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ABSTRACT

The reports of eight studies testing the effects of elaboration on the learning of children are compiled in this document. Mental elaboration is "thinking while learning" which occurs as the learner actively adds context to the material he is asked to process. Supplied elaboration, included in these studies, occurs when the learner is provided with elaborative learning aids such as pictures and sentences. Attempts are made to state the differential effects on learning of the two types of elaboration. A model for research on elaboration was presented, and it was hypothesized that children could learn much more rapidly when supplied with contexts or instructed in how to make up their own contexts. The general approach was to test a range of tasks for which imagery or verbal elaboration would be effective. Seven of the studies involved the paired-associate recall of nouns, while the other involved the learning of a finger maze. The most striking finding was that instructing children in mental elaboration (imagery and sentence generation) significantly increased the recall of nouns when compared with rote repetition, and it seems that instructing children in "how to learn" strategies may be appropriate for several school learning tasks. (AJ)

FINAL REPORT
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Visual Imagery Instruction and Non-Action Versus Action Situations Relative to Recall by Children

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Bloomington, Indiana 47401
April 15, 1970

The research reported herein was performed persuant to a grant with the Office of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
Bureau of Research

In consideration of the flight of Apollo XIII, the following space quotes are presented to point out two critical aspects of imagery--the need for a model and the problems of observation . . . .

"I am so glad we can send these pictures back to you on earth. For I could describe the beauty of the sunrise and sunset and you might be able to picture them in your mind; but for you to communicate this beauty to another you must first have seen it yourself."

-Eugene Cernan

"You earth people speak of seeing things in your minds eye. We martians are able to project these images in three dimensions."

-My Favorite Martian

SUMMARY

Eight studies were reported which test the effects of elaboration, both in the form of supplied sentences (imposed elaboration) and instructions to generate sentences or form images (mental elaboration), on the learning of children. A model for research on elaboration was presented, and it was hypothesized that children could learn much more rapidly when supplied with contexts or instructed in how to make up their own contexts. The general approach was to test a range of tasks for which imagery or verbal elaboration would be effective. Seven of the studies involved the paired-associate (P-A) recall of nouns, while the other involved the learning of a finger maze.

A total of 27 college students, 24 mentally retarded children, and 419 normal children served as subjects (Ss) in one of the eight experiments. All children tested were from the intermediate grades (fourth, fifth, and sixth) of the Monroe County School System; and although most of the Ss were drawn from middle class schools, two of the studies were particularly designed so as to test children from lower-middle and lower class SES areas (III and IV). Each child was tested individually for approximately 1/2 hour on one of three learning tasks: simple P-A recall, complex P-A recall; and maze learning. Instructional sets to form images (mental pictures) and use these images to learn the materials were presented in all the studies except experiment I. When the facilitative effects of imagery and verbal instructional sets were compared within an experiment (III-VI and VIII), precautions were taken to equate the instructional sets so that differences in learning could be attributed to the mode of representation (mental elaboration) used.

The most striking finding was that mental elaboration in the form of imagery or sentence generation instructions resulted in significantly more nouns recalled than rote repetition, with the mental elaboration Ss recalling as much as 7 times as many concrete nouns. Retarded and culturally deprived children recalled up to 80% of the nouns from 16 pair lists when given mental elaboration instructions, and these Ss recalled relatively more nouns when given imagery instructions, as opposed to sentence generation instructions. In general, no consistent differences were found between imagery and sentence generation as mediational strategies; but if S was given instruction in the use of both imagery and sentence generation, he recalled more nouns than if he was instructed in only one of the two strategies.

The other question of major interest dealt with whether verbally implied action facilitated the recall of nouns. It seems that action verbs product relatively more recall than non-action verbs only when the nouns are concrete and the stimulus noun plus the verb are presented at testing. The hypothesis that imagery instructions plus action verbs would facilitate recall was unsupported, but this might have been due to methodological problems. Therefore, one of these problems--the development of functional imagery instructions--became the critical aspect of several of the later experiments. In addition, reliable norms on the degree of action implied by a verb or sentence are now being obtained. It seems that these problems must be dealt with before the facilitation caused by verbally implied action can be properly evaluated.

ACKNOWLEDGMENTS

I am pleased to note the substantial contributions of others to the research reported, for without them this project would have surely been less successful. Three graduate students have made particularly notable contributions to the project as a whole, as well as individual studies--Marie Josberger, Paul Schneller, and Paul Peloquin, while several other students have made significant contributions to individual studies--Richard Clark, Chris Fitch, James Kenworthy, William Van Keuren, James Ekstrum, Robert Flanagan, and Russell Cassidy.

Several members of the faculty of Indiana University have been extremely helpful. Dr. Harvey B. Black guided the project in general, and also was a major factor in the design of the first two experiments. Dr. Joan L. Prentice aided in the design of several experiments, provided trained experimenters, and critically evaluated preliminary drafts of several of the studies reported. Dr. James Q. Knowlton and Donald J. Cunningham provided inspiration and guidance throughout the studies reported, and in current studies. Dr. Knowlton supplied important input into experiments VI and VIII, and much of his thinking is implicit in the entire report. Dr. Samuel L. Guskin provided much-needed advice with respect to educable mentally retarded children, and made available the full facilities of the Center for Education Research and Development in Mental Retardation (R & D center) to the principal investigator and his associates. Experiment VIII was fully supported by the R & D center, the final report was written at the R & D center, and many of the implications presented grew out of this stimulating research atmosphere. A number of other I.U. faculty members were helpful at different points in the project, in particular, Dr. Malcolm L. Fleming, Dean L. C. Larson, Dr. Larry Brown, Dr. Frank Restle, and Dr. Lloyd R. Peterson.

Three prominent verbal learning researchers were kind enough to supply advice, constructive criticisms, and pre-publication drafts of their research: Dr. Allan Paivic (U. of Western Ontario), Dr. Gordon Bower (Stanford University), and Dr. William D. Rohwer, Jr. (U. of California at Berkeley). Without their contributions this project could not have been nearly as comprehensive.

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Special appreciation is due my wife, Ann-Louise, who served as pilot-subject, proof reader, and critic throughout the project. Finally, the preparation of the final report was greatly facilitated by skill of Linda Ricks and Pat Stapleton.

A.M.T.
April 15, 1970

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I. INTRODUCTION

In order for two things to be associated in memory, it seems that some relationship must be established between them. One means by which this relationship may be established is by repeated presentations or rehearsals in a rote associative manner. It is apparent that to a certain extent--possibly much more extensively than might be expected or desired--it is this type of associative learning that occurs in basic school learning tasks (Bower, 1970a). Unfortunately, it also has been shown that this rote repetitive learning is the least efficient memory device (Bower, 1970b). It was the goal of the present research to discover and investigate learning strategies and devices that could be used to make relationships both more meaningful and less rote. The characteristics implicit in this approach to educational research are highly related to the more general principles of: mnemonics (Yates, 1965; and Norman, 1969), mental elaboration (Rohwer, 1967, and 1970), strategies, plans or structures (Miller, Galanter, and Pribram, 1960), grouping and relational operations (Bower, 1970b), and symbolic representation (Bruner, et al., 1966). However, in order to sustain consistent terminology, Rohwer's label "elaboration" will be used to describe this broad general area of research. Rohwer (1970) has briefly described mental elaboration as "thinking while learning," which occurs as the learner actively adds context to the material he is asked to process. There is another type of elaboration, supplied elaboration, which occurs when the learner is provided with elaborative learning aids (e.g., pictures, sentences, etc.). Although the primary focus of the present research is on mental elaboration, attempts will be made to state the differential effects on learning of the two types of elaboration.

One method of studying mental elaboration is for the college student, professor, or human learning researcher to introspect his mental activities. The primary value of this approach seems to be that it may result in researchable questions and self-confirmed hypotheses. One such hypothesis is that well-educated (or maybe all) adults use forms of mental elaboration to solve all kinds of problems, and further, that these learners use their knowledge of how things are organized as well as many other past experiences as a means of remembering newly presented material (Rohwer, 1968). This hypothesis has been empirically confirmed in the research on subjective organization (Tulving, 1962, and 1968), which has demonstrated that college students provide organization even in lists specifically designed to be unstructured. As Paivio (1969) and Bower (in press) have pointed out, there are problems involved in studying elaborative processes in college students; one of these is that college students seem to have their own well-developed elaborative devices which are difficult to study and control. However, there is an additional reason why college students were not used as subjects in the current series of experiments, and that is the interest in applying this research directly to education or instruction (Taylor, 1970). Therefore, the decision to use children as subjects in these experiments was made primarily because they are the ones that seem to be in the most need of training in how to

make better use of learning strategies such as those involved in elaboration. If this is the case, then, within certain limitations, younger children as well as the culturally deprived should benefit most from training in mental elaboration.

The term mental elaboration has been further subdivided into verbal and nonverbal symbolic processes (c.f., Rohwer, 1967; Paivio, 1969a; and Bower, in press), and it is the nonverbal or imagery processes that were primarily investigated in the present series of studies. Research on children's imagery is becoming increasingly popular as can be seen in two recent symposia on developmental and educational implications of research on imagery (Reese, 1969a; and Taylor, 1970). Bruner (1964, and Bruner et al., 1966) and Piaget and Inhelder (1969) have also found imagery to be an important mode of representation with children. However, they have primarily discussed imagery as a pre-symbolic and highly perception-bound process, while in the research to be presented we have considered imagery to be a highly symbolic process and an alternative to verbal processing as a mode of symbolic representation. Imagery as a type of mental elaboration has at least two major forms--pictorial and spatial diagrammatic, with the effectiveness of each being a function of the relationship between or interaction of the components to be remembered. That is, memory imagery follows the same principles of organization as other forms of representation (Bower, 1970b; Underwood, 1969; Shifrin and Atkinson, 1969; and Norman, 1969). Imagery in the form of internal pictorial representations seems to facilitate the recall of concrete objects, and it was this pictorial imagery that was primarily of interest in the present research. Since both types of imagery are purely internal, it is nearly impossible to represent either with pictures, but Figure 1 can serve as a spatial-diagrammatic "internal structure" which the reader might have gained from the current introduction. Note there are both imagery and verbal components in Figure 1, and if you try to image this figure in your mind the result is something like a spatial-relational framework on which the words may be hung.

The research to follow falls into two major categories. Experiments I and II were primarily concerned with children's recall as a function of the degree of verbally implied action; imagery instructional sets were only of secondary importance. However, in the remainder of the experiments, the manipulation of imagery instructional sets was the critical variable. The shift in research emphasis was based on the following two assumptions: 1) for verbally implied action to increase recall, the nouns must be picturable (concrete) and imagery representation must be involved; and 2) for imagery to be effectively used by children, it must be controlled by explicit instructional sets.

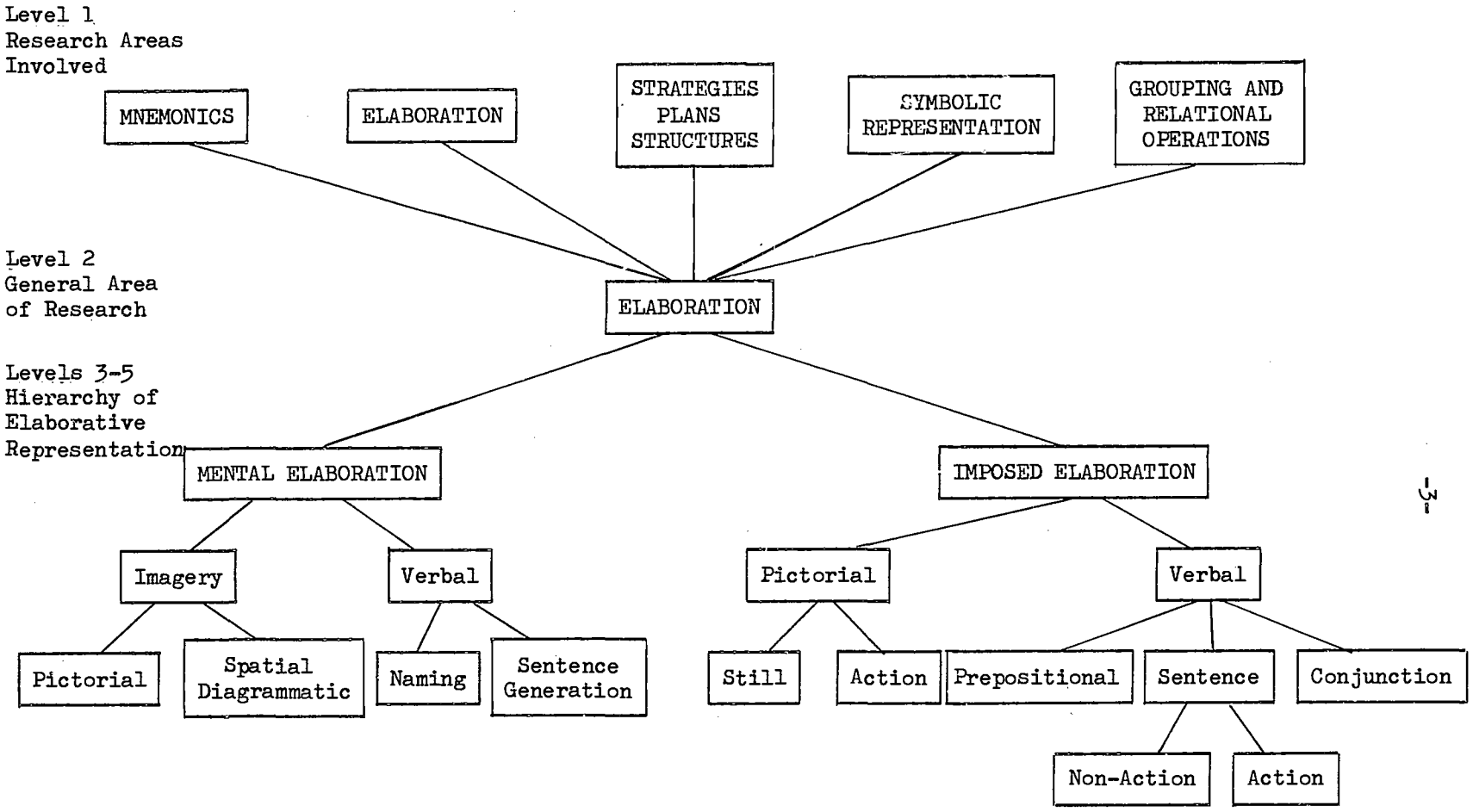

Fig. 1. A Spatial-Diagrammatic Representation of This Introduction, with Verbal Components.

EXPERIMENT I:
SENTENCE FACILITATION AND DEGREES OF VERBALLY IMPLIED ACTION

Rohwer (1966) found that noun pairs presented in simple declarative sentences are recalled better by children than noun pairs presented alone. Rohwer and his associates (cf., Rohwer, 1967) have tested several hypotheses in an attempt to determine what properties of verb connectiveness lead to this increased recall of nouns. Among the hypotheses tested were that verbs place increased semantic constraints on the noun in a sentence (Rohwer and Lynch, 1966); that conjunctions as connectives result in more intralist similarity than verbs (Rohwer and Lynch, 1967); that verbs result in higher context availability (Rohwer, Shuell, and Levin, 1967); and that verbs are most effective because of verbally implied action (Rohwer and Levin, 1968). Each of these studies investigated "imposed elaboration" (see Figure 1) in that the manipulations involved only changes in the sentence context.

It seems that the reason sentences lead to increased recall must be some function of what they provide for the learner and not merely the surface characteristics of a list of sentences. Rohwer and Lynch (1967) have suggested that sentences act as mediators, and Rohwer, Shuell, and Levin (1967) have found support for such a mediational hypothesis. Rohwer (1967, and 1968) has included this hypothesis within a theory of mental elaboration, in which he suggests that learning should be facilitated proportional to the elaboration S performs on the initial presentation. Rohwer's conception of mental elaboration and sentence mediation is the basis for the present research, but the problem remains as to what variables influence these processes. If mental elaboration and not imposed elaboration is critical to the sentence facilitation effect, then it must be assumed that supplying a sentence context leads to some of the same processes as having S generate a sentence (i.e., mental elaboration applied to a pair with a sentence as a product).

One variable of particular interest is activity, both pictorial and verbal. Davidson (1964) has shown that nouns presented pictorially are learned better when the spatial configuration has the objects joined in some way, and other experimenters have consistently found learning to be facilitated when pictures were joined in some interacting scene (Milgram, 1967; Reese, 1965; and Rohwer, 1967). Davidson and Adams (1970) have also found that with second grade children the greatest facilitation occurs when both pictorial and verbal elaboration are supplied. Rohwer, Lynch, Levin, and Suzuki (1968) found that filmic action improved children's recall of nouns even more than interacting still pictures. Rohwer, Lynch, Suzuki, and Levin (1967) have hypothesized and found support for a pictorial continuum of facilitation of noun recall similar to the verbal ordering found by Rohwer (1966), such that action depictions were superior to locational (e.g., "on," "above") depictions which were superior to coincidental (i.e., "and") depictions. These findings with relation to pictorial activity seem inconsistent with Rohwer and Levin's (1968)

negative finding with respect to verbally implied action, that is unless verbally implied action and pictorial action supply varying degrees of activity.

Rohwer and Levin (1968) manipulated two levels of semantic meaningfulness (normal and anomalous) as well as implied verbal activity. Although action verbs did not lead to higher recall scores than still verbs, the authors do report a pronounced trend in this direction for normal but not anomalous sentences. The question asked in the current experiment is--within normal sentences, under what conditions does verbally implied action lead to increased recall? In addition, this research is intended to further verify Rohwer's (1966) sentence facilitation hypothesis.

Several variables are considered to be important to both sentence and action facilitation, including the concreteness of the nouns to be recalled. Paivio (1968a) has found that the rated concreteness of a noun correlates highly with vividness of rated imagery and that both concreteness and imagery are good predictors of paired-associate (P-A) learning. Yuille and Paivio (1967) have found noun concreteness-imagery to be related to children's learning, and Begg and Paivio (1969) have found superior recognition of sentence meaning changes when the nouns were concrete than when they were abstract. In addition, it must be noted that Rohwer and his associates (e.g., Rohwer, 1966, and 1967; and Rohwer and Levin, 1968) have consistently used concrete nouns in their research on sentence facilitation. It is therefore hypothesized that there will be no sentence facilitation for abstract sentences and further that verbally implied action will be unrelated to recall of abstract nouns, while with concrete nouns action sentences will lead to greater recall than nonaction sentences, which will be superior to no sentences.

A final variable of interest in the present study, portion of the original stimulus context presented at testing, was investigated because of recent contradictory findings. Rohwer, Schuell, and Levin (1967) found that the presentation of the noun and verb (N + V) from the original sentence leads to more recall than the presentation of the subject noun (N) only. Rohwer and Levin (1968) found that presentation of N + V did not lead to more recall than presentation of N alone when the sentences were action, still and anomalous; however, Rohwer and Levin did note superiority of N + V over N when the sentences were of the action type. In an attempt to find a solution to this contradiction Ehri and Rohwer (1969) manipulated the test stimulus (N vs V vs N + V) when the verbs were related to the subject or object of a given sentence. However, the findings again were inconsistent in that the N + V test stimulus facilitated recall better than N stimuli only when the verbs were object related, and the effect was not as general as that found by Rohwer, Shuell, and Levin (1967). Ehri and Rohwer (1969) suggest that sentences improve recall only when there are appropriate syntactic and semantic contexts and it seems that the features of sentences that increase recall are those which arouse relationships (Asch, 1968 and 1969). Therefore, the presentation of N + V at testing should increase recall most where the relationship between components in the sentences is the strongest, which in the present study

would be sentences containing concrete nouns and action verbs. More generally, the prediction for the present study is that the N + V context at testing should result in increased recall.

Method

Subjects. Thirty-two fifth-grade children from a heterogeneous (suburban-rural) school were randomly assigned to one of 4 experimental groups. The groups differed only as to the form class in which the paired-associates were presented--noun pairs, noun phrases, and pairs embedded in action and nonaction sentences. Each subject (S) was tested individually by a male E.

