	4	6	6	7	100	-20	50	-31
49	15	15	15	13	100	100	100	100
50	10	12	12	12	100	100	100	-3
51	10	11	14	11	100	100	100	4
52	9	10	11	7	100	100	100	100
53	9	11	11	9	100	100	100	67
54	14	15	14	12	100	100	100	-17
55	9	10	14	10	100	100	100	-14

Summary Data - Continued

Case	N1	N2	N3	N4	ARC1	ARC2	ARC3	ARC4
56	12	11	13	10	100	100	100	100
57	7	7	7	5	100	100	100	100
58	11	12	13	11	100	83	85	100
59	11	13	12	10	100	100	100	50
60	9	7	8	9	100	100	100	42
61	9	11	11	12	100	60	100	66
62	10	9	11	11	100	71	100	79
63	10	12	13	12	100	100	100	100
64	11	10	10	10	79	100	100	75
65	14	12	12	10	100	100	100	100
66	12	11	12	12	100	100	100	49
67	10	12	13	14	100	100	100	87
68	11	11	10	11	100	100	100	17
69	15	16	16	16	100	100	100	100
70	7	8	8	9	100	100	100	18
71	14	15	15	15	100	100	100	100
72	11	14	16	16	100	100	100	100
73	9	8	8	10	100	100	100	100
74	7	8	10	8	100	100	100	100
75	10	11	12	13	100	100	100	54

Summary Data - Continued

Case	N1	N2	N3	N4	ARC1	ARC2	ARC3	ARC4
76	6	8	7	9	100	100	100	73
77	9	11	11	9	100	100	100	47
78	12	15	16	11	100	100	100	81
79	13	13	13	15	85	100	100	100
80	10	12	12	7	100	100	100	100
81	7	8	8	7	100	100	100	-8
82	11	11	11	12	100	100	100	100
83	12	13	14	13	100	100	100	40
84	6	8	8	9	100	100	100	0
85	13	14	12	15	100	100	100	-10
86	10	12	13	13	100	100	100	8
87	10	13	14	12	100	100	100	-20
88	12	10	11	8	100	100	100	100
89	8	9	12	10	100	100	100	32
90	5	5	8	8	100	100	100	100
91	9	11	11	7	100	100	100	100
92	7	11	11	11	100	100	100	23
93	8	10	11	7	100	100	79	53
94	9	11	12	10	100	100	100	78
95	7	9	10	8	100	38	100	27

Summary Data - Continued

Case	N1	N2	N3	N4	ARC1	ARC2	ARC3	ARC4
96	14	15	15	15	100	100	100	39
97	8	10	11	11	-54	0	23	14
98	7	8	10	10	-31	67	25	9
99	8	8	10	10	0	20	50	50
100	8	9	10	12	100	42	100	49
101	5	8	8	5	100	0	8	17
102	7	8	8	7	46	60	60	46
103	12	13	13	15	64	25	24	63
104	5	7	7	8	-67	-62	-62	11
105	6	6	8	8	-20	25	-9	64
106	3	4	6	6	0	-99	-20	40
107	10	8	8	9	25	27	-23	47
108	7	7	9	9	22	0	42	42
109	3	6	6	5	0	40	100	100
110	9	10	12	10	38	25	66	50
111	7	7	7	8	0	56	59	0
112	8	7	9	10	27	-40	33	-25

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