TABLE 1

Stimulus Materials for Experiments 1 and 2

Stimulus noun	Action/Nonaction verbs	Noun associate	Phrases
	Eight Concrete Pairs		
The STRING	cuts/effects	the BUTTER.	The string butter
The MOTHER	tastes/forgets	the SUGAR.	The mother's sugar
The OFFICER	touches/wants	the BLOOD.	The officer's blood
The NAIL	tears/hurts	the FLESH.	The nail's flesh
The FLOOD	strikes/changes	the COAST.	The flood coast
The CAT	scratches/likes	the HOUSE.	The cat's house
The PROFESSOR	draws/has	the CIRCLE.	The Professor's Circle
The MAIDEN	turns/misses	the CORNER.	The Maiden's corner
	Eight Abstract Pairs		
The LORD	saves/desires	the LIFE.	The Lord's life
The DIRECTION	points to/is	the NORTHWEST.	The direction northwest
The LAW	stops/limits	the SCIENCE.	The law's science
The HISTORY	pictures/tells	the TRUTH.	The history's truth
The JOKE	breaks/causes	the SILENCE.	The joke's silence
The DREAM	attacks/starts	the TROUBLE.	The dream's trouble
The TIME	commands/sets	the STYLE.	The time style
The BELIEF	melts/becomes	the HOPE.	The belief's hope

Design and Materials. Only one of the factors, form class of the stimulus presentation, was manipulated between Ss in a 4 x 2 x 2 (Form Class x Test-trial Context x Noun Concreteness) analysis of variance with form class manipulated between Ss and the other 2 variables nested within

Ss. All Ss received a mixed list of concrete and abstract nouns and two tests on that list, the first with just the subject noun (N) as the test stimulus and the second test with the complete original context as the test stimulus (N + V for sentences). The 4 form classes of materials used were noun pairs, noun phrases, and action and non-action sentences. Since the procedures involved repeated tests after one presentation with each S serving as his own control, the order of test-trial was necessarily confounded with context. Each S received the stimulus noun as the test stimulus for the initial presentation, and two of the form class groups (noun pair and noun phrase) received essentially the same context for the second test. In this way, if the recall of these groups increased with tests, a practice effect would be indicated. But if no differences were found for these groups and the sentence groups improved with tests, then the increase in recall would be a function of test-trial context and not of order of testing or practice.

All nouns were selected from the norms established by Paivio, Yuille, and Madigan (1968), who obtained production meaningfulness scores (m), two ratings of concreteness, C and I, and Thorndike-Lorge frequency (TLF) counts on 925 nouns. Sixteen nouns rated high on concreteness and 16 nouns rated low or abstract were selected in order to maximize the differences in concreteness. These nouns were equated on TLF and matched on m values of the abstract (mean m = 6.01) and concrete nouns (mean m = 6.03). The 32 nouns were then paired, so that eight pairs were high in rated concreteness (mean C = 6.70 and I = 6.38) and eight pairs were low in rated concreteness (mean C = 2.86 and I = 3.86). Twelve additional nouns were selected from the same source, and three filler pairs were inserted at the beginning and at the end of the experimental list.

After the nouns were paired, 16 action and 16 nonaction verbs were selected from those words familiar to at least 85% of all fourth-grade children (Dale and Eichholz, 1960). One action and one nonaction verb were then used to connect each pair, with the requirement that the resulting sentences be semantically meaningful. The verbs were judged to be action and non-action by E and three associates. The noun phrases were of three types: 12 possessive nominals (e.g., "the officer's blood"); 3 adjectival nominals (e.g., "the time style"); and an expletive (e.g., "the direction northwest"). All materials were then pretested to insure that sixth grade children were familiar with all the words. The list is presented in Table 1.

Procedure. Each S was tested individually on a paired-associate recall task. An overview of the general procedure follows: S was seated in front of a blank screen; was given the standard P-A recall instructions; practiced with three sample pairs; studied 22 pairs, sentences, or phrases; was tested for the 16 correct associates with the paired noun as the stimulus; was tested again with the complete context of the original presentation; and was questioned as to his learning methods.

The P-A recall instructions varied slightly with the form of the stimulus presentation, but basically S was told that he would hear many

pairs (phrases or sentences) each of which would contain two nouns. S was instructed to learn the final noun of each presentation, so that he could recall it when he was presented with the first noun.

The presentation and testing rates were 5 seconds for all groups. These rates are consistent with those suggested by Yarmey (1967) as optimal for image formation and retrieval. Thirty second delays occurred between the study trial and first test and between the two tests, at which times S was reminded of the instructions.

Procedures were utilized to maximize the opportunity for mental elaboration which were adapted from Paivio and Yuille (1967). S was seated facing a blank screen, with E seated to the right and slightly behind S to avoid direct eye contact. The pairs were presented orally to avoid interference from visual stimuli, and a minimum of noise was maintained.

A three-minute post-experimental inquiry followed the second test, and was designed primarily to determine if S followed the appropriate instructional set (or) to discover what instructional set S did employ. Paivio and Yuille (1969) have questioned the functional set S actually uses to learn, and several experimenters have analyzed their data with respect to the set S reported following rather than the experimenter defined instructional set (Eagle, 1967; Yarmey and Csapo, 1968; and Paivio and Yuille, 1969). The data from the present study was to be analyzed in this way, if a large number of Ss reported using a particular strategy (e.g., imagery). The inquiry was handled in as unobtrusive a manner as possible. S was first asked to explain how he tried to learn the list. Then four individual responses were singled out for questioning. The general rule for selection was 2 concrete--2 abstract pairs, and, when possible, one of each type having been recalled correctly and the other incorrectly. If S reported using imagery, he was asked to describe his images.

Results and Discussion

The mean number of concrete and abstract nouns recalled are presented in Table 2 as a function of form class and test-trial context. The main effect for noun concreteness was significant, $F(1,28) = 46.49$, $p < .001$, with Ss recalling more than 1 1/2 times as many concrete as abstract nouns. No other main effects were significant at the .05 level. The predicted form class main effect approached significance, $F(3,28) = 2.69$, $.05 < p < .10$, as did the predicted test-trial context, $F(1,28) = 3.97$, $.05 < p < .10$. The failure to find these significant main effects may in part be due to the small sample size (n = 8) and to the significant interactions between each of these factors and noun concreteness.

TABLE 2

Mean Number of Abstract and Concrete Nouns Correctly Recalled as a Function of Form Class and Test-trial Context: Experiment 1.

Test-trial context	Noun concreteness	Presentation Form				
		Non-action	Action	Pair	Phrase	Total
1-No Context	Concrete	4.62	4.12	2.62	4.38	3.94
	Abstract	2.62	2.50	2.62	2.75	2.62
	Sub-total	3.62	3.31	2.62	3.56	3.28
2-Context	Concrete	5.12	4.75	3.12	4.38	4.34
	Abstract	2.62	2.88	2.25	2.62	2.59
	Sub-total	3.88	3.81	2.69	3.50	3.47
	TOTAL	3.75	3.56	2.66	3.53	

The Test-trial Context x Concreteness interaction was found to be significant, $F(1,28) = 6.79$, $p < .05$, and the appropriate means are presented in Table 3. Scheffe's test for multiple comparisons (Edwards, 1968) demonstrated that the presentation of the complete context at testing did not facilitate the recall of abstract nouns ($p > .05$), while it did increase the recall of concrete nouns ($p < .05$). The increased recall of concrete nouns with N + V test stimuli is consistent with previous findings where the nouns were more or less concrete (Rohwer, Shuell, and Levin, 1967; Ehri and Rohwer, 1969; and Bower, 1970), while the change in recall with abstract nouns more closely approximates the effects of anomalous contexts on recall (Rohwer and Levin, 1968).

Also significant was the Form Class x Concreteness interaction $F(3,28) = 2.96$, $p < .05$. The means for this interaction are presented in Table 4. The critical hypotheses tested by this interaction were that sentences would facilitate the recall of concrete but not abstract nouns as compared to a control condition. In order to test these hypotheses Dunnett's test (Edwards, 1968, pp. 148-150) for comparing each treatment with a control was computed separately for concrete and abstract noun recall, and as predicted the 2 sentence groups recalled significantly more concrete nouns than the control: Non-action, $t(K = 3, df = 28) = 3.28$, $p < .01$, and action, $t(3,28) = 2.59$, $p < .05$; while the phrase Ss did not recall significantly more concrete nouns than the control, $t(3,28) = 2.48$, $p > .05$. This finding is consistent with Rohwer's (1966 and 1967) sentence facilitation hypothesis. Dunnett's test applied to

TABLE 3

Mean Number of Concrete and Abstract Nouns Correctly Recalled with N and N + V Contexts: Experiment 1.

Test-trial context	Noun concreteness		
	Concrete	Abstract	
1-N	3.94	2.62	3.28
2-N + V	4.34	2.59	3.47
	4.14	2.61	

the abstract means revealed no significant differences, $t < 1.0$, and the hypothesis that no sentence facilitation form class effect would be found with abstract nouns was confirmed. It seems that there is another condition which must be added to Ehri and Rohwer's (1969) list of conditions under which sentence facilitation does not hold, which is, sentences containing abstract nouns. Inspection of the means in Table 4 also revealed no differences in the number of abstract and concrete nouns recalled when the form class was noun pairs. This finding was inconsistent with Yuille and Paivio's (1967) finding with children, and leads to the conclusion that Paivio's (1969) general concreteness finding may not hold for non-elaborated noun pairs when children are the subjects.

TABLE 4

Mean Number of Concrete and Abstract Nouns Correctly Recalled for 4 Form Classes: Experiment 1

Noun concreteness	Form class				
	Non-action sentence	Action sentence	Noun pair	Noun phrase	
Concrete	4.87	4.45	2.87	4.38	4.14
Abstract	2.62	2.69	2.44	2.69	2.61
	3.75	3.56	2.66	3.53	

The final hypothesis, that action verbs would lead to more nouns recalled than non-action verbs, was not supported. Not only was the form class main affect non-significant, but the direction of the differences was opposite from that which was predicted. Although the presentation of the complete context and the use of concrete nouns tend to reduce these unexpected differences, the interactions predicting the effects of verbally implied action to be particularly large under these conditions were not confirmed. This study has clarified nothing with respect to verbally implied action; and it seems that one or both of Rohwer and Levin's (1968) hypothetical explanations may also hold here: that verbally implied action is unrelated to recall, or that the subjectively evaluated differences between action and non-action verbs was not large enough to allow for significant effects. In order to test the second of these possible conclusions, norms must be established. For a description of the norms needed see the implications section of this paper.

However, the following argument is offered in lieu of the conclusion stating that there is no verbally implied action effect to be found. Pictorial action seems to consistently increase recall (Rohwer, 1967 and Davidson, 1969). The verbs portrayed in the pictorial action experiments do not differ markedly from the action verbs in the present study. What differs between the two conditions is that the action verb only implies action, and this may not be enough for children. Therefore, the hypothesis is offered that action verbs plus imagery instructions should produce the same beneficial effects as pictorial action.

EXPERIMENT II:
VARIABLES EFFECTING IMAGERY INSTRUCTION IN CHILDREN

The present study was conducted to test the same hypotheses as Experiment I plus those relating to imagery instruction. To repeat the general hypothesis mentioned in the discussion of Experiment I--it is predicted that action verbs presented with instructions to image will lead to higher recall scores than: action verbs without such instructions, and nonaction verbs presented with instructions to image.

Imagery is a construct developed primarily by Paivio (1965, 1968a, 1969a, 1969b, and 1970). One of the critical predictions from Paivio's theory of imagery is that concrete nouns should be recalled more easily than abstract nouns because they have a higher probability of arousing memory images (Paivio, 1965 and 1969a). Paivio and his associates have frequently found support for this hypothesis with college Ss (Paivio, Yuille, and Smythe, 1966; and Paivio, Smythe, and Yuille, 1968). However, Paivio (1969b) and others (cf., Reese, 1969a) have discussed the problems of extrapolating Paivio's research on imagery to children, since few studies have varied noun concreteness in studies with children (Paivio and Yuillo, 1966). Cognitive theorists (Bruner et al., 1966; Neisser, 1968; and Piaget and Inhelder, 1969) stress that imagery is a dominant mode of representation with young children (i.e., about age 7 and

younger), but that it becomes relatively less important with age. Paivio (1969b) also suggests that imagery is well developed in young children, but that it is not functional as a means of coding verbal material until the child is capable of making transformations between the verbal and imagery modes of representation. Dilley and Paivio (1969) have found support for this hypothesis in a study involving young children (ages 4-6). They found that pictures lead to high recall when they are the stimulus term, but decreased recall when they are responses. The present study involves older children (about age 11) and this transformational ability is assumed not to be a problem since imagery for this age S is considered to be a highly symbolic form of representation (Bower, in press; Paivio, 1969a; and Rohwer, 1969) and not predominantly a pre-symbolic mode of representation (Bruner et al., 1966).

In experiment I it was found that Ss in the noun pairs condition recalled equal numbers of concrete and abstract nouns, which suggests that although concrete nouns may arouse more images with college students this may not be the case with children. An alternative hypothesis is that the concrete nouns arouse images but that imagery is not an effective learning strategy. If this hypothesis is correct, then instructional sets to use imagery should not increase the number of nouns recalled. However, if children fail to create images spontaneously when given concrete nouns, then instructional sets to form images should increase the number of nouns recalled. The general conceptual approach here is developmental, that is, as children get older it is assumed they need less instruction about forming or using appropriate imagery mediators.

In addition to the predicted Instructional Set x Form Class interaction, it seems that imagery instructional sets should be more effective with concrete than abstract nouns. Paivio (1969a), however, reports difficulty in verifying this assumption, since subjects tend to use alternative strategies when the instructional sets are not appropriate for the materials to be learned (e.g., imagery instructions with abstract pairs of nouns). More recently two studies (Yarmey and Csapo, 1968; and Paivio and Foth, in press) have reported finding this interaction between instructional set and noun concreteness. In the Yarmey and Csapo (1968) experiment it seems that strict instructional sets and/or cooperative subjects led to this finding, while Paivio and Foth (in press) used a pictorial orienting task to force their Ss to use imagery for abstract nouns. The present study will use imagery instructional sets in an attempt to ensure that Ss use imagery when it is assumed they should (w/concrete nouns) and also when it assumed not to be aroused (w/abstract nouns). However, the use of orienting tasks (Paivio and Foth, in press; Bower, in press; and Taylor, 1968) may be the optimal way of controlling imagery and verbal modes of processing.

Method

Subjects. The Ss in this study were 96 sixth-grade children selected from the same school as the fifth-grade children in experiment I. The 96

Ss were randomly assigned to one of 8 groups, which were formed by the factorial combination of 4 form classes and 2 levels of Instructional set.

Design and materials. Half the design was identical to that of experiment I, while the other half received the same form classes and other manipulations plus administration of imagery instructional sets, with the instructional set factor manipulated between Ss. The resulting design is a 4 x 2 x 12 x 2 x 2 (Form Class x Instructional Set x Ss x Noun Concreteness x Test-trial Context) factorial design with the last two factors nested within Ss.

The materials from the previous experiment I were used in the present study (see Table 1).

Procedures. Each S was tested individually on the same (one-presentation two-test-trial) P-A recall task. The same procedures as those in experiment I were used except that half the Ss received imagery instructions in addition to the standard P-A instructions. The general aim of the imagery instructions was to get S to construct an interacting image around the two nouns presented, and for S to use this interacting image (picture) to remember the nouns. The instructions were provided as more of a set to respond than training in how to image, and therefore allowed for individual differences in S's understanding of what was expected of him, as well as differences in imagery ability (Sheehan, 1966; Kuhlman, 1960). No pictorial examples were provided and only limited feedback was supplied when S described his images for the practice pairs.

The difficulty in constructing functional imagery instructional sets was compounded by several factors: the differences in elaboration required for different form classes; the use of a mixed list of abstract and concrete nouns, and the problems associated with controlling response sets to such a list (Paivio and Yuille, 1969); and that no experiments reported in the literature manipulated imagery instructional sets with children (Rohwer, 1969). It is also possible that the presentation/testing rate of 5 seconds per pair may be too short for children to construct adequate images (Wood, 1967).

The post-experimental inquiry was considered more critical in the present experiment than in experiment I, since it provided an index of how well the Ss followed the imagery instructions, as well as some examples of constructed images reported by children. However, this knowledge was used solely as a take off point for future research, rather than as a means of eliminating Ss in the present study for failure to follow instructions. The post-experimental inquiry served the same purpose with the control Ss (no imagery instructional set) as it did with the fifth-grade Ss in experiment I. However, in this case a baseline of verbal reports was available for classifying Ss as to whether or not they used imagery as a means of remembering specific pairs or the entire list.

Results

The dependent measure was the number of nouns correctly recalled, with four scores obtained on each S, abstract and concrete scores under both no context and context conditions at testing.

As predicted imagery instruction facilitated noun recall as compared to the control group, $F(1,88) = 3.96$, $p < .05$. However, although imagery instructional sets did increase recall as expected, none of the hypotheses predicting significant interactions were supported. The only interaction involving instructional set with an F value in excess of unity was Instructional Set x Form Class, $F(3,88) = 1.17$, $p > .05$ (see Table 5), and no support was found for the Instructional Set x Noun Concreteness interaction critical to Paivio's (1969a) two process theory.

TABLE 5

Mean number of nouns correctly recalled as a function of Form Class and Instructional Set, 96 sixth-grade Ss

Instructional Set	Form Class				Total
	Non-Action	Action	Pair	Phrase	
Imagery	4.17	4.40	4.00	3.60	4.04
Control	3.14	3.40	3.69	3.79	3.50
Total	3.66	3.90	3.84	3.69	

Although the main effect of form class was not significant ($F < 1$), the Form Class x Test-trial Context interaction was significant, $F(3,88) = 7.93$, $p < .01$. However, as can be seen in Figure 2, it seems that this effect is included within a significant second order interaction, Form Class x Test-trial Context x Noun Concreteness, $F(3,88) = 3.20$, $p < .05$. The predictions relevant to this interaction were that: sentences (primarily those connected by an action verb) facilitate recall only when the nouns are concrete and the original stimulus context is presented at testing, but neither Form Class nor test-trial context effects recall when the nouns are abstract.

TABLE 6

Mean Number of Concrete and Abstract Nouns Correctly Recalled as a Function of Form Class and Test-trial Context, for 96 Sixth-grade Ss

Test-trial context	Noun concreteness	Form Class				Total
		Non-Action	Action	Pair	Phrase	
1-No Context	Concrete	4.38	4.29	4.58	4.21	4.36
	Abstract	2.67	2.96	3.17	3.20	3.00
	Sub-total	3.52	3.62	3.88	3.70	3.68
2-Context	Concrete	4.75	5.21	4.50	4.21	4.66
	Abstract	2.83	3.12	3.12	3.17	3.06
	Sub-total	3.79	4.17	3.81	3.68	3.86
	TOTAL	3.66	3.90	3.84	3.69	

From Figure 2 and Table 6 it can be seen that the critical comparisons for testing these predictions involve recall of concrete nouns and are between the following orthogonal sets of means: (a) Action-no-context + Nonaction-no-context vs Action-context + Nonaction context (4.29 + 4.38 - 5.21 + 4.75); and (b) Action-context vs Non-action context (5.21 vs 4.75). The differences were tested by orthogonal comparisons on treatment means (Edwards, 1968, pp. 135-138). The test for comparison "a" was significant, t (1,88) = 2.32, $p < .05$, which suggests that the presentation of sentence context at testing does facilitate the recall of concrete nouns. The test for comparison "b" was also significant, t (1,88) = 2.30, $p < .05$, which suggests that verbally implied action does facilitate recall, but only when the context is presented at testing and the nouns to be recalled are concrete. A third orthogonal comparison, which was identical to comparison "a" but with abstract nouns, was non-significant, t (1,88) < 1.0.

The first comparison above revealed that the presentation of sentence context (N + V) at testing can improve recall under certain conditions. The main effect for test-trial context was significant, F (1,88) = 13.28, $p < .01$. However, this effect is totally within the two first-order interactions (Test-trial Context x Noun Concreteness, F (1,88) = 5.80, $p < .05$; and Test-trial Context x Form Class, F(3,88) = 7.93, $p < .01$); and the Test-trial Context x Noun Concreteness x Form Class second-order interaction, F(3,88) = 3.20, $p < .05$. This second order

interaction is depicted in Figure 2, and the conclusion can be drawn from this figure and the comparisons above that the presentation of context at testing facilitates recall only when the nouns are concrete and when the original context is a sentence (either action or non-action).

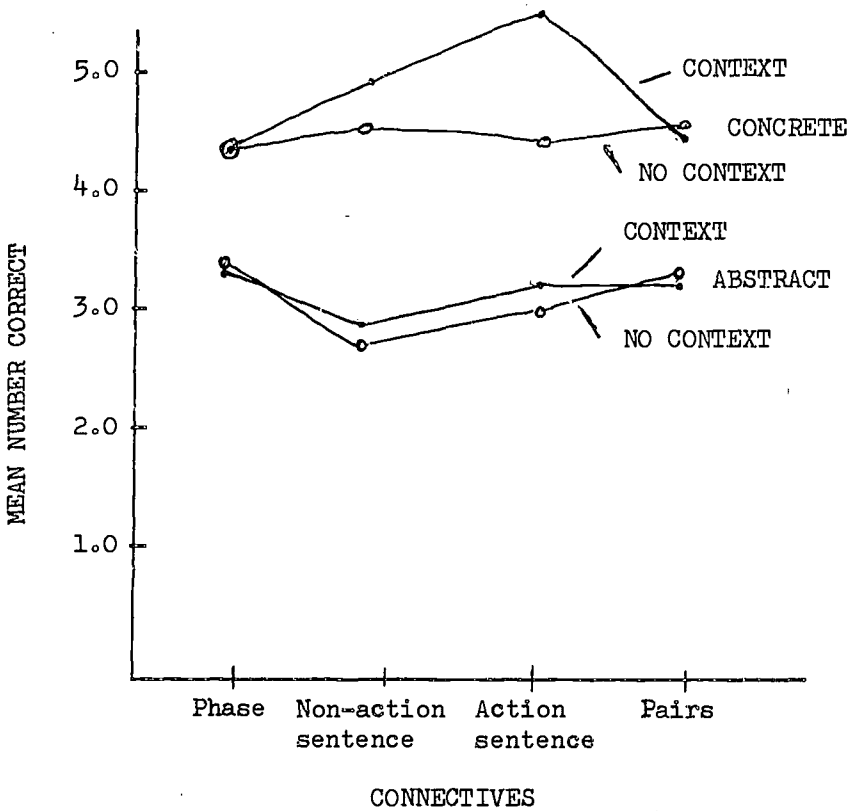

Fig. 2. Connective x Context x Concreteness interaction showing that the number of concrete nouns correctly recalled increases when the nouns were presented in sentences and when the original sentence contexts (particularly action sentences) were presented at testing.

The test-trial context factor confounds order of testing (practice) with the context presented at testing. However, it seems that if the significant effects were due to practice, then the effect would be more general and include abstract nouns as well as concrete. That practice is not the critical factor can be seen from the means appropriate for the Test-trial Context x Form Class interaction (see Table 6); for if practice was important then sub-totals for the noun pairs form class should increase from trial 1 to trial 2, and it does not.

Noun concreteness again accounted for a large portion of the total variance and produced a significant main effect, F (1,88) = 74.22, $p < .001$. As can be seen in Figure 2, this effect is very general, and concrete nouns are always recalled about 1½ times as often as abstract nouns. This is in opposition to the results found in experiment I, in that, non-elaborated concrete noun pairs were recalled significantly more often than abstract noun pairs in the present study and not in the previous one.

Analyses of the post-experimental questionnaire revealed that half the Ss given no mediation instructional sets for each form class condition (n = 6) reported using imagery mediators (in varying degrees) on their own. The 5-way analysis of variance for repeated measures which appears in appendix B-2 was calculated for the no instructional set Ss (N = 48). This analysis is similar to the original analysis of the data except that reported imagery replaces instructional set as a factor. The resulting design is a 4 x 2 x 6 x 2 x 2, with the first two factors, form class and reported imagery, being fully crossed and the last two factors nested within Ss (n = 6).

The analysis of variance revealed that Ss reporting self-instructed imagery recalled significantly more nouns than those Ss not reporting imagery, F (1,40) = 6.12, $p < .05$. The expected interaction between imagery and concreteness was not significant ($F < 1.0$), nor were any other interactions significant involving reported imagery. However, the Reported Imagery x Test-trial Context x Noun Concreteness interaction did excede unity, F (1,40) = 1.69, $p > .05$. The means for this nonsignificant interaction are reported in Table 7. An inspection of these means reveals a slight trend in the direction that reported imagery facilitates recall of concrete nouns more than abstract nouns, while the major reason for this trend seems to be that those Ss reporting imagery recalled many more concrete nouns when the complete context was presented.

TABLE 7

Mean Number of Concrete and Abstract Nouns Recalled as a Function of Whether Control Ss Reported Imagery and the Test-trial Context.

Test-trial context	Reported imagery			
	Imagery		None	
	Concrete	Abstract	Concrete	Abstract
1- No Context	4.62	3.08	3.67	2.29
2- Context	5.04	3.12	3.79	2.41
Total	9.66	6.20	7.46	4.70
	7.90		6.08	

Since the instructional set S was supplied with did not interact with any of the factors in the first analysis, no major changes in the results are expected here when the imagery Ss are not represented in the data. This assumption was for the most part supported, with the main effects for test-trial context and noun concreteness again significant, F (1,40) = 7.81 and 37.87 respectively, $p < .01$. Although the expected Test-trial x Noun Concreteness and Form Class x Test trial x Noun Concreteness interactions were not significant, $1.5 < F < 2.0$, $p > .05$; the Form Class x Test-trial Context interaction was significant, F (3,40) = 3.28, $p < .05$. Table 8 includes the means involved in these interactions, and a comparison between tables 6 and 8 reveals only minor differences. In summary, the major finding in this post hoc analysis was that Ss reporting imagery, even though given control instruction, recalled significantly more nouns than the remainder of the control Ss.

TABLE 8

Mean Number of Concrete and Abstract Nouns Correctly Recalled by 48 Sixth-Grade Ss Given Control Instructions as a Function of Reported Imagery and Test-trial Context

Test-trial context	Noun concreteness	Form class				Total
		Non-Action	Action	Pair	Phrase	
1-No Context	Concrete	3.75	3.75	4.66	4.42	4.15
	Abstract	2.25	2.58	2.75	3.17	2.68
	Sub-Total	3.00	3.16	3.71	3.79	3.42
2-Context	Concrete	4.25	4.50	4.58	4.33	4.42
	Abstract	2.33	2.75	2.75	3.25	2.77
	Sub-Total	3.29	3.62	3.67	3.79	3.59
	TOTAL	3.15	3.40	3.69	3.79	

Discussion

One of the major purposes of the first two experiments was to determine the effect of verbally implied action on the P-A recall of nouns, and further, to determine what factors interact with verbally implied action. Verbally implied action was only found to facilitate recall under very limited conditions, when the N + V original context was supplied at testing with concrete nouns. The effects of verbally implied action were found to be much less consistent than those reported for pictorial action (Davidson and Adams, 1970; Rohwer, Lynch, Suzuki, and Levin, 1967; and Rohwer et al., 1968). It seems possible that only when an appropriate relationship is established will the recall of noun pairs be facilitated (Asch, 1968 and 1969; and Bower, 1970b), and that action may only provide an appropriate relationship for concrete nouns. That verbally implied action was found to facilitate the recall of concrete nouns only when the N + V were presented as test stimuli and not when the noun alone was presented, may only be an artifact of the single presentation on which S heard the sentence, and this effect should be replicated over trials.

Two critical interactions were hypothesized involving imagery instructional sets, and neither interaction even approached statistical significance. The hypothesis that verbally implied action plus imagery will facilitate recall in a manner similar to pictorial action was

totally unsupported. However, the hypothesis should not be discarded since the result may have been due to inadequately controlled imagery instructional sets. An evaluation of the effects of the present imagery instructional sets would suggest that the sets could be improved upon, for example, with the addition of an orienting task (Paivio and Foth, in press) or training procedures (Yarmey and Csapo, 1968). The Instructional Set x Noun Concreteness interaction predicted by the two process (imagery and verbal) theory of mediation (Paivio, 1969a) was also unsupported in the present study. Repeated attempts by Paivio to find this Instructional Set x Noun Concreteness interaction have been unsuccessful (Paivio and Yuille, 1967 and 1969; and Yuille and Paivio, 1968). Once again the problem seems to be one of discovering means of controlling Ss functional mediating response set (Paivio and Foth, in press). Further evidence that Ss functional response set was not adequately controlled by the present instructions comes from the the analysis of the post experimental inquiry. In that, when permitted to, Ss seek out functional response sets has frequently been demonstrated (Tulving, 1962; Paivio and Yuille, 1969; Eagle, 1967, and Bower, in press). It is suggested that both the verbally implied action and noun concreteness interactions with imagery instructional sets need further study utilizing more well controlled instructional sets.

An interesting contradiction between experiments I and II involves the form class effect (Rohwer, 1966 and 1967). The initial intent of the current research was to discover what conditions increased the facilitative effect of sentences, as the assumption was made that in general sentences would be facilitating. In experiment I sentences were facilitative, at least with concrete nouns, and Rohwer's (1966) form class finding was essentially replicated. However, with the sixth-grade Ss in experiment II the recall of the noun pair condition was identical to that of the 2 sentence conditions. Analysis of the significant Form Class x Noun Concreteness x Test-trial Context revealed that sentence facilitation occurred only when the nouns were concrete and the test stimulus was the N + V context. Rohwer's (1966, 1967, and 1970) research, in which he has consistently found sentence facilitation, has not utilized abstract nouns, and the consistent finding in the present research that sentences do not facilitate the recall of abstract nouns seems to add a new dimension to the sentence facilitation hypothesis.

The fact that in the present study meaningful sentences did not facilitate the recall of concrete nouns when N was used as the test stimulus, is in direct opposition to previous findings (Rohwer, 1966 and 1967). However, there were major differences between the Rohwer studies and the present one. First the inclusion of sentences containing abstract nouns may have reduced the probability of S using the sentence context as a cue. Second, it is possible that sentences used by Rohwer and his associates provided more direct relations between the noun pairs to be associated, and a review of Rohwer's sentences (cf., Rohwer, 1967) revealed a general tendency for the verbs to be related to one of the nouns. Although in the present series of studies the sentences were constructed so as to provide a meaningful context, verbs were selected so

as to minimize the previous associations between noun and verb. For example, the sentence--The professor draws the circle--was used in the present study as opposed to--The professor teaches the circle--which has a noun-verb relationship with high probability of occurrence. It is hypothesized that sentence facilitation should only occur when the sentence provides an appropriate relationship, and for many pairs it may be difficult to establish such a relationship in one trial. Therefore, the conclusion of studies finding sentence facilitation (Rohwer, 1966 and 1967; Bean and Rohwer, 1970; and Milgram, 1967) might better be that highly related and not just meaningful sentences will facilitate children's recall of concrete noun pairs.

The present study served to clarify the effects of presenting the original context as the test stimulus. Nearly a significant main effect for test-trial context was obtained with fifth-grade Ss, and this effect was highly significant with sixth-grade Ss. These results are consistent with those found in several other studies (Rohwer, Shuell and Levin, 1967; Ehri and Rohwer, 1969; and Bower, 1970), but inconsistent with those of Rohwer and Levin (1968). It seems that Rohwer and Levin's use of anomolous and meaningful sentences restricted the N + V context facilitation, and this assumption is given some support by trends in the appropriate direction of Rohwer and Levin's data for meaningful sentences. A similar finding occurred in the present study since N + V context did not facilitate the recall of abstract nouns. In summary then it seems that N + V test context does facilitate the recall of concrete nouns embedded in meaningful sentences.

With this new data it now seems that the three alternative hypotheses to Rohwer and Levin's (1968) conclusion that verbs are not functional stimuli for recall of noun pairs embedded sentences must now again be considered tenable. "Three additional interpretations should also be mentioned. The first is that the subject noun and the verb serve as a single configurational stimulus for the object noun. The second is that independent associations are formed between the subject and object nouns and between the verb and object noun. The third is that an association is formed between the subject noun and the verb and between the verb and the object noun such that on test trials the verb mediates between the subject and object nouns. Although no one of these three interpretations is entirely discounted by the present results, each implies the prediction that N and V condition should produce the best performance and this prediction was not confirmed." (Rohwer and Levin, 1968, p. 140). Each of these hypotheses seem to be consistent with the "appropriate relationship hypothesis" proposed earlier, however, the first alternative about a single configurational stimulus seems more consistent with both the data and recent theoretical statements by (Asch, 1968; and Bower, 1970).

The final variable to be discussed is noun concreteness. The results in the present study replicate and extend the results of the previous study manipulating noun concreteness with children (Paivio and Yuille, 1966). Although the effect of noun concreteness is large and quite consistent across fifth- and sixth-grade Ss in the present study, it may be

difficult to determine the reason for this difference. The problem arises mainly because the norms on concreteness-imagery-vividness are all based on the ratings of college Ss (Gorman, 1961; Tulving, McNulty, and Ozier, 1965; Paivio, Yuille, and Madigan, 1968; and Spreen and Schultz, 1966). The recent interest in manipulating the concreteness or "imagery value" of words has occurred because several researchers (Paivio, 1965; Paivio and Yarmey, 1965; Yarmey, 1967; Gorman, 1961; Dukes and Bastian, 1966; Paivio, Yuille, and Smythe, 1966; and Paivio, Smythe, and Yuille, 1968) have found that concrete nouns are recalled significantly more than abstract nouns even when production meaningfulness (m) and Thorndike-Lorge Frequency are controlled, when college Ss are the population. These findings led Paivio (1969) to propose his two process theory of associative mediation, which states that concrete stimuli (nouns or pictures) are recalled more frequently because these stimuli evoke mental images in S. In a factor analytic study Paivio (1968a) found that rated concreteness and imagery are the most potent stimulus factors yet isolated with respect to correlations with paired-associate recall (again with college Ss).

Why were concrete nouns recalled more by children in the present study? At least in part this probably occurred because of mental imagery, but matching for m on Paivio et al.'s norms is not sufficient to rule out meaningfulness as the underlying factor with children. It seems that although the abstract nouns used in the present study were all known to the children they were not as meaningful to those Ss as the concrete nouns. Although m probably varies between the abstract and concrete lists, it is more likely to be something like Deese's (1965) conception of associative meaning or Bower's (1970) conception of meaning as a bundle of semantic features that is confounded with noun concreteness in the present study. Partial support for such a finding comes from the fact that neither presentation or testing within the context of a sentence facilitated the recall of abstract nouns. However, the critical point is that, no matter what the underlying factor the materials to be learned are very important (Battig, 1968).

EXPERIMENT III:
THE FACILITATION OF CHILDREN'S RECALL WITH IMAGERY AND SENTENCE GENERATION INSTRUCTIONAL SETS

The primary purpose of the present study was to develop well controlled instructional sets to elaborate, both imagery and sentence generation, and to determine the facilitative effects of these instructional sets on the one-trial paired-associate recall of children. In addition it was suggested that the increased control of Ss functional mediational set should lead to a more powerful test of the interaction critical to Paivio's (1969a) two process theory of mediation, that Ss given imagery instruction should recall more concrete than abstract nouns while sentence generation instructions should be equally facilitative for the recall of all nouns.

The facilitating effects of imagery instructional sets when compared to control groups in paired-associate (P-A) learning have been consistently demonstrated with college students (Bower, in press; Bugelski, Kidd and Segman, 1968; and Paivio, 1968b); but whether imagery instruction is superior to verbal mediation is in doubt (Paivio, 1969a) since both seem to be equally facilitative (Paivio and Yuille, 1967 and 1969; and Yuille and Paivio, 1968). However, there is limited evidence (Yarmey and Thomas, 1966; and Bower, in press) that imagery instruction leads to slightly higher P-A recall than verbal mediation, but again this evidence was obtained with college Ss. Paivio (1969a) has proposed that imagery instructional sets should facilitate the recall of concrete nouns more than verbal mediation, and that the reverse should be true for abstract nouns. This hypothesis has been unsupported in several studies (Paivio and Yuille, 1967 and 1969; and Yuille and Paivio, 1968), but has recently been supported when extra precautions were taken to insure that S utilizes only the specified instructional set. This has been accomplished by supplying strict instructional sets which include examples, either pictorial or verbal (Yarmey and Csapo, 1968); and by providing an imagery orienting task (Paivio and Foth, in press). It seems that research approaches which attempt to insure Ss attention and comprehension of the instructional set (Yarmey and Csapo, 1968; Paivio and Foth, in press; and Bower, in press) and attempt to demonstrate under what conditions imagery facilitates recall (Paivio, 1969a and b; Bower, in press; Rohwer, 1969; and Palermo, 1969) are necessary for valid inferences to be drawn about associative imagery.

Although the same approach and controls are needed for research on children's imagery, the problems are even greater with children since only a few studies have manipulated imagery instructional sets with children (Reese, 1969b; Taylor and Black, 1969; and Montague, 1970). Recently more interest seems to be directed towards children's imagery, as evidenced by recent symposia on developmental (Reese, 1969a) and educational implications (Taylor, 1970) of research on imagery. In these symposia Rohwer (1969) and Davidson (1970) have pressed the need for increased research utilizing instructional sets, which should lead to more well controlled experiments and more direct educational implications. The emphasis on instructional sets is consistent with the position that imagery is a mode of internal communication (i.e., representation, mediation, and/or memory processing), and that the probability of any given S using the imagery mode of internal communication increases with the concreteness of the material and the degree to which the instructional set controls Ss mediating responses.

The present study tested three kinds of instructional sets: imagery, verbal or sentence generation, and control--given no mediation instructions. On the basis of previous research with children (Taylor and Black, 1969) and adults (CF. Paivio and Yuille, 1969) it was predicted that imagery instructions would facilitate the recall of nouns. Previous research by Rohwer (1967, 1968, 1970, and in press) has demonstrated that instructions to generate sentences also facilitates the P-A recall of nouns. However, little is known about the relative effects of imagery and sentence generation instructions with children. A study by Ruth

Montague (1970) provides the only data available on this topic. She tested 7 year-old ghetto children on two levels of imagery, sentence, and naming conditions (with and without supplied elaboration appropriate for each condition, for example with and without pictures for Ss given imagery instructions). Although this study is interesting for several reasons, the three conditions most critical to the present study are represented by the instructional sets with no imposed elaboration. It seems that sentence generation instructions facilitate the P-A recall of 7-year-olds, while imagery instructions produce only about the same number of nouns correctly recalled as control instructions. Montague (1970) concludes that there is an imagery production deficiency with these children; but an alternative hypothesis could be that Montague's imagery instructional set, although quite clear to the adult reader, may not have supplied her 7-year-olds Ss with enough of a set to construct appropriate memory images. Results suggesting the need for imagery training procedures in support of this alternative hypothesis have been reported recently by Taylor, Josberger, and Knowlton (1970), who found no evidence for an imagery production deficiency with retarded children (CA $\geq$ 9). However, the critical question in the present study is--will both imagery and sentence-generation instructional sets facilitate fifth-grade Ss recall of noun pairs.

As in the first 2 experiments noun concreteness is also of interest in the present study, and two levels of concreteness (abstract and concrete) were manipulated within a mixed list. The main effect for noun concreteness found consistently with adults (cf., Paivio, 1969) and children (Taylor and Black, 1969) was predicted for the present study. In addition it was hypothesized that noun concreteness would interact with instructional sets, as predicted by the two process theory of mediation (Paivio, 1969a). Specifically it was predicted that children will recall more concrete nouns when given imagery instructions since both verbal and imagery mediators would be available to S, and that sentence generation instructions will also facilitate the recall of concrete nouns as compared to controls. Further, it was predicted that only sentence generation instructions will facilitate the recall of abstract nouns since by definition imagery is not an appropriate relation or preferred mediator (Paivio and Yuille, 1969) for remembering abstract nouns.

A final factor of interest in the design for initial recall is the form class within which the noun pairs are presented. It has been consistently reported that noun pairs embedded in sentences are recalled better than noun pairs presented alone (Rohwer, 1966 and 1967; and Milgram, 1967), but no data is available in which a mixed list of sentence and noun pair forms of presentation was employed. It seems possible that when S is given a mixed list of sentences and pairs he would be more likely to supply his own elaborative context for the pairs than when given a list containing pairs only. This extension of Rohwer's (1966) theory of mental elaboration seems consistent with the hypothesis that there is a spontaneous production deficiency of elaboration mediation in children (Rohwer, 1967 and 1968; and Montague, 1970) which may

still be functioning until the eighth grade (Rohwer, 1970; Bean and Rohwer, 1970). It was not expected that this form class factor would interact with instruction; since Montague (1970) reports additive effects of supplied sentence elaboration plus instructions to use sentences, and no Form Class x Instructional Set interaction was reported by Taylor and Black (1969). However, it was predicted that form class would interact with rated noun concreteness-imagery, and Black (1969), with sentences only facilitating the recall of concrete nouns (Taylor and Black, 1969).

In addition to adding to our knowledge of elaboration effects on immediate recall, the present study was also intended to extend these findings to both transfer and retention. As an extension of Rohwer's theory of mental elaboration (Rohwer, 1968) it was expected that Ss instructed to elaborate, either with images or sentences, would be able to transfer their skills to a new list (Rohwer, 1968) and that the P-A recall of these elaboration Ss would be facilitated as compared to controls. It was further predicted that Ss given an initial mixed list of sentences and pairs would recall more nouns from a transfer list of noun pairs than: Ss always provided with sentences on the initial list, since this group is not used to constructing their own sentences; and Ss who received only noun pairs because of the spontaneous production efficiency noted earlier.

Palermo (1969) has reported that concrete items assumed to be evoking imagery are retained minimally over a two-day period, which seems inconsistent with Bower's (in press) assumption that memory images should result in rather permanent traces with a slow decay-rate. Although the effects of instructional set on retention would probably be minimal over a one-week period, it was expected that instructional set differences would still be significant after one-week, when measured by a relearning task. It was further hypothesized that more concrete than abstract nouns would be recalled during relearning.

Method

Subjects. Ninety fifth-grade students from a heterogeneous rural-sururban school were randomly assigned to one of nine experimental groups. The entire fifth-grade population (N = 131) had been arbitrarily assigned at the beginning of the year into three homerooms. It was assumed that as of the beginning of the year no systematic differences existed between the experimental groups drawn from two homerooms and the relearning control Ss drawn from the third homeroom.

The experiment was conducted during a period of high absenteeism which was most probably related to a near epidemic of a 24 to 48 hour virus infection. This resulted in 21 of the original experimental Ss being absent on the day the relearning post-test was administered, which reduced the N of experimental Ss from 90 to 69. Six additional Ss were randomly dropped from the analysis of the relearning post-test in order to obtain equal cell n (n = 7).

Design and materials. Each S was randomly assigned to one of the 9 conditions resulting from a fully crossed factorial design. S received either imagery, sentence generation, or no mediation instructions and was presented with noun pairs in one of 3 form classes. The instructional set-form class condition S served in for list 1 was also used as his condition label for lists 2 and 3.

The nouns for test 1 were selected from the norms established by Paivio, Yuille, and Madigan (1968), which were obtained on college Ss. List 1 contained the same nouns and pairings used by Taylor and Black (1969), which were selected as follows. Sixteen nouns rated high on imagery and concreteness and 16 nouns rated low or abstract were selected so as to minimize differences in production meaningfulness (m) and maximize differences in imagery-concreteness. The nouns were then paired so that 8 pairs were high in rated concreteness (mean C = 6.70) and 8 pairs were low in rated concreteness (mean C = 2.86). According to Paivio et al. (1968) the concrete nouns should arouse more nonverbal images than the abstract nouns, and Yuille (1968) has demonstrated the image evoking aspect of concreteness is the factor critical to recall. Twelve additional nouns were selected from the same source, and 3 filler pairs were inserted at the beginning and end of the experimental list. The verbs for the sentence and pair-sentence form classes were selected from Taylor and Black (1969). Half the verbs were labeled action types by these Es (see experiments I and II) and the other half non-action, with each verb selected for a noun pair so as to provide a highly meaningful relation (see Table 9) for the lists used).

The materials for the transfer list consisted of ten pairs of highly meaningful concrete nouns (see column 2, Table 9). The only requirement for the establishment of these pairs was that there were no direct associations within pairs, as judged by E and 2 assistants. No primacy and recency fillers were used for this list.

The noun pairs for the relearning post-test consisted of 4 pairs from each of 4 nouns classes: 4 concrete and 4 abstract noun pairs were randomly selected from list 1; 4 of the concrete noun pairs from list 2 were also randomly selected for this list; and 4 new concrete pairs were constructed. The primacy and recency fillers were 6 noun pairs, 3 new and 3 old. All noun pairs in both lists 2 and 3 were presented in the form of noun pairs and no sentences were supplied.

TABLE 9

Noun Pair Lists Used to Test Original Learning, Transfer, and Relearning

Type	List 1	List 3	List 3
PRIMACY FILLER	Dust covers the telephone.		Hero - Game
	The person feeds the crow.		Cat - House
	The pencil stabs the potato.		Library - Answer
CONCRETE NOUNS	The String cuts the Butter.	Egg - Hat	Mother - Sugar
	Mother forgets the Sugar.	Dollar - Cup	Nail - Flesh
	The officer wants the Blood.	Horse - Carrot	Flood - Coast
	The Nail tears the Flesh.	Banana - Ant	Professor - Circle
	The Flood strikes the Coast.	Wagon - Bell	(transfer pairs)
	The Cat scratches the House.	Baby - Letter	Egg - Hat
	The Professor draws a Circle.	King - Candy	Horse - Carrot
	A Maiden misses the Corner.	Bird - Window	Baby - Letter
		Corn - Hill	Bird - Window
		Radio - Pie	
ABSTRACT NOUNS	A Lord saves a Life.		Direction - Northwest
	A Direction is the Northwest.		History - Truth
	The Law stops the Science.		Dream - Trouble
	History pictures the Truth.		Time - Style
	The joke breaks the Silence.		(new pairs)
	The Dream starts the Trouble.		Magazine - Trouble
	The Time sets the Style.		Scissors - flag
	The Belief buries the Hope.		Flower - Umbrella
			Gentleman - Factory
RECENCY FILLER	The Judge grades the Paper.		Fish - Soda
	A Lion eats the Garden.		Law - Science
	The Arrow hits the Dirt.		Radio - Pie

Procedure. Ss were tested for one-trial P-A recall on three separate lists, with list 1 (original learning) and list 2 (transfer) administered individually during the same session. List 3 (relearning) was presented to groups (homerooms) 5 days after the last S was tested on lists 1 and 2.

Ss were given one of 3 instructional sets and received the noun pairs of list 1 in one of 3 form classes. These factors were fully crossed in list 1, and the instructional set-form class condition S was assigned to in list 1 was used to identify him throughout the experiment. Before the presentation of list 1 all Ss were given standard study-test P-A instructions (Runquist, 1966). Basically each S was told that he would be presented with many pairs (sentences or pair-sentences-P or S) each of which would contain 2 nouns, and that his task was to try to learn the last noun of each pair (sentence or P or S) so that he could recall it when he heard the noun with which it was paired.

In addition to the above instructions those Ss in the imagery groups were given instructions to "make up pictures" (visual images) and use their pictures to help remember the nouns. Imagery Ss were specifically instructed to form one picture for each verbal presentation, in which the things named were doing something together. The additional instructions for the sentence generation Ss were to "make up sentences or stories" they could use to remember the noun pairs.

Each S was given three practice pairs, and was told to follow all the instructions; if S responded incorrectly he was given more practice with the same pairs. Although the imagery and sentence generation instructional sets were more precise and more directed to the child's level of comprehension, there was no attempt to insure that S followed these instructions during either practice or the list itself. This is to say that no instructional aids were used and no feedback was given.

For list 1 S was presented with 22 noun pairs in the appropriate form class--including 3 primacy fillers, the 16 tested pairs, and 3 recency fillers--which were read at a presentation rate of approximately 5 seconds. After the presentation of the list and an unfilled 30 second delay, S was tested with the first noun from each of the 16 pairs and asked to supply the associated noun. The test rate was also 5 seconds, and both rates were established on the basis of previous research by Paivio (1967), Yarmey (1967) and Taylor and Black (1969).

Procedures considered by Paivio, Yuille, and Smythe (1966) and Taylor and Black (1969) to maximize the opportunity for imagery and other forms of mental elaboration were followed. Auditory presentations were chosen to avoid interference with visual imagery by visual presentation of words (Bower, in press). A clear screen placed a few feet in front of S provided a relatively uniform visual field which was assumed to interfere minimally with the formation of visual images. In addition attempts were made to minimize E - S eye contact and extraneous noise and movement. However, the data from 2 Ss was lost because of unavoidable extraneous interruptions occurring at critical points in the presentation.

Immediately after the conclusion of the testing on list 1 S was told, "That was very good: and now I'm going to read you another list." The instructions for list 2 varied slightly with respect to the form class S was presented with in list 1 since list 2 contained only noun pairs. However, no instructions about generating sentences or images were given to the Ss, and if S asked how he was to remember the pairs he was told to remember them in any way he desired. No practice pairs were presented, and list 2 contained no primacy and recency fillers. Otherwise the procedures for presentation and testing were identical to those for list 1 except that the list contained only 10 noun pairs. After the test on list 2 S was asked to verbalize how he tried to remember the noun pairs, but was given no feedback on his methods. The procedures for the post-experimental inquiry were along the same lines as those used by Taylor and Black (1969), but limitations were placed on the questions asked because of the relearning post-test to follow. However, the inquiry was still an attempt to unobtrusively discover the functional set S was following. At conclusion of the inquiry S was told not to tell anyone anything at all about what he did or what materials he was to learn.

List 3 was presented and tested on a one-trial free recall task, and was administered in groups to each of the 3 fifth-grade homerooms. The instructions were, "I'm going to read you a long list of nouns, two at a time, and I'd like you to try to learn as many as you can. The 22 item list (see column 3 of Table 9) was then read in a random order at the rate of about 10 seconds/pair. After a 10 second unfilled pause the Ss were asked to write down as many of the nouns as they could remember (either singly or in pairs), and were informed that mispelled words would not be counted as wrong. These results were analyzed according to the instructional set-form class condition S was in for list 1, and the means were compared to the recall scores of 32 post-hoc controls. The Ss in the experimental condition had initially been tested on lists 1 and 2 from 5 to 12 days earlier (median and mode was 7 days). The time since original testing should not have interacted with experimental condition since Ss had been randomly assigned to conditions so as to keep the cell ns within one at all times.

Results

The dependent variables for list 1, original learning, were the number of abstract and concrete nouns correctly recalled by each S, with the cell means for this 3 x 3 x 2 repeated measures factorial analysis presented in Table 10 and the ANOVA (Analysis of Variance) table in Appendix C-3. As expected, a significant main effect was found for instructional Set, $F(2,81) = 8.76$, $p < .01$. The critical hypotheses--that instructions to elaborate either with sentences or images, facilitates recall as compared to control instructions; and that imagery instructions result in significantly more nouns correctly recalled than instructions to generate sentences--were tested by orthogonal planned comparisons. However, neither comparison was significant, $t(81) = 1.31$ and 1.12

respectively, $p > .05$, and it seems that the significant instructional set main effect was probably due to the difference between the imagery and control groups. The failure to find a general effect for mental elaboration was unexpected and may have been an artifact of the conditions tested, as will be discussed later. However, the Instructional Set x Noun Concreteness interaction predicted by the two-process theory was also not significant, $F(2,81) = 1.36$, $p > .05$, with the imagery group recalling slightly more abstract and concrete nouns than the other instructional groups. The interaction has actually only been predicted for the pair form class (Paivio, 1969), and from inspection of the "P" means in Table 10 it can be seen that imagery and sentence generation instruction sets resulted in identical mean recall for both concrete and abstract nouns when they were presented as non-elaborated noun pairs. In summary, the present study offers no support for the critical Instructional Set x Noun Concreteness interaction.

TABLE 10

Mean Number of Abstract and Concrete Nouns Recalled by 90 Fifth-Grade Children as a Function of Instructional Set and Form Class of the Noun Pairs.

Instructional Set	Noun Concreteness	Form class			Noun Concreteness	Instructional Set
		Pair (P)	Sentences (S)	S & P		
IMAGERY	Concrete	4.70	6.50	4.50	5.23	4.47
	Abstract	3.30	4.10	3.70	3.70	
VERBAL	Concrete	4.70	3.70	3.40	3.93	3.55
	Abstract	3.10	3.50	2.90	3.17	
NONE	Concrete	3.20	4.90	3.30	3.80	3.08
	Abstract	2.30	2.10	2.70	2.37	
		3.55	4.13	3.42		

The form class effect of sentence facilitation found consistently by Rohwer (cf., 1966) was not significant in the present study, $F(2,81) = 2.58$, $.05 < p < .10$. The Instructional Set x Form Class interaction was

also non-significant, $F(4,81) = 1.11$, $p > .05$. However, when each of the means from the elaboration groups were compared against the control group (pairs - no mediation instructions, Dunnett's test (Edwards, 1968, pp. 148-150) revealed that only the mean of the sentence-imagery instructional set group (5.30) was significantly different from the control (2.75), $t(81) = 3.10$, $p < .05$. Some suggestions concerning the nonsignificant differences between the other elaborative conditions and the control may be more evident after an inspection of the relevant means for the Instructional Set x Form Class x Noun Concreteness interaction (see the cell means in Table 10). This interaction only approached statistical significance, $F(4,81) = 2.08$, $.05 < p < .10$, therefore, an inspection of these means serves only to speculate about causality and is not offered as either theoretical or causal evidence. The most interesting mean is that for the recall of concrete nouns by Ss receiving sentences and instructed to generate sentences. It has consistently been found that sentences facilitate recall either in the form of imposed elaboration or mental elaboration (Rohwer, 1967) and therefore the failure of this combination to increase recall seems to result from an artifact of the present study, that imposed and elaborated sentences in some way interfered with each other. It is suggested that this interference deflated not only the mean for this condition, but was at least partially responsible for reducing the overall effect of the sentence form class. The only other interaction, Form Class x Noun Concreteness, was not significant, $F(2,81) = 2.69$, $.05 < p < .10$; and the magnitude of this nonsignificant interaction was probably due both to chance and the artifact discussed above.

The dependent variable for list 2-transfer was the number of concrete nouns correctly recalled, and the ANOVA table for this 3 x 3 factorial analysis is presented in Appendix C-2 for the means shown in Table 11. As in the analysis for original learning, the main effect for instructional set was significant, $F(2,81) = 6.31$, $p < .01$, and the same orthogonal planned comparisons were used to test the same hypotheses as had been tested for original learning. Once again the hypothesis about a general facilitation due to elaboration (imagery + sentence - none) was unsupported, $t(81) < 1.0$. However the hypothesis that imagery instructions would lead to significantly more nouns correctly recalled than sentence generation instructions was supported, $t(81) = 1.86$, $p < .05$. It seems that imagery instruction during original learning did result in significantly more nouns correctly recalled by fifth-grade children on a 10 pair transfer list.

The form class S was presented within original learning did not produce a significant main effect on list 2-transfer, $F(2,81)$ 1.0, nor did form class interact with instructional set, $F(4,81) = 1.91$, $p = 0.11$. Dunnett's test to compare treatments means ($K = 8$) with the control mean (pairs-no instructional set) was used to determine which combinations of imposed and mental elaboration from original learning facilitated transfer when compared to the non-elaborative control group. Two groups that received imagery instructional sets recalled significantly more nouns from list 2 than the control group (mean = 4.0 out of a possible 10), with those Ss originally presented with sentences and given instructions to

image recalling about 6.7 nouns, $t(81) = 3.09$, $p < .05$, and those Ss originally presented with the mixed form class list (P or S) who received instructions to image recalling a mean of 6.5 nouns, $t(81) = 2.87$, $p < .05$. A comparison of the means for the Instructional Set x Form Class interaction presented in tables 10 and 11 reveals two consistent effects: a) imagery and sentence generation instructions facilitate recall equally when list 1 was presented as noun pairs; b) but sentence generation instructions did not facilitate learning when the original form class involved sentences.

The analysis of the number of nouns recalled (list 1-concrete, list 1-abstract, list 2-concrete, and list 3-new concrete) as a function of the conditions under which original learning occurred is presented in Appendix C-3. The only significant effect found was for the Noun Class of the words to be recalled, $F(3,162) = 34.52$, $p < .001$ (see Table 12). Dunnett's test for comparing treatment means (previously presented pairs) with the mean of the control condition (new pairs) revealed that previously tested abstract nouns from list 1 were not recalled significantly more than the new pairs, $t(162) < 1.0$, while the mean number of concrete nouns from list 1 and list 2 were significantly greater than the mean for the new pairs, $t(162) = 2.68$ and 2.84 respectively, $p < .05$.

TABLE 12

Mean Number of Nouns Recalled, as a Function of Noun Concreteness and Previous Experience

Groups	Noun classes				
	List 1 Concrete	List 1 Abstract	Transfer Concrete	New Concrete	
Relearning Ss n = 63	3.06	1.55	3.19	1.00	2.20
Control Ss n = 32	2.25	1.19	2.00	1.10	1.64
	2.65	1.37	2.60	1.05	

In order to estimate the effects of previous presentation on relearning a group of 32 control Ss were tested on the same lists. The mean number of nouns correctly recalled by the relearning Ss (collapsed over conditions) and the control Ss are presented in Table 12. No statistical tests were conducted on these means since the results are confounded by design, scoring, and interpretive problems. However, it does seem that the relearning Ss did recall more of the concrete nouns from lists 1 and 2 than controls.

Discussion

The findings of this study were consistent with those of several other studies in demonstrating that instructional sets to use imagery facilitate the immediate P-A recall of nouns (Taylor and Black, 1969; Bugelski, Kidd, and Segman, 1968; Bower, 1970; and Paivio and Yuille, 1967 and 1969). These results extend the findings of Taylor and Black (1969), in that fifth-grade children given imagery instructions recalled more nouns than Ss given sentence generation instructions. The research comparing the facilitative effects of imagery and verbal instructions on the recall of college Ss has been inconsistent (cf., Paivio, 1969a; and Bower, in press). Considering that Montague (1970) has found that sentence generation and imagery instructions facilitated the P-A recall of 7-year-old children, it seems that the present study provides inconsistent data with regard to the modes of mental elaboration used efficiently by children. However, there are several theoretical, developmental, and methodological positions that could account for these inconsent findings. It has been suggested that imagery is less effective than sentences when both are defined in terms of imposed elaboration for younger children and that the reverse is true for older children (Reese, 1969b). An alternative interpretation is that young children have the capacity to image but do not spontaneously use imagery (Montague, 1970) or that young children are unable to make the appropriate transformations between imagery mediators and verbal responses (Paivio, 1969b). Another alternative suggestion is that both Montague's (1970) results and the present findings may be due to methodological artifacts. It is possible that Montague did not provide enough training in memory imagery (Neisser, 1969; and Richardson, 1969) for her young Ss to make use of this less practiced skill, and in the present study it seems that the presentation of sentences interfered with sentence generation, with this interference probably resulting from the complexity of the instructional set given these Ss. In any case, neither the findings of Montague nor the present study are consistent with the hypothesis of Bruner et al. (1966), in that imagery doesn't seem to develop first and that the imagery is highly symbolic and only distantly related to the perception-bound iconic imagery proposed by Bruner, et al.

It was again demonstrated that children recall significantly more concrete than abstract nouns (Yuille and Paivio, 1966), but the critical interaction between instructional set and noun concreteness (Paivio, 1969a) was again unsupported (Taylor and Black, 1969; Paivio and Yuille, 1967 and 1969; and Yuille and Paivio, 1968). Of the two studies which have found differential effects of instructional sets on concrete and abstract nouns (Yarmey and Csapo, 1968; and Paivio and Foth, in press), the present study most closely approximates the approach used by Yarmey and Csapo, in that attempts were made to control Ss functional response set solely through instructional sets. However, the present study provided no support for the existence of this interaction with children, and future research will have to use more well controlled instructional sets (Bower, in press) or an imagery orienting task similar to that developed by Schnorr and Atkinson (1969) and used successfully by Paivio and Foth (in press).

The fact that the form class in which the noun pairs were presented was not found to be significant can probably be accounted for by the interference of imposed sentences with instructions to generate sentences. That only the mean of the group supplied with sentences and given imagery instructions was significantly higher than the mean of the non-elaboration control group suggests that the facilitative effects of elaboration may not be as general as previously expected (Rohwer, 1967; 1968; and 1969).

The results from list 2 provide the first evidence that the facilitative effects of imagery instructional sets transfer, which in this study occurred between lists presented within the same session but without imagery instructions being provided for list 2. That sentence generation instructions failed to produce any increment in recall on list 2 was not surprising since they did not facilitate recall during original learning. It seems that Ss who had been both presented with sentences and asked to generate sentences in list 1 were also unable to generate effective mediators when only noun-pairs were presented in list 2. One interpretation of this finding is that these Ss relied on imposed elaboration and were unable to make use of mental elaboration when sentences were no longer supplied. This interpretation is consistent with the finding that Ss given imagery instructions and noun pairs embedded in sentences for list 1 were able to transfer their skills to noun pair lists with sentences provided. It is suggested that Ss instructed to make up images recalled more nouns from the transfer list because they were forced to use mental elaboration even when sentence contexts were provided in original learning.

EXPERIMENT IV:
CONCRETENESS, VERBAL CONTEXT, AND IMAGERY AS FACTORS IN CHILDREN'S PAIRED ASSOCIATE RECALL

The first three studies in the series investigated the P-A recall of middle class fifth- and sixth-grade children. Studies of P-A recall indicate that children from lower SES backgrounds perform as well as other children (Rohwer, Levin, Lynch, and Suzuki, 1968; and Semler and Iscoe, 1963). However, Rohwer (1970) has recently suggested that lower SES children do not perform as well as middle SES children when the P-A task involves imposed or mental elaboration. Montague (1970), on the other hand, has reported that the recall of lower SES first- and second-grade children was facilitated by pictorial and verbal imposed elaboration and sentence generation instructions, but that it was not facilitated by imagery instructions. Therefore, the present study is an attempt to extend the current research on mental elaboration to lower SES children with the P-A recall of these Ss being a function of noun concreteness, form class of the presentation, and instructional set.

Three types of instructional sets were tested: no mediation, sentence generation, and imagery; it was hypothesized that both sentence generation and imagery would facilitate recall as compared to the control

group, and that imagery Ss will recall more nouns than Ss given sentence generation instructions. The first hypothesis has been consistently supported (Rohwer, 1966, 1967, and 1969; Milgram, 1967; and Montague, 1970), and is a general test of the mental elaboration effect (Rohwer, 1968). However, the results are not so clear with respect to the comparative facilitating effects of imagery and sentence generation instructions on the P-A recall of children. In experiment III imagery was found to be relatively more facilitative, but Montague (1970) reports that only sentence instructions facilitated the recall of 7 year-old lower SES children in her study.

Rohwer (cf., 1967) and his associates have consistently found a form class or sentence facilitation effect in studies of children's P-A recall, which has been supported in several other studies (Reese, 1969b; Montague, 1970; and Milgram, 1967). However, none of the first 3 experiments in this series resulted in a significant main effect for form class. A major difference between these studies and those of Rohwer and others was that the present series of studies employed a mixed list of abstract and concrete nouns while the previous ones used only concrete nouns. The analysis of a significant Form Class x Noun Concreteness interaction in experiment 1 revealed that the sentence facilitation effect was only significant for concrete nouns. In the present study it is hypothesized that the form class main effect will not be significant, but that a Form Class x Noun Concreteness interaction would be found since imposed sentences facilitate only the recall of concrete nouns. Therefore, when the presentation of the mixed abstract and concrete list is followed by lists containing only concrete nouns, the typical sentence facilitation and form class effect should be found for the concrete lists.

Method

Subjects. Sixty-six upper elementary school children from a lower-middle to lower class SES urban area were randomly assigned to one of 6 experimental conditions, resulting from the factorial combination of 3 levels of instructional set (none, sentence generation, and imagery) and 2 levels of form class (pairs and pairs embedded in sentences). The entire fifth-grade population of the school was tested (N = 50) as were 21 randomly selected fourth-grade children, with the mean IQ of the sample (N = 66) being about 100. The data from 5 Ss was lost due to excessive extraneous noise. Each of 2 experimenters tested 33 of the remaining Ss.

Materials. The 6 experimental groups differed as to the instructional set provided S and the form class of the stimulus presentation. Each S was given 1 test trial on each of 3 P-A lists. List 1 was a 16 pair P-A list similar to that used in the first three experiments (see Table 13); the 32 nouns from the original list were used, but three of the original abstract pairings were re-paired after analysis of the previous studies revealed high order associations (direction-northwest and lord-life) or extreme difficulty of the pair (belief-hope). The resulting three new pairs seemed to be more neutral (lord-northwest,

belief-direction, and hope-life). The verbs used to form the embedded sentence condition were those used previously by Taylor and Black, and all sentences were pre-tested to insure understanding by fourth-grade children.

TABLE 13

Sentences Used in Experiment IV
Lists 1, 2, and 3

LIST 1

Dust covers the Telephone.
The Person feeds the crow.
The Pencil stabs the Potato.

__ The String cuts the Butter.
__ Mother forgets the Sugar.
__ The Officer wants the Blood.
__ The Nail tears the Flesh.
__ The Flood strikes the Coast.
__ The Cat scratches the House.
__ The Professor draws a Circle.
__ The Maiden turns the Corner.

__ The Lord explores the Northwest.
__ A belief is a Direction.
__ The Hope saves a Life.
__ The Law stops the Science.
__ History pictures the Truth.
__ The Joke breaks the Silence.
__ The Dream starts the Trouble.
__ The time sets the style.

The Judge grades the paper.
A lion eats the Garden.
The Arrow hits the Dirt.

- - -

LIST 2

The Horse chews the Carrot.
The Wagon breaks the Window.
The Umbrella protects the Flag.

__ The Teacher makes the Discovery.
__ The Fact costs a Dollar.
__ The Car carries the Gold.
__ The Wife kicks the Gentleman.
* The Speech loses the Contract.
* The railroad buries the Ghost.
__ A girl throws a rock.

* The Palace becomes a square.
__ The Insect bites the Shadow.
* The Event shows the Material.
* Knowledge builds the Pole.
* The Tree finds a Seat.
__ The Author climbs a Tower.
__ A Toy spills the Evidence.

The Hammar dents the pot.
The Camp cooks the Macaroni.
The Rod stops the Thief.

- - -

LIST 3

The film shows a School
The saw breaks the Table.
The Baby eats the Pie.

__ The Leader smells the Flower.
__ The Owner wears the Dress.
* The Friend does the Duty.
__ The Iron smashes the Engine.
* A Newspaper praises the Air.
* The Method finds the Creature.
__ The Letter contains a Fortune.

__ The Cost hurts the Factory.
__ A Beast ruins the Hall.
__ The Brain wins a Victory.
* The Volume takes a Chance.
* The Hotel holds the Body.
__ The Machine spins the World.
* The Village guides the Student.

The Grass is a Field.
The Corn covers the Hill.
The King shoots the Bird.

Lists 2 and 3 were composed of moderately concrete nouns (mean C = 5.46 and 5.50), and each list was matched to list 1 on mean m of the nouns. As with the original list, 6 filler pairs were used with both list 2 and 3 to control for the effects of primacy and recency of presentation. The verbs used to form the embedded sentences were selected from the same source (Dale and Eichholtz, 1960), and were familiar to fourth-grade children. However, although all the nouns and verbs from these lists could be assumed to be both familiar and meaningful to all Ss, the relationships implied in these sentences may not have been as meaningful as those in the sentences used by Rohwer (1966 and 1967), which resulted in significantly sentence facilitation. Rohwer and Levin (1968) have found that anomolous sentences do not facilitate recall, and those sentences used in the present study that could be considered to be anomolous or highly ambiguous are marked with an asterick (*) in Table 13. Although none of the sentences from list 1 seem ambiguous or anomalous, 6 sentences each from lists 2 and 3 are questionable.

Procedures. Each S was tested individually by one of 2 Es, and during the experimental session, which lasted approximately 35 minutes, S was given 1 test-trial on each of 3 P-A lists. S was given one of 6 sets of instructions based on the combination of mediation instructions and form class appropriate for the condition to which S was randomly assigned (Imagery-Pairs (IP), Imagery-Sentences (IS), Sentence generation-Pairs (SP), Sentence generation-Sentence (SS), None-Pairs (NP), None-Sentences (NS). Regardless of condition each S was told that he would be presented with many pairs (sentences) each of which would contain 2 nouns, and that he was to learn the last noun of each pair (sentence) so that he could remember it when he heard the noun with which it was paired.

In addition to the above instructions those Ss in the imagery groups were given instructions to "make up pictures" and use their pictures to remember the nouns. Imagery Ss were specifically instructed to form one picture for each verbal presentation, in which the things named were doing something together. The additional instructions for the sentence generation Ss were to "make up a sentence or story" for each presentation, that they could use to remember the noun pairs.

Each S was given three practice pairs, and was told to follow all the instructions; if S responded incorrectly he was given more practice with the same pairs. Although the imagery and sentence generation instructional sets were more precise and more directed to the child's level of comprehension than those in previous experiments, there was no attempt to insure that S followed these instructions during either practice or the list itself. That is to say that, no instructional aids were used and no feedback was given.

For list 1 S was presented with 22 noun pairs in the appropriate form class--including 3 primacy fillers, the 16 tested pairs, and 3 recency fillers--which were read at a presentation rate of approximately 5 seconds. After the presentation of the list and an unfilled 30 second

delay, S was tested with the first noun from each of the 16 pairs and asked to supply the associated noun. The test rate was also 5 seconds, and both rates were established on the basis of previous research by Paivio (1967), Yarmey (1967) and Taylor and Black (1969). Lists 2 and 3 were presented and tested in the same manner, with the exception that there were only 14 tested pairs in each of these lists.

Procedures considered by Paivio, Yuille, and Smythe (1966) and Taylor and Black (1969) to be optimal for imagery and other forms of mental elaboration were followed. Auditory presentations were chosen to avoid interference with visual imagery through visual presentation of words (Bower, in press). A clear screen placed a few feet in front of S provided a relatively uniform visual field which was assumed to interfere minimally with the formation of visual images. In addition attempts were made to minimize E-S eye contact and extraneous noise and movement. However, the data from 5 Ss was lost because of unavoidable extra-experimental interruptions, with the general noise level being much higher than that considered optimal for any verbal learning research.

Only limited post-experimental inquiry was conducted in order to determine to what extent S was reporting strategies other than the one he was instructed to use.

Results. Preliminary analyses revealed that experimenters (Es) did not result in any significant main effects or interactions, and this extraneous variable was dropped from the analyses. The results from list 1 were analyzed by a 3(instructional sets) x 2(form classes) x 11(Ss) x 2(noun concreteness) factorial analysis for repeated measures on the concreteness factor. The means for this analysis are presented in Table 14, and the ANOVA Table is presented in Appendix D-1. The only statistically significant effect in this analysis was the noun concreteness main effect, $F(1,60) = 52.91$, $p < .001$. This effect accounted for approximately 40% of the total variance, with 1 and 2/3 as many concrete as abstract nouns recalled. The predicted instructional set main effect was not significant, $F(2,60) = 1.18$, $p > .05$, nor was the instructional set x form class interaction significant, $F(2,60) = 1.32$, $p > .05$. The form class main effect was nonsignificant as expected, $F(1,60) = 1.41$, $p > .05$, but the hypothesized interaction between form class and noun concreteness also was not significant, $F < 1.0$.

TABLE 14

Mean Number of Concrete and Abstract Nouns Correctly Recalled as a Function of Instructional Set and Form Class

Instructional Set	Form class				
	Pairs		Sentences		
	Concrete	Abstract	Concrete	Abstract	
NONE	2.54	1.82	3.45	1.73	2.39
Sentence (Verbal	4.36	3.09	3.18	1.82	3.11
Imagery	4.27	2.27	3.36	1.91	2.95
	3.73	2.39	3.33	1.81	
	3.06		2.58		

An identical 3 x 2 x 11 x 2 analysis was conducted with lists (2 and 3) as the factor nested within Ss. The appropriate means are presented in Table 15, and the ANOVA Table is presented in Appendix D-2. The instructional set main effect was found to be significant, $F(2,60) = 3.81$, $p < .05$, and a Schefee's test was conducted on the means ($p \leq .05$). This test revealed a significant elaboration effect--the sentence generation and imagery instructional sets resulted in more nouns recalled than the control set, but only sentence generation and not imagery instructions resulted in significantly more nouns recalled than the control set.

TABLE 15

Mean Number of Concrete Nouns Correctly Recalled as a Function of Instructional Set and Form Class from Lists 1 and 2

Instructional Set	Form class				
	Pairs		Sentences		
	List 2	List 3	List 1	List 2	
NONE	3.73	2.82	4.09	4.27	3.72
Sentence (Verbal)	7.36	5.27	5.73	4.18	5.64
Imagery	5.37	4.54	6.00	4.18	5.11
	5.61	4.21	5.27	4.21	
	4.91		4.74		

The lists main effect was significant, $F(1,60) = 15.39$, $p < .001$, with more nouns recalled on list 1 than on list 2. The Instructional Set x Lists interaction was not significant, $F(2,60) = 1.99$, $p > .05$, nor were any other interactions or the form class significant. Of the remaining interactions, only the Instructional Set x Form Class interaction resulted in an F in excess of unity, $F(2,60) = 1.27$, $p > .05$.

Discussion

The use of elaboration instruction seems to be an effective means of facilitating the P-A recall of ghetto children. However, the facilitory effect does not seem to be as consistent as in previous studies since elaboration instructions did not significantly increase recall on a mixed list of abstract and concrete nouns (Taylor and Black, 1969; and Taylor, 1969). As in Montague's (1970) study using 7 year-old lower SES children, only sentence generation and not imagery instrictions facilitated the P-A recall of the fourth- and fifth-grade (about 10 year-old) children in the present study.

Several hypotheses could be offered to account for the failure of imagery instructions to facilitate P-A recall in this study, while imagery instructions did increase the recall of comparable middle SES children in experiments II and III. One subset of these hypotheses is based on the assumption that ghetto children have an imagery or possibly even a mental elaboration deficit. Montague (1970) has suggested that

the children in her study exhibited an imagery production deficiency. Rohwer (1969) suggests that younger children may lack the ability to produce covert verbalizations, which are necessary for recall using imagery; and Paivio (1969b) provides the hypothesis that children have difficulty in making the appropriate transformations between imagery mediators and verbal responses. Although each of these alternatives offers a possible explanation, it seems that the problem may be methodological in nature. It seems from subject reports that the high noise level combined with somewhat distracting experimental chambers may have made the 5 second presentation and recall rates too rapid for the production of functional memory images. One final hypothesis offered in opposition to the production deficiency hypothesis (Flavell, 1970; and Montague, 1970), is that younger children (CA = 4-10), the culturally deprived, and the mentally retarded have a greater need for more explicit instructional sets, but once they have understood the instructional sets these children can and will perform as well as other children on elaborative P-A tasks; and it was indicated from the subject reports in the present study that the Ss did not fully comprehend the imagery instructions, which presumably did not meet the high degree of clarity needed. Bower (1970) has stressed the need for increased task analysis in research on memory and memory tasks and one of the by products from this analysis should be more appropriate instructional sets (Taylor, 1970).

The failure to find a form class main effect or interactions involving the form class manipulation is also difficult to explain. The form class main effect was not predicted for the mixed concrete-abstract list since Taylor and Black (1969) have found that sentences do not seem to facilitate the recall of abstract nouns. However, sentences did not facilitate the recall of the concrete nouns from list 1 nor the relatively concrete lists (2 and 3). One hypothesis that might account for this lack of facilitation is that Rohwer's (1966, 1967, 1969, and 1970) consistent finding of sentence facilitation may not be as general as previously expected, but it is much more likely that certain methodological differences can account for the contradictory findings. The task and therefore the instructional set required to obtain experimental control were more complex in the present study than in the previous research (cf., Rohwer 1966 and 1967) because of the difficulty in ensuring that Ss provided with sentences elaborated on these sentences. In addition this sentence elaboration may require more time than the 5 seconds provided considering that the Ss are approximately 10 points lower in mean IQ and slightly younger than in previous studies in this series. A second methodological difference was that 6 of the 14 sentences in each of the two concrete lists seem somewhat anomolous, while Rohwer and Levin (1968) have demonstrated that anomolous sentences do not facilitate recall and Rohwer (1967) has generally used very meaningful and more highly probable sentences.

It seems obvious that the 5 seconds allowed for elaboration is not enough time, and equally obvious that this time factor has influenced the outcome of previous studies by increasing individual differences.

If the researcher is interested in the facilitory effects of elaboration on children's recall and not speed of elaboration, then it seems that the presentation time should be long enough to allow each S to make use of what elaboration or instructional set is provided.

The main effect for noun concreteness was again quite large, but the failure of this factor to interact with instructional sets is still unexplained. Since Ss do not report images for abstract pairs yet recall these pairs when given imagery instructions as well as when given sentence generation instructions, it seems that Ss may be using some type of verbal mediation instead of or in combination with imagery mediation. What do kids do when given abstract pairs and instructions to image? This question must either be answered by item-by-item S reports of mediators, or the processes must be controlled with training procedures and/or orienting tasks (Paivio and Foth, in press).

EXPERIMENT V:
MENTAL ELABORATION INSTRUCTIONS AND CHILDREN'S RECALL

There are two major types of elaboration, one in which the learner supplies the mental activity (mental elaboration) and a second type in which the experimenter supplies appropriate context (imposed elaboration). Within each of these types of elaboration are two major modes of communication that have been identified: verbal and nonverbal. Bean and Rohwer (1970) have demonstrated that both types of verbal elaboration facilitate children's recall, and Dilley and Paivio (1968) and Rohwer, Lynch, Suzuki and Levin (1967) have demonstrated that imposed pictorial elaboration is at least as facilitative as imposed verbal elaboration. Although several studies have demonstrated that instructions to use mental imagery facilitates the recall of adults (Paivio and Yuille, 1967 and 1969), only a few studies (Taylor, 1969; and Taylor and Black, 1969) have demonstrated the facilitative effects of imagery instructions with children.

Several researchers have suggested that verbal and imagery mediators are connected and involve overlapping processes (Berlyne, 1965; Bower, in press; Bruner et al., 1966; and Paivio, 1969), and several researchers have found it difficult to separate these processes (Bower, in press; Paivio, 1969a; and Ehri and Rohwer, 1969). Berlyne has described the problem very succinctly. "We can do more than classify symbolic responses as more or less imaginal" (1965, p. 137). However, an alternative to separating these symbolic processes is to maximize the interconnectedness of the two processes and obtain multiple memory codes (Bower, 1967; and Paivio, 1969a). Some research has been conducted which bears on this problem; however, one of the major limitations seems to be that the research has manipulated different types of elaboration (mental and imposed).

Paivio and Csapo (1969) have demonstrated that recall of concrete nouns decreases when the latency is too short to allow for the construction of an image, and Wood (1967) has suggested that latency may be critical in research involving imagery instruction. Paivio (1968b) found maximum recall when both an imposed "peg list" and imagery instructions were present, and Taylor and Black (1969) found the most highly facilitative effects on recall when sentences were supplied and imagery instructions were given. A few studies have investigated verbal and nonverbal combinations within a single type of elaboration. Davidson and Adams (1970) and Rohwer, Lynch, Levin and Suzuki (1968) have found pictorial plus imposed verbal elaboration to result in the highest level of facilitation, while Yarmey and Csapo (1968) found that college Ss given both sentence and imagery instructions recalled no more nouns than Ss given only imagery or only sentence generation instructions.

It seems that if imagery and verbal elaboration are alternative forms of symbolic processing, then Ss who use imagery when imagery is most appropriate (i.e., with concrete nouns) and verbal elaboration with abstract materials, should recall more nouns than Ss who use only one of these processes in all situations. In order to test this hypothesis, both instructional sets and training procedures were developed to provide children with a means of deciding whether to use imagery or sentence (I or S) elaboration to remember concrete and abstract noun pairs. The basic idea of the I or S procedures was for S to attempt to make up a picture for all pairs; and when he encounters problems using imagery for certain pairs, he was to embed the pairs in sentences. Paivio's (1969) two process theory of mediation and memory predicts that although imagery is most effective with concrete nouns it should not facilitate the recall of abstract nouns. Only two studies have found statistical support for this interaction (Paivio and Foth, in press; and Yarmey and Csapo, 1968); several other studies have not found the predicted interaction (Paivio and Yuille, 1967 and 1969; Yuille and Paivio, 1968; and Taylor and Black, 1969). It seems that using imagery to remember concrete pairs and sentences to remember abstract pairs should lead to maximum recall both on the basis of the above theory and research.

The prediction of I or S facilitation is consistent with recent theories of memory organization (Mandler, 1967; and Bower, 1967 and 1970). Miller (1965b) has proposed that memory becomes more efficient as S unitizes or groups the material to be learned. Other researchers have suggested the value of plans, strategies, and structures for facilitating memory and recall (Miller, Galanter, and Pribram, 1960), and that mediation can only be effective when it is based on a strategy (Earhard and Earhard, 1968; and Mandler, 1967). Bower (1967, 1968, and 1970) has discussed the need for organization in memory and the idea that a particular memory is based on a particular bundle of semantic features, which can include images and verbal contexts (Bower, 1970). However, of particular importance to the I or S manipulation is Peterson's (1967) decision process model of memory, which suggests that memory is facilitated when S can make a series of discrete decisions and use these decisions as a memory retrieval plan. For example, when S codes a particular pair as

an image, the knowledge that an image was stored can serve as an additional memory cue. This is also consistent with the Miller's (1956a) hypothesis that memory is most efficient when S has approximately seven items in a bundle, and therefore, two groups of eight pairs (units) should be easier to remember than one group of 16 pairs. Therefore, if S codes approximately 8 noun pairs as images and 8 noun pairs as sentences, then he should be able to recall more nouns than if he had coded each pair as an image (or a sentence).

Five instructional set conditions were selected for study: Imagery; Sentence Generation; I or S (instruction); I or S Training; and a Repetition control. Bower (in press) suggests the use of a repetition control to prevent S from elaborating on his own, and to provide a more valid baseline against which to measure the facilitation resulting from elaborative instructions. The two I or S conditions differ in the extent to which S is trained to make a decision on the basis of noun concreteness. As a result, it would seem that The I or S training should be superior to I or S instruction wherever the I or S decision rule is appropriate, while I or S training may interfere with recall when the I or S decision rule is inappropriate for a given task (Earhard, 1967; Runquist and Hutt, 1961; Wood and Bolt, 1968; and Yarmey and Thomas, 1966). The general prediction is that all 4 elaboration conditions should facilitate recall as compared to the repetition control; and more specifically that the I or S conditions should be superior to imagery only instructions, which in turn should be superior to the sentence generation condition.

One final group was tested on list I to determine to what extent the imagery Ss were using imagery mediation when it was most appropriate (i.e., with concrete nouns). This group was to receive imagery instructions and only concrete nouns. The hypothesis being tested here was that when imagery Ss are given both concrete and abstract noun pairs, they fail to follow the imagery instructions for any of the pairs since the instructions are not appropriate for the abstract pairs. If this is the case, the concrete control group should recall more concrete nouns correctly than the standard imagery group given a mixed list of concrete and abstract nouns. If this hypothesis is disproven, then it would seem that children given imagery instructions do follow these instructions, at least for concrete pairs.

Method

Subjects. Sixty 10-, 11-, and 12-year-old children in the intermediate level of a nongraded school were randomly assigned to one of 6 conditions, 5 experimental and a control. The school is located in a lower-middle to lower SES class working area, and the intermediate level of the school was divided into 3 classes on the basis of school performance. All the children in the low and middle classes of the intermediate level served as Ss (N = 49), and 11 other Ss were drawn from the upper class. Lorge-Thorndike IQ scores were available on each S, and the total (verbal + nonverbal) IQ ranged from 60-132 for the sample tested.

Materials and Design. Each S was tested on two lists, each containing 16 noun pairs. All nouns were selected from the norms established on college Ss by Paivio, Yuille, and Madigan (1968), who obtained production meaningfulness scores (m), two ratings of concreteness-imagery value (C and I), and Thorndike-Lorge frequency (TLF) counts on 925 nouns. Therefore, the basic design was a one way analysis of variance with either repeated measures from list 1 (abstract or concrete nouns recalled) or the number of concrete nouns recalled on list 2 as the dependent measure.

List 1. Sixteen nouns rated high on concreteness and sixteen nouns rated low (or "abstract") were selected in order to maximize the differences in concreteness. These nouns were equated on TLF and matched on m values (abstract mean m = 6.01, and concrete mean m = 6.03). The 32 nouns were then paired so that eight pairs were high in rated concreteness (mean C = 6.70 and I = 6.38) and eight pairs were low in rated concreteness (mean C = 2.86 and I = 3.86). Twelve additional nouns were selected from the same source, and three filler pairs were inserted at the beginning and at the end of the list. This list was identical to that used in experiment IV and similar to that used by Taylor and Black (1969).

List 1A. One of the six conditions was a control group. This control group received an initial list of concrete pairs, 8 of which were the same pairs presented to the five experimental groups. The remaining 8 pairs of list 1-A were also rated high in C, I and m, and the filler pairs from list 1 were used for this list.

List 2. All Ss received this list which consisted of 32 nouns rated moderately high on concreteness (mean C = 6.03 and I = 5.78). The sixteen pairs had been matched on meaningfulness (mean m = 6.10) to List 1, and all pairs have been subjectively judged by E to be highly picturable. Six filler pairs, 3 at the beginning and 3 at the end of the list, were included to control for primacy and recency effects.

Four random orders were used for both the presentation and testing of each list, and all pairs and test stimuli were presented orally.

Procedure. Each S was tested individually by one of 2 male experimenters (Es). S was seated to the left and in front of E, and faced a blank wall. E read the instructional set appropriate for the condition to which S was assigned, presented 3 practice pairs, and tested S on these pairs. E then orally presented list 1 or 1A, and after a 20 second unfilled pause S was tested on the appropriate list. List 2 was then presented and tested in the same manner, and finally S was questioned about his learning methods.

The presentation and testing rates were 8 seconds per pair. Wood (1967) has suggested the need for longer presentation rates (5 seconds or more) when mnemonic systems including imagery are of interest to the verbal learning researcher. The 5 second rate suggested by Wood (1967), Paivio (1967), and Yarmey (1967) may be sufficient for the P-A learning

of college Ss, but it was suggested in previous studies in this series (e.g., Taylor and Black, 1969) that 5 seconds was not adequate for the production of functional memory images by children. In addition, it was assumed that more time was needed by Ss in the I or S conditions since these conditions required S to make a decision as well as generate images and sentences.

The experimental environment was considered optimal--the test room was a well lighted and well ventilated office containing two chairs and a desk, which allowed for the maintenance of a minimum level of extraneous noise and movement.

S was given a set to play a memory game, and was told, "I will read many pairs of words to you, and the game is for you to remember as much as you can." Each S was given instructions to learn the pairs in a specific way. The five different instructional sets were made as similar as possible, with particular regard to language, form, examples, and length. The control group was also given specific instructions--to repeat the noun pairs to themselves over and over until another pair was read. These repetition instructions have been suggested by Bower (in press) as a means of establishing a more appropriate baseline for any elaboration condition.

Ss in the imagery condition and sentence generation condition were given instructions which were modified slightly from those used in experiment IV, with changes made to facilitate S's understanding. Depending upon the condition, S was instructed to make up one picture (or a sentence) using the two nouns together. S was then told to use the picture (sentence) to remember the second noun when E read the stimulus noun of that pair. Ss in the concrete-imagery condition were given the identical instructions as those in the imagery condition.

In the I or S condition, S was given instructions to try and make up a picture with the things doing something together. But if he could not make up a picture or could not remember the nouns from the picture, he was to make up a short sentence using the two nouns and remember the sentence.

The I or S training condition followed the same format as the I or S instruction condition. The main difference between I or S instruction and training conditions was that S in the training condition were given feedback during practice as to the appropriateness of their mediator (imagery or sentence), the unitization of the picture or sentence, and examples of possible pictures or sentences for the first two pairs. In all other conditions, the practice pairs were presented and tested with no feedback.

Ss were scored for the number of nouns correctly recalled from: the 8 abstract pairs (list 1), the 8 concrete pairs from list 1 or 1A, and the 16 pairs of list 2.

Results

Preliminary analyses made with experimenters as an independent variable showed no significant main effects or interactions involving this extraneous variable. Therefore, the following analyses were conducted across Es. The means (abstract and concrete for list 1, list 1 total, and list 2 total) are presented in Table 16 for each of the 6 conditions.

TABLE 16

The Number of Nouns Correctly Recalled: Experiment V

Lists	Instructional set						
	Imagery (I)	Sentence (S)	Repetition	I or S	I or S Training	I Concrete	
8 Concrete	4.50	3.50	2.20	4.70	4.80	4.80	3.94
8 Abstract	2.10	2.40	1.60	3.00	3.00		2.41
List 1	6.60	5.90	3.80	7.70	7.80		6.35
List 2	8.30	7.00	3.90	9.20	6.50	8.20	7.17
TOTAL	14.90	12.90	7.70	16.90	14.30		

The first analysis was conducted on the 5 experimental groups with the number of concrete and abstract nouns recalled by Ss within groups as the dependent measure. The main effect for noun concreteness was significant, $F\ (1,45) = 31.06$, $p < .001$, with Ss recalling about 1 and ½ times as many concrete as abstract nouns. However, neither the Instructional set main effect, $F\ (4,45) = 2.31$, $p = .07$, nor the Instructional set x Noun Concreteness interaction, $F\ (4,45) = 1.28$, $p > .05$, were significant. However, Dunnett's test (Edwards, 1968, pp. 148-150) for comparisons between the treatment means ($K = 4$) and the mean of the control group revealed that: both I or S groups recalled significantly more nouns from list 1 than the repetition control, $t\ (45) = 3.64$ and 3.75, $p < .01$; and the imagery condition, $t\ (45) = 2.62$, $p < .05$, but not the sentence generation condition, $t\ (45) = 1.96$, $p > .05$, facilitated list 1 recall significantly more than the repetition control.

A one-way analysis of variance with 6 treatment groups was used to evaluate the difference in the recall of concrete nouns from list 1 (see

row 1 of Table 16). The analysis for the instructional set main effect was significant, $F(5, 54) = 3.04$, $p < .05$. Scheffe's Test for multiple comparisons (all significance tests evaluated at $p \leq .05$) revealed a significant elaboration effect--the mean of the five elaboration treatments was significantly higher ($p < .05$) than the mean of the repetition control, and that with the exception of the sentence generation condition each of the elaboration conditions (two imagery and two I or S) facilitated the recall of concrete nouns significantly more than the repetition control. However, the Sheffe's test revealed no combination of the means that were significantly different than the mean of the sentence generation condition.

A final one way analysis of variance was run with the dependent measure being the number of nouns correctly recalled on list 2 (see row 4 of Table 16) for each of the 6 conditions. The analysis was significant, $F(5,54) = 2.78$, $p < .05$), and Scheffe's test for multiple comparison was again computed (all significance tests evaluated at $p \leq .05$). Once again there was a significant elaboration effect, in that the combination of the means from all the elaboration conditions exceeded the mean of the control. However, for list 2 only the means of the two imagery conditions and I or S instruction conditions were significantly higher than the control. Not only didn't the I or S training condition facilitate recall, on list 2, but as can be seen in Table 16 the mean for this condition fell from the highest of the five elaboration conditions to the lowest. Also, looking at Table 16 it can be observed that the two imagery conditions failed to differ on the number of concrete nouns recalled from either list.

Discussion

The hypothesis that instructions to elaborate on noun pairs facilitates recall was confirmed by all analyses. Mental elaboration, either in the form of imagery or sentence generation, was proven to be a more successful P-A memory strategy than rote repetition for upper elementary children. The use of a repetition control condition seemed to have the desired result of producing a control group which was less likely to use elaborative strategies to remember pairs (Bower, in press), than a control group merely given instructions to learn the pairs (Taylor and Black, 1969).

Comparisons of the treatment means with the control mean revealed the unexpected finding that sentence generation instructions did not facilitate recall on either list. Although it was hypothesized that the sentence generation instructions would be the least facilitative of the elaborative sets, it has been frequently demonstrated that instructions to generate sentences increases the P-A recall of children (Rohwer, 1967 and 1968; and Montague, 1970). As expected, the sentence generation Ss recalled relatively more abstract nouns than the imagery Ss, but the sentence generation Ss recalled less concrete nouns. This is particularly intriguing in that Taylor, Peloquin, and Kenworthy

(Experiment IV, 1969) found the opposite effect with the same materials--concrete pairs--and the same basic instructional sets.

The concrete imagery group was used to test the dual hypotheses that Ss given imagery instructions and a mixed list of concrete and abstract pairs reject the set for all pairs since it is not functional for abstract pairs, or that the task of constructing images for abstract pairs becomes so confusing as to interfere with the imagery involved in concrete pairs. Each of these hypotheses predicts that Ss given a concrete list will recall more concrete nouns than Ss given a mixed list; this was not found in the means for the concrete means of list 1. In addition, the rejection hypothesis would also predict inferior performance by the mixed list imagery Ss on a list composed of only concrete pairs, but the means for the two imagery conditions were approximately equal for list 2.

A final result of interest was the relatively small number of nouns recalled from list 2 by the I or S training Ss. If this decreased recall was caused by the inappropriateness of the I or S set for list 2, then the I or S instructions condition would also exhibit decreased recall and this was not the case. An alternative hypothesis is that the decision rule on which the I or S training concentrated (that is, for concrete words make up a picture while for abstract words make up a sentence) was inappropriate for list 2. This alternative hypothesis seems viable in that: no abstract pairs were included in list 2 and the decision in all cases should be to make a picture; several children reported confusion because they always felt they should construct a picture; and this hypothesis is consistent with other research dealing with the effects of inappropriate sets on recall (Earhard, 1965; Runquist and Hutt, 1961; and Yarmey and Thomas, 1966). It seems that future research must discover the effects of inappropriate decision rules as well as functional rules, but that elaboration instructions are very effective when the type of elaboration is appropriate for the task (Bower, 1970b; Davidson, 1970; and Rohwer, 1970).

EXPERIMENT VI: RELATION BETWEEN THREE REPRESENTATIONAL STRATEGIES AND PERFORMANCE ON A FINGER MAZE TASK

One possible means of separating the combination of imagery and verbal processes usually present in verbal learning tasks is to provide instructional sets, which have the effect of increasing the likelihood of a particular type of representational response (Bower, in press; and Paivio, 1969). However, this does not insure that the representational processes aroused are still not some combination of verbal and imagery responses (Berlyne, 1965). Bower (in press) has suggested that most tasks require both verbal and nonverbal processing, but that there are certain spatial tasks that can be solved solely with imagery representations. When it is desired that the subject use mainly imagery

representations to solve a task, one way of reducing the need for and the tendency to use verbal representations might be to require a non-verbal response. Therefore, many of the traditional verbal learning tasks (e.g., P-A recall and Free Recall) may be of limited use in evaluating the facilitating effects of "purely" imagery representations since verbal responses are required which may confound imagery and verbal processes.

Shepard and Chipman (1970) have reported a method for evaluating internal imagery representations that may be free of many of the problems discussed above, and have argued for what they call "second order isomorphism of internal representations." This approach differs markedly from the early "wax tablet" model of memory (see Paivio, 1969a), which has stemmed from the theorizing of William James (1890), in that, ". . . while there is no structural resemblance between an individual internal representation and its corresponding external object, an approximate parallelism should neverless hold between the relations among different internal representations and the relations among their corresponding external objects." (Shepard and Chipman, 1969, p. 1). Shepard and Chipman have found support for this position using subjective judgments of similarity among the shapes (internal images and pictures) of 15 states.

Another task that might be amenable to an independent measure of the facilitative effects of imagery (or kinestic or verbal) on learning involves the learning of mazes. Woodworth (1938) provides an excellent review of research on human maze learning, but since this time, the maze has not been a frequently used tool of the verbal learning researcher. It seems that a maze learning task may be particularly valuable as a means of testing a developmental theory proposed by Bruner (1964; and Bruner, et al., 1966), which suggests that human beings learn first through tactile interactions (enactive), later via imagery (iconic), and eventually by means of language (symbolic). Bruner et al. (1966) do not suggest that these modes of representation are completely independent, but only that children of certain ages are more likely to rely on certain modes of representation. The hypothesis that children function better when given learning strategies consistent with their primary mode of representation--and more specifically, that children of age 9 or 10 would be relatively more successful at using imagery representation when this mode is consistent with the task, while college Ss should be relatively more successful than 9 or 10 year olds using symbolic (verbal) representation as a problem solving strategy--can be derived from the theorizing of Bruner, et al. (1966). Kuhlman (1960) found support for similar hypotheses, in that imagery ability (perceptual-iconic) is highly related to school success in grades 1 and 2, but negatively correlated to school performance in later years.

Recently it has been suggested that imagery is a highly symbolic process (Paivio, 1969a, and b; Bower, in press; Harré, 1967; and Smith, 1966) and not the pre-symbolic, iconic process suggested by Bruner, et al. (1966). The symbolic imagery position would seem to predict the

opposite results from Bruner et al.'s theory on a maze learning task, in that, the highly symbolic Ss (college student) should perform better than the children when given verbal or imagery instructions.

However, implicit in the research of Shepard and Chipman (1970) is the fact that imagery representation requires exposure to a model, which has been made explicit in the S-R approach to imagery acquisition (Skinner, 1953; Staats, 1968). In Skinner's terms, images are "conditioned sensory responses" which are elicited to stimuli that arouse similar verbal responses only after they have been conditioned to the appropriate verbal response. A clear presentation of a related philosophic approach to memory imagery has been made by Rom Harré (1967). Harré suggests that imagery is a post-symbolic form of representation that can act as a model for performance, but that imagery can only serve as a model after it is learned or made isomorphic with the task. Therefore, this "imagery as a representational model" approach would seem to predict relatively superior learning by adults than children given instructions to image a maze and use that image to learn the maze, but with no model presented to the blindfolded S, imagery instructions should not result in as functional a strategy for maze learning, as verbal processing.

Method

Subjects. A total of 54 Ss were selected from two student populations, with 9 Ss from each population randomly given one of 3 instructional sets (control, verbal, imagery). Twenty-seven fourth-grade children (approximately age 9) were selected from a "disadvantaged" rural school, serving a rural area of lower SES background. A second sample of 27 Ss were drawn mainly from an undergraduate introduction to mass communication course and more generally from the undergraduate population at Indiana University.

The resulting design was a 3 x 2 factorial with instructional set and age as the independent variables. The major dependent variables were trials to criterion, time to criterion, and errors to criterion on the task described below.

Task. The task was to learn a raised finger maze to the criterion of two consecutive correct trials. The task was similar to that of Warden (1924) who used a stylus versions of the present maze (see Figure 3) to investigate the learning and representational strategies of blindfolded college Ss. Warden's (1924) Ss reported using a motor strategy when first presented with the maze, and most Ss reporte final learning strategies that involved imagery, verbal, and numeric representations. The raised version of Warden's maze was first used by Husband (1931), and is discussed thoroughly by Woodworth (1938, pp. 147-149).

The particular maze chosen has 10 choice points (see Figure 3), and although it is very easy to trace this maze once one has seen it, it has been shown to be a moderately difficult task for blindfolded Ss. The finger maze was utilized here for a number of reasons: 1) for most

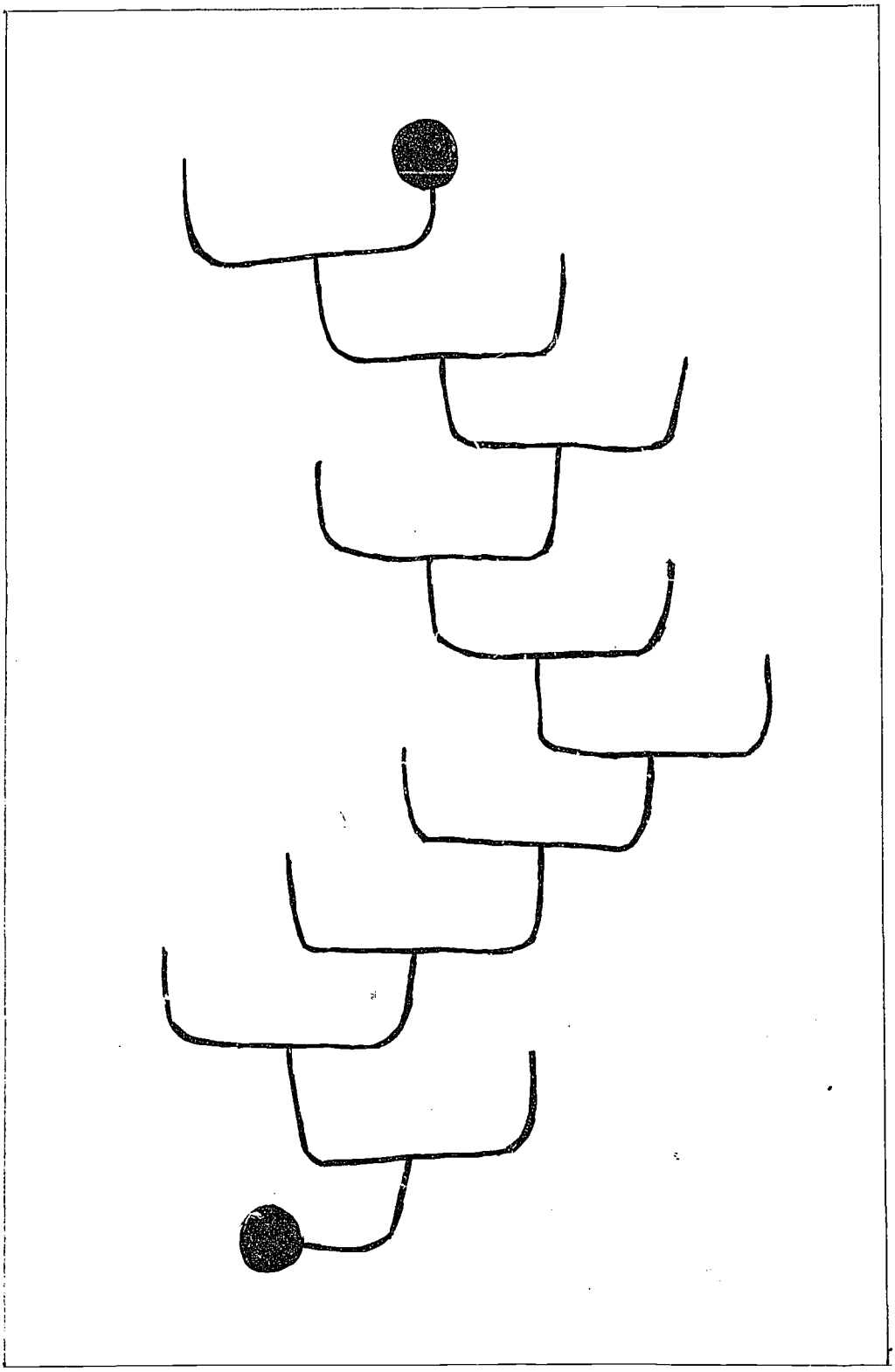

Fig. 3. The Finger-Maze Used in Experiment 6.

purposes, rats, children, and adults are nearly equal in performance on this type of task (Hicks, 1921); and 2) prior instruction dealing with suggested approaches to learning the maze should be used by S since the task is novel and does not seem to elicit overlearned responses sets.

Procedure. S was individually tested by one 2 Es, one female and one male, in a small testing room. Each S was told that he was going to play a game for which he would have to be blindfolded; and that in this game he would have to use his finger to find his way and "learn how to get from your house to your friends house without coming to a dead end." S was then blindfolded and allowed to feel the raised wire path and a dead end. The blindfold was removed, the maze was hidden, and S was given the special instructions for his condition:

Control . . . you can put your blindfold on in a second and try to learn the way from your house to your friend's house as fast as you can. Try not to make mistakes and work carefully. Let's start, OK . . .

Verbal . . . I'm going to tell you how to win at this game so that you can beat everyone else. OK? Do you remember the first turn? Which way did it turn to get to the next street? Do you remember? (If he does reward the response and go on . . . if not let him feel it again and get him to say LEFT). Good! It turns Left. Now . . . all the turns are either left or right . . . if you memorize which way the street turns to get to the next street you'll win at the game and get to your friends house before anyone else. Do you have any questions? OK then put your blindfold on and I'll get you started. Remember. Memorize whether each street turns left or right and you'll get there fastest and not make many mistakes. Let's start, OK . . .

Imagery . . . I'm going to tell you how to win at this game so that you can beat everyone else. OK? When I put your finger on the streets again try and picture them in your head. Pretend that your drawing a picture with your finger of the best way to get to your friend's house without any mistakes. OK? Can you make a picture now of the first turn you felt a minute ago? Draw it out for me on the table top. Good! (If he draws it correctly go on . . . if not . . .) Lets feel the streets once more. Put your blindfold back on for a second. OK, now try to picture how the streets run. Can you picture it? Good. Any Questions? Good. Lets get started. Try to get to your friends house without making one mistake. As you get a picture of the right streets in your head, you'll go fast and not make any mistakes. Let's start, OK . . .

S was blindfolded, and his finger was placed at the start, and told to begin. S had previously been told that he could return to the beginning or retrace and continue on after a dead end was reached, and each time S returned to the starting point of the maze began a new trial. The criterion was one perfect trial, with S given a maximum of 20 trials to reach this criterion.

S removed his blindfold after the final trial, and was asked to describe how he learned the maze. After this description S was asked to draw the maze (due to an oversight this was done only with children).

Results

The results were analyzed for time (rounded to the nearest minute), errors, and trials to criterion by a 2 (age) x 3 (Instructional Set) x 2 (Experimenters) fixed effects factorial design (Hays, 1962). The analysis with trials to criterion as a dependent measure was conducted with Es as a fixed effect (see Appendix F-1), and although none of the interactions nor the main effect involving Es were significant, the Age x Experimenter interaction (see Table 16) suggests a difference in mean performance for both college and elementary as a function of E, $F(1, 36) = 2.59$, $.05 < p < .10$.

TABLE 16

Trials to Criterion on Maze Learning Task as a Function of Age and Experimenters: Experiment VI

Experimenter	Age		
	Elementary	College	
Male	15.83	9.00	12.42
Female	13.58	12.75	13.17
	14.71	10.88	

Only the age main effect resulted in significant differences in the number of trials to criterion, $F(1,36) = 4.24$, $p < .05$, with college Ss taking significantly less trials to reach criterion (see Table 17). Although the Age x Instructional Set interaction was not significant, $F < 1.0$, an inspection of the means in Table 17 reveals that the smallest difference between age groups occurs in the control condition. This is inconsistent with the hypothesis derived from Bruner et al. (1966), but consistent with the two hypotheses from memory imagery. However, the main effect for instructional set was nonsignificant, $F(2,36) = 1.14$, $p > .05$ which would not be predicted from any of the hypotheses.

TABLE 17

Trials to Criterion on Maze Learning Task as a Function of Age and Instructional Set: Experiment VI

Age	Instructional set		
	Verbal	Imagery	Control
Elementary	14.25	17.12	12.75
College	8.75	12.38	11.50
	11.50	14.75	12.12

The analysis of variance with total time to criterion as the dependent measure resulted in a significant main effect for age, F (1,36) = 4.79, $p < .05$, which revealed that college Ss completed the task more rapidly. The Age x Instructional Set interaction was again nonsignificant, F (2,36) = 1.18, $p > .05$, but Dunnett's test for the difference between treatment and control means (Edwards, 1968) revealed a significant difference between the mean number of minutes to criterion for the imagery and control groups for the elementary Ss (t (k = 2, df = 36) = 2.61, $p < .01$). Dunnett's test revealed no other significant differences between the control and other groups for either age group. The main effect for instructional sets was nonsignificant, F (2,36) = 2.64, $.10 < p < .05$, with the appropriate means presented in Table 18.

TABLE 18

Time to Criterion on Maze Learning Task as a Function of Age and Instructional Set: Experiment VI

Age	Instructional set			
	Verbal	Imagery	Control	
Elementary	9.12	13.12	6.75	9.67
College	5.62	7.62	6.50	5.68
	7.38	10.38	6.62	

The analysis of variance with errors to criterion as the dependent measure resulted in a significant main effect for Es, $F\ (1,36) = 6.54$, $p < .05$, which was caused by the Ss tested by the female E making about 1 and 3/4 times as many errors as those tested by the male E (see Table 19). Further analysis of the data revealed that this effect was due primarily to two factors: the Ss for the female E took more trials to reach criterion, and the Ss for this E tended to continue on the same trial after making an error. However, since the E factor did not interact with the other variables the remainder of the analysis was relatively uneffected by the E effects. The age main effect was not significant, $p\ (1,36) = 3.39$, $.05 < p < .06$. All other effects did not result in F values in excess of unity.

Analysis of the drawings of the elementary Ss was inconclusive because of the failure to find a reliable means for evaluating the drawings. A summary of the reported strategies tended to suggest that the verbal strategies were preferred.

Table 19

Errors to Criterion on Maze Learning Task as a Function of Age, Instructional Set, Experimenters: Experiment VI

E	Instructional set	Age			
		Elementary	College		
Male	Verbal	30.50	14.50	22.50	26.12
	Imagery	34.75	23.25	29.00	
	None	35.00	18.75	26.88	
Female	Verbal	49.00	32.00	40.50	43.62
	Imagery	64.25	41.00	52.62	
	None	33.50	42.00	37.75	
		41.67	28.58		

Discussion

Three different predictions were made about the relative and absolute effects of imagery instructions on the maze learning of fourth-grade and college Ss. The hypothesis that children would function relatively better than adults when given instructions to image the correct path of the maze, which was derived from the developmental theory of Bruner, et al. (1966),

was definitely not supported by the results. The hypothesis based on recent imagery research in verbal learning (e.g. Paivio, 1969; and Taylor and Black, 1969) was partially supported in that college Ss given imagery instructions learned about as rapidly as controls while children given imagery instructions completed the task significantly slower than the controls. However, it seems that each of these positions would predict positive facilitation of learning by imagery Ss in one age group or both, and the data fail to support this in direction as well as magnitude.

The hypothesis that was most consistent with the data was based on the assumption that imagery can function efficiently only when a model of the task has been previously presented to S (Harré, 1967). As in the case of the Shepard and Chipman (1969) study it was assumed in the present study that original learning had occurred previously, and that what was being manipulated by the instructional sets was Ss internal representations. Therefore, it is suggested that the failure of the imagery instructions to facilitate maze learning for either group, was at least in part due to inappropriate and possibly even interfering internal representations caused by the lack of an appropriate model to use in constructing the image. From this it can be concluded that imagery is only a feasible and functional alternative mode of internal symbolic representation when S has previously acquired an appropriate model for the task. A possible alternative hypothesis to account for the data suggests that the imagery instructional set was not properly communicated to S, however, when judged in comparison to previous imagery instructions used with children (Taylor and Black, 1969; Taylor and Schneller, 1969; and Montague, 1970) the present instructions seem relatively clear, with a positive factor being the practice in drawing the first turn provided before the testing.

Previous research using a similar maze has revealed relatively equivalent learning rates for children and adults (Hicks, 1921), while college Ss did learn the maze more rapidly in the present study. However, a closer inspection of the means in Tables 17 and 18 revealed that the control Ss for the two age groups learned the maze at approximately the same rate, and the previous research (Hicks, 1921) utilized a set most similar to the control condition of the present study. The significant and nearly significant experimenter effects found in the present study result in some problems with interpretation, as well as in evaluating the potential for the maze learning task. However, the task seems to have a potential capability for evaluating and measuring the effectiveness of internal representations and particularly for separating the verbal and nonverbal components of these representations.

EXPERIMENT VII
IMAGERY ORGANIZATION AND CHILDREN'S RECALL

Mental imagery as an approach to learning and thinking was in vogue with early psychologists (e.g., Titchener, 1909) before the onslaught of behaviorism ended its popularity. However, imagery has recently gained new acceptance as an approach to mediated learning and memory. The first manifestation of this acceptance has been research intended primarily to demonstrate the effectiveness of imagery for improving learning, which has been reviewed by Paivio (1969). Imagery and verbal mediation are considered to be alternative modes of intrapersonal communication or mental elaboration, but for research purposes imagery has been operationally defined in two ways. The first is the concreteness-imagery value of nouns, defined on the basis of rated ease of formation and vividness of an image; and the second involves instructional sets to form images. Paivio (1969) noted the consistent finding that noun concreteness accounts for more of the variance in paired-associate (P-A) recall scores than imagery instructional sets, when both are manipulated with college students. This conclusion is supported in the research of Paivio and Yuille (1967 and 1969), and is consistent with the findings of Taylor and Black (1969) investigating P-A recall in children. However, the opposite results have been found with a mnemonic technique involving imagery, which requires the over-learning of a rhyming serial "peg list" (e.g., one is a bun, two is a shoe, three is a tree, etc.). Bugelski, Kidd, and Segmen (1968) suggested that imagery instructions were critical to the effectiveness of this technique. Paivio (1968b) clarified the issue by manipulating both the concreteness of the "peg list" and imagery instructions, and found that in this case instructional sets accounted for most of the variance attributable to imagery.

Rohwer (1969) has pointed out that almost all the research manipulating imagery instructional sets has been with college subjects (Ss). One recurring problem in the manipulation of imagery instructional sets has been the limited experimental control over the mediational activities of college Ss (e.g., Paivio and Yuille 1969; and Persensky and Senter, 1969). Although Taylor and Black (1969) have reported similar problems in controlling imagery instructional sets with children; they have suggested that it should be easier to gain control over the mediational activities of children since younger Ss would be less likely to have their own well-developed mediational strategies. Taylor and Black (1969) proposed the following means of increasing the control over the responses of children given instructional sets; the use of a more complex task for which S is less likely to have a response set; the use of only concrete nouns, since little is known concerning the activities Ss perform in order to construct images for abstract nouns; the use of more elaborate training procedures involving feedback and examples supplied by E; and the use of repetition instructions as a means of preventing the control Ss from "doing their own uncontrolled thing." Bean and Rohwer (1970) have found support for a similar set of assumptions from a recent P-A study. These researchers found that the performance of first- and sixth-

grade children given no specific instructional set (NS) was similar to that of Ss given repetition instructions and significantly below the performance of Ss given sentence-generation instructions; while eleventh grade Ss given the NS set not only recalled more words than repetition Ss, but recalled significantly more words than the sentence generation Ss.

Since the initial research on imagery has shown it to be a potent variable in mediation and memory, some of the attention of researchers interested in imagery has shifted to: the theoretical analysis of the functions of imagery (e.g., Paivio, 1969; Bower, in press; and Rohwer, 1969); and to the developmental and educational implications of research on imagery (Reece, 1969a; and Taylor, 1970). Although all these recent approaches to imagery stress some aspect of its mediational function, the conclusions of Bower (in press), that imagery functions mainly as a relational-organizer, seems to be particularly descriptive and easily testable. Bower (in press) reports philosophical, behavioral, and experimental evidence for this relational-organizer function of imagery, and other researchers (Tulving, McNulty, and Ozier, 1965; and Frincke, 1968) have found a relationship between a stimulus dimension of noun concreteness-vividness-imagery and both clustering and learning in free recall. Cofer (1968) has also suggested that organization is inherent in sentence structure and mnemonic learning devices (e.g., imagery), but that this organization interferes with the formation of larger and more functional memory units (i.e., "chunks" or "clusters"). It is possible that Cofer's suggestion may be correct with respect to the traditional P-A paradigm, which seems to place limitations on the effectiveness of imagery instructional sets. However, this interference was not evident in the recent research of Bower and his associates (Bower, Lesgold, and Tieman, 1969; and Bower and Lesgold, 1969), who have used an imagery instructional set in several free recall studies that involves the construction of an interacting image of four concrete nouns as a means of insuring organization of an unassociated list. The task employed in the present experiment is modified from Bower's task and involves the P-A recall of three response nouns to a single stimulus noun, which Bower, Lesgold, and Tieman (1969) have called a 4-tuple or quartet.

This 4-tuple presentation allows for the manipulation of instructional sets varying in the degree of organization S is instructed to use in learning. For example, in the P-A paradigm, Ss could be instructed to organize the 4-tuple into one unit or they could pair the stimulus individually with each of the responses in the traditional way. Independent of instructions to organize, however, it seems the 4-tuple task should result in large differences between Ss given imagery and repetition instructional sets. If Bower (in press) is correct that imagery primarily functions as a relational-organizer, then the unitized-imagery Ss should be effectively clustering their recall in larger memory units, while the type of images formed by the paired-imagery Ss should restrict the formation of these units. It is predicted that the recall of the unitized-imagery Ss will be more highly organized than the recall of

paired-imagery Ss, and that unitized-imagery instructions should lead to significantly more nouns correctly recalled than paired-imagery instructions. Similar findings are not expected for the repetition controls with respect to instructions to organize, since Tulving (1966) has suggested that rote repetition leads to improved recall only when it leads to the organization of larger functional memory units.

Method

Subjects. Forty-eight sixth-grade children from a rural-suburban school were randomly assigned to one of four experimental groups, two imagery (unitized and paired) and two repetition (unitized and paired). Each S was tested individually by one of these experimenters (Es), with each E testing three subjects in each of the four conditions. The data from one S in the paired-imagery condition was lost because S reported not attempting to use the instructional set provided; while all remaining Ss reported following the specified instructions.

Materials. All nouns were selected from the norms established on college Ss by Paivio, Yuille and Madigan (1968), who obtained production meaningfulness scores (m), two ratings of imagery-concreteness, C and I, and Thorndike-Lorge frequency (TLF) counts on 925 nouns. Eighty-four nouns rated high on concreteness were selected from this source, and pilot tests were conducted to insure that the words were in the vocabularies of sixth-grade children. The words were then divided into groups of four, and each 4-tuple was checked to insure that there were no direct associations between two or more words within a set. Each 4-tuple was typed in primary letters on 5 x 8 flash cards, with the stimulus noun in one column and the 3 response nouns in another. Three of the resulting cards were used as training materials, and the remaining 18 r-tuples were divided into two lists, as shown in Table 20. The lists were matched on m and C for both the stimulus nouns and the response nouns. Line drawings in black ink on white 5 x 8 cards were used as instructional aids in the training of imagery Ss.

TABLE 20

Two Lists of Noun 4-Tuples Used in Experiment VII with Sixth-Grade Ss

List 1	
Nail	Flesh Mother Flood
Star	Tower Peach Army
Horse	Strawberry Window Letter
String	Butter Cat House
Brain	Hotel Table Magazine
Judge	Hall Devil Professor
Flower	Baby Fox Engine
Girl	Pole Library Umbrella
Railroad	Frog Rattle Bowl
List 2	
Hammer	Gold Insect Child
Arrow	River Tree Potato
Elephant	Doll Piano Candy
Circle	Blood Flag Corner
Beast	Machine Student Village
King	Bird Truck Dress
Sugar	Car Dollar Whale
Lemon	Officer Corn Palace
Toy	Toast Camp Slave

Procedure. All Ss were tested individually and informed concerning the general procedure, that they would be shown cards containing four nouns and would be asked to use a special way to remember them. The special ways to remember the nouns were the four conditions resulting from a fully crossed factorial design involving two instructional sets (imagery or repetition) and two levels of organization (unitized and paired). Therefore, Ss in each condition received a different instructional set and the appropriate training procedures. The unitized-imagery (UI) Ss were instructed to imagine one picture containing the four things named on each card doing something together; while the paired-imagery (PI) Ss were instructed to imagine three separate pictures, one interacting picture for each pairing of the stimulus word with one of the three response nouns. The training for the unitized-repetition (UR) condition consisted of having S repeat each 4-tuple over and over as one group (e.g., Boy-Lion-Banana-Cup). In the paired-repetition (PR) condition S was instructed to repeat three pairs over and over, one for each pairing of the test word with the other three stimulus words (e.g., Boy-Lion, Boy-Banana, Boy-Cup, Boy-Lion, etc.).

The training for all four conditions followed the same general pattern; the individual presentation of three practice cards with a lesser amount of instructional aid accompanying each succeeding card. For example, in the UI training the first practice card was accompanied by an integrated picture containing all the referents of the four stimulus words. The second practice 4-tuple was accompanied by an instructional aid which presented isolated pictorial representations of each of the four nouns, and no instructional aids were given for the third card. In the repetition groups, E provided verbal instructional aids by repeating the stimulus words over and over in the appropriate manner. After training, S was tested on the three practice cards and asked to describe how he tried to learn the 4-tuples. S was then informed as to the procedure to be followed in the remaining portion of the experimental session and was given an opportunity to ask questions, which E answered only by repeating relevant portions of the instructional set.

List 1 was presented with each card shown for twenty seconds (5 sec. per word). Immediately after the presentation of the complete list, S was tested immediately on List 1 by an oral presentation of the test word followed by a recall period (maximum 15 sec./4-tuple) during which S responded verbally. After a brief pause in which a review of the instructions was provided (approximately 30 sec.), List 2 was presented and tested in the same manner as List 1. The two lists served as repeated measures of immediate recall since the high likelihood of ceiling effects made it less desirable to have multiple trials on a single list.

Prior to the presentation of the lists the cards were shuffled and the first and last 4-tuples were recorded so that the effects of primacy and recency could be determined. The order of testing was randomly determined and systematically varied so that 3 Ss from each condition were tested with each of 4 random orders on each of the 3 tests.

Results

Data were pooled over experimenters since this extraneous variable produced no significant effects. In addition the separate analysis controlling for primacy-recency effects (i.e., analysis of only seven 4-tuples) was dismissed as it produced results identical to those for the complete list.

Following the procedures developed by Cohen (1963) to measure clustering in free recall, three related measures were recorded for each S on each of the lists: words correct (W), the number of nouns correctly recalled in a given test (maximum = 27); number of categories (C), the number of 4-tuples-test from which S correctly recalled at least one noun (maximum = 9); and words per category (W/C), the ratio expressing the mean of words recalled per 4-tuple in a test (maximum = 3.00). Of the 3 dependent measures W has been found to be the best general indicator of recall. However, Cohen (1963 and 1966) has demonstrated that C is quite

sensitive to lists and learner differences, while W/C is particularly sensitive to organizational factors and has been found to be nearly a constant for categorized lists (Cohen, 1966). The results for immediate recall were analyzed by a 2 x 2 x 12 x 2 (Instructional Set x Organization x Ss x Lists) analysis of variance for each of the dependent variables ($\bar{W}$, $\bar{C}$, and W/C).

The major findings with W as the dependent variable are shown in Table 21. As expected, the main effect for instructional set was significant, F (1, 44) = 83.57, $p < .001$, with this difference between imagery and repetition instructional sets accounting for slightly over half the total variance in recall (est. $W^2 = .56$). The Instructional Set x Organization interaction was not significant, F (1, 44) = 1.60, $p < .05$. The lists main effect was found to be significant, F (1, 44) = 15.28, $p < .01$; however, since the order of the lists was not counterbalanced, the effect could be due to the increased difficulty of list 2 or to retroactive interference. All other effects were nonsignificant, $F < 1.0$.

TABLE 21

Mean Number of Nouns Correctly Recalled as a Function of Lists, Organization and Instructional Set: Experiment VII

Lists/ organization	Instructional set				
	None		Imagery		
	Unitized	Paired	Unitized	Paired	
List 1	5.50	6.75	17.75	16.33	11.58
List 2	3.67	4.83	15.42	13.42	9.33
	4.58	5.79	16.58	14.88	
	5.19		15.74		

The specific predictions with C, the number of 4-tuples from which at least one noun was correctly recalled, as the dependent measure were that imagery Ss would enter more 4-tuples than repetition Ss and that the Instructional Set x Organization interaction would not be found significant. These hypotheses were confirmed by the data as presented in Table 22. Imagery training resulted in S entering significantly more 4-tuples than Ss instructed to use repetition, F (1,44) = 66.35, $p < .001$, est. $W^2 = .52$. Also as predicted the Instructional Set x Organization interaction was not significant, $F < 1.0$. The main effect for lists was again significant, F (1,44) = 9.05, $p < .01$, and as expected all other effects were nonsignificant.

TABLE 22

Mean Number of Categories Recalled as a Function of Lists, Organization and Instructional Set: Experiment VII

Lists/ organization	Instructional set				
	None		Imagery		
	Unitized	Paired	Unitized	Paired	
List 1	3.33	3.57	7.25	7.17	5.33
List 2	2.50	2.92	6.42	6.67	4.62
	2.92	3.25	6.83	6.92	
	3.08		6.88		

The results for the mean number of words-recalled per category (W/C) are presented in Table 23. Since W/C was developed by Cohen (1963) as a measure of categorical organization, it was primarily on this dependent variable that instructions to unitize the 4-tuples were expected to be effective. The main effect for instructional set was again demonstrated, F (1,44) = 48.30, $p < .001$; est. $\omega^2 = .33$, and this effect was modified by the significant Instructional Set x Organization interaction, F (1,44) = 14.04, $p < .01$; est. $\omega^2 = .09$. Two orthogonal planned comparison, that UI Ss would recall more W/C than PI Ss and that imagery instructions would result in higher W/C scores than repetition, were supported ($p < .05$), but the final orthogonal planned comparison, that the two repetition conditions would be equal, revealed an unexpected significant difference in favor of the paired-repetition group.

TABLE 23

Mean Number of Words/Category Recalled as a Function of Lists, Organization and Instructional Set: Experiment VII

Lists/ organization	Instructional set				
	None		Imagery		
	Unitized	Paired	Unitized	Paired	
List 1	1.53	1.87	2.43	2.19	2.00
List 2	1.05	1.61	2.40	1.97	1.76
	1.29	1.74	2.41	2.08	
	1.52		2.25		

However, it is possible that this difference may be accounted for by the statistical deflation of the mean of the unitized-repetition group, which resulted from two Ss recalling no categories and therefore being given a zero W/C score. That this statistical deflation only accounts for part of the difference can be seen in Table 24. The top half of Table 24 presents the group means for each of the dependent measures; and a group measure of W/C calculated by dividing the total words the group recalled, by the number of 4-tuples (C) the group recalled (Cohen, 1966). The lower part of Table 24 shows some representative means reported by Cohen (1966) using lists composed of 3-word exhaustive categories (E, i.e., feminine, masculine, neuter) and 3-word non-exhaustive categories (NE, i.e. dog, horse, cow). Although no statistical test was conducted, an analysis of W/C (group) means suggests that unitized-imagery instructions lead to about the same high degree of clustering (2.43) as Cohen reports for exhaustive categories (2.48); and that the degree of clustering with paired-imagery instructions and non-exhaustive categories is roughly equivalent.

TABLE 24

Means from Taylor, et al., 1970 (Experiment VII) and Cohen (1966)

Conditions	Dependent measures			
	W	C	W/C	(group) W/C
Paired-Repetition	5.79	3.25	1.74	1.79
Unitized-Repetition	4.58	2.91	1.29	1.57
Paired-Imagery	14.88	6.92	2.08	2.15
Unitized-Imagery	16.58	6.83	2.41	2.43
Cohen's E-list	-	-	-	2.43
Cohen's NE-list	-	-	-	2.20

Discussion

The results indicate that children given imagery instructions recall 3 to 4 times as many words as repetition controls. Since most of the previous research using imagery instructional sets has been with college Ss and the magnitude of the differences found with these Ss has not been nearly as large as in the present study, it is possible to hypothesize that imagery instructions aid the recall of children more than adults. However, the conclusion cannot be quite so broad since Taylor and Black (1969) have found only relatively small but significant differences between children instructed to use imagery and control Ss. The present study differs from previous studies (i.e., Taylor and Black, 1969) in several ways including: a more controlled imagery instructional set; the addition of repetition instructions to limit the strategies employed by controls; and the complexity of the 4-tuple task. It seems that these factors and not just the use of children as Ss were responsible for the large recall differences found between imagery and repetition groups in the present experiment.

Although the data is clear with respect to the imagery factor, some discussion seems necessary in regards to organization instructions. That instructions to organize or group nouns does not always increase recall had been suggested by Tulving (1966) and is supported in the present experiment since in no case was there a significant main effect for organization instructions. One conclusion that could be derived from this is that the present organization instructions were not functional. However, that the organization instructions did function as predicted is demonstrated by the interaction between Instructional Set and Organization

instructions observed when W/C, a measure sensitive to organization, was the dependent variable. Instructions to unitize increased W/C organization for imagery Ss but not for repetition Ss, however, this effect was not large enough to produce a significant increase in the number of nouns recalled (W).

The theoretical implications from these findings are that imagery instructions do seem to provide a mediational or relational set, which seems to be functionally similar to the "conceptual peg" hypothesis (Paivio, 1969). Further it seems that the unitized-imagery instructions function to provide a relational-organizer (Bower, in press) in that the recall of these Ss is highly clustered. Regardless of the specific interpretation it seems quite possible that imagery does function as an organizer (Bower, in press), and that instructions to unitize adds to this by supplying an integrated-relational set. The real test of UI instructions is whether they result in an increased number of words recalled; if not, then the significant interaction found in the present study is either meaningless or an artifact of the dependent measure, W/C. The use of W, C, and W/C as dependent measures seems appropriate since Tulving and Pealstone (1966) have suggested that these measures serve to breakdown the gross recall measure, W, to its component parts (W = C x W/C).

The use of a new paradigm seems justified in light of: criticisms of the traditional P-A paradigm with mnemonic organizers (Cofer, 1968); the large differences between conditions found in the present study; the possibility of manipulating organization within a 4-tuple; and also the proximity of such learning to educational concept learning (Carroll, 1964). There is nothing magic about 4-tuples, and what might make this modification of traditional P-A recall significant is the possibility of varying the number of responses per stimuli. In fact, in our research group at the present time studies are being conducted using 3-tuples, 5-tuples and 7-tuples, as well as 4-tuples and the traditional 2-tuples. Probably the most interesting thing I have to report about tuples for the present is a study by Russ Cassity and myself which shows UI far exceeding PI in total recall (W) with only a shift from 4-tuples to 5-tuples. It seems that there is a limit as to the number of unorganized images that can be connected to a single stimulus noun, but judging from the work of Mandler (1967) and Bower, et al. (1969) the limit of a "well" organized mnemonic may be quite high.

It seems that imagery is a functional strategy for improving children's recall, at least with concrete nouns. In addition, it seems that instructional sets can improve learning and memory in many contexts: learning from text (Frase, 1969, and 1970); recalling nouns embedded in sentences (Rohwer, 1970); and learning from a mnemonic "peg list" (Paivio, 1968). Possibly the most important educational implications of research with instructional sets is Bower's (1970) proposal that a "task analysis" of each instructional setting is necessary in order to determine the applicability of specific mnemonic or instructional sets for school learning.

EXPERIMENT VIII
MENTAL ELABORATION AND LEARNING WITH MENTALLY RETARDED CHILDREN

Much of the verbal learning research with the mentally retarded has used the traditional paired-associate (P-A) task and methodology (Denny, 1964; and Prehm, 1967), but the findings with the P-A task have been inconsistent (Mordock, 1968). However, Rohwer's (1966) finding that sentences facilitate the P-A recall of children has been consistently found with mentally retarded adults and children (Jensen and Rohwer, 1962 a and b; Borkowski and Johnson, 1968; and Milgram 1968 and 1969). It seems that providing imposed elaboration in the form of meaningful sentences is one means of facilitating the P-A recall of retarded children. Another means of facilitating recall may be to provide elaboration in the form of pictures (Davidson, 1964), but the results for retarded Ss seem to be inconsistent with respect to pictorial elaboration (Spiker and Bartel, 1969).

An alternative to supplying mentally retarded subjects (Ss) with appropriate elaboration is to train each S to construct his own elaborative contexts which he can then use to learn noun pairs (or any other associative relationship. This orientation has been suggested by Rohwer (1968, and in press; and Rohwer, Lynch, Levin, and Suzuki, 1967) as a means of supplying children with a general learning strategy, and several verbal learning researchers interested in education have recently stressed the enrichment possibilities and educational implications of well developed instructional sets serving to supply S with an appropriate learning strategy (Bower, 1970a; Taylor, 1970; Davidson, 1970; and Denny, 1964). Rohwer (1968) has reported that retarded adults are capable of providing mental elaboration, in the form of sentences or stories, which greatly facilitates P-A recall. However, little is known about the problems involved in, or facilitating effects of, giving retarded children instructional sets to use mental elaboration. All that seems to be known is that retardates have "weak internal learning sets" (Denny, 1964).

The purpose of the present study was to determine whether instructional sets to elaborate, either in the form of sentences or images, improve the P-A recall of retarded children as compared to controls given rote repetition instructions. The results are inconclusive as to the superiority of imagery or verbal elaboration with normal children, but both types of representation have consistently been found to facilitate P-A recall of children (Montague, 1970; Taylor, 1969; and Reese, 1969b). It was hypothesized that imagery instructions would be relatively more facilitative than instructions to generate sentences with retarded children since imagery representation is more of less free of verbal processing, which according to Luria (1963) may be defective in retarded children. Another reason for the predicted superiority of imagery instructions is that the function of memory imagery has been described as that of a relational organizer (Bower, in press) and Spitz

(1966) has suggested that a lack of organization is one reason for the memory deficit found with retarded children (Fagan, 1968).

An additional purpose of the present study was to investigate the efficacy of paradigms more complex than the traditional P-A paradigm. Turnure and Walsh (1970) have found that imposed verbal elaboration in the form of two-sentence paragraphs (PM) results in at least as rapid learning as imposed sentence mediation (SM) with retarded children, and that both PM and SM greatly facilitate the P-A learning of retarded children. Although Turnure and Walsh (1970) did not require the learning of more than 2 nouns from each presentation, their elaborative context was more complex than that previously used (Rohwer, 1966 and 1967; Milgram, 1967 and 1968). Turnure and Walsh (1970) interpret their data, which include a R-S (response-Stimulus) reversal, in terms of Asch and Eberholtz's (1962) principle of associative symmetry, and conclude that their Ss are indeed using syntactic mediation. It seems that both elaborative conditions supplied relations between the terms, and that these retarded children did not seem to be deficient in verbal processing, as Luria (1963) has proposed.

Taylor, Josberger, and Prentice (1970) have devised a 4-tuple task and related methodogy which allow for the manipulation of organizational relations through instructional sets. This task involved the P-A recall of three nouns to each stimulus, and Taylor et al. (1970) reported that Ss given imagery instructions recalled three times as many nouns as controls. The present study was designed to extend the Taylor et al. study to retarded children, and to compare the effects of two kinds of elaborative instructions (imagery and verbal) on the recall of noun 3-tuples by retarded children.

Methods

Subjects. The 27 children from three Special Education classes (CA = 10-13 yrs, IQ $\leq$ 75), in the Monroe County (Bloomington) Indiana school system were randomly assigned to one of three experimental conditions: Imagery (IM), Sentence Generation (SG), and Repetition-Control (R-C). Each S was tested individually by one of two experimenters (Es), such that each E tested four Ss in each of the three conditions. The data from one S in the IM condition and one S in the SG condition were lost due to inability of both Ss to carry out the instructional set provided; all remaining Ss reported following the specified instructions. An additional S was dropped from the IM condition due to the excessive time required to complete the task; which was judged to be independent of the instructional condition.

Materials. The 64 concrete nouns used in the study were drawn from a pool of nouns (Taylor, Josberger, and Knowlton, in preparation) which have been used in previous studies involving elaboration (e.g., Taylor and Black, 1969; Taylor et al., 1970; and Rohwer, 1967). The nouns for

this study were selected on the basis of the following criteria: presence in the reading and speaking vocabularies of retarded children; ease with which sentences could be generated using each noun; and high picturability or concreteness of the referent of each noun. Pilot tests of the nouns selected were conducted with younger retarded children (CA = 8 - 11) and all words appeared to meet the stated criteria.

Subsequently the nouns were distributed into three lists containing 16, 24, and 24 nouns respectively. The nouns in lists 1 and 2 were paired such that no direct associations between pairs was evident. List 3 was divided into eight sets of three nouns (3-tuples), with each 3-tuple composed of one stimulus and two response nouns. The 3-tuple list was constructed so as to avoid direct association between any 2 nouns of a set. Sixteen additional nouns drawn from the same source were used as examples throughout the training session. The lists are presented in Table 25. The only additional materials used were 2 line drawings in black ink on white 5 x 8 cards, which were used as instructional aids in the training of imagery Ss.

TABLE 25

Lists used by Taylor, Josberger, and Knowlton with Retarded Children: Experiment VIII

List 1	List 2	List 3 (3-Tuples)
Cat-Log	Man-Fork	Broom--Snake Flashlight
Pencil-Potato	Devil-Truck	Tire--Mop Button
Girl-Umbrella	Frog-Clock	Spider--Clown Tent
Blanket-Table	Bird-Pie	Bread--Scissors Lock
Car-Horse	Needle-Sock	Piano--Fan Zipper
Elephant-Strawberry	Bat-Lion	Mailbox--Turtle Donut
Rope-Dress	Knife-Box	Bullet--Toothbrush Letter
Hammer-Bell	Shoe-Cake	Dog--Radio Skate
	Horse-Hat	
	Baby-Bicycle	
	Fire-Chair	
	Doll-Book	

Procedure. At the outset each S was informed concerning the general procedure; that he would be told a series of noun pairs, that he should

repeat aloud the pairs of nouns, and that he should remember the words so that when presented with the stimulus word he could provide the response word. The task consisted of oral presentation and testing of three separate lists in a paired-associate (PA) paradigm. List 1 was included as a control measure, consequently instructional procedures in elaborative techniques were not initiated until just prior to presentation of list 2. List 1, however, was preceeded by three practice pairs to insure that S understood the task and could recall the response nouns.

The instructional phase prior to presentation of list 2 consisted of asking S to use a special technique to remember the words. This special way defined the three levels of the independent variable (IM, SG, and R-C), and Ss in each experimental group received a different instructional set and the appropriate training procedures. For instance, Ss in the IM condition were instructed to imagine a picture containing the iconic referents of the nouns (things the words named) interacting in some way. SG Ss were instructed to make up a sentence about the nouns (things the words named), and R-C Ss were to repeat the noun pairs over and over.

The training for all three conditions followed the same general pattern; the individual presentation of three practice pairs with a lesser amount of instructional aid accompanying each succeeding pair. For example, in IM training the first practice pair was accompanied by an interacting line drawing of the referents of the two words (the example used was a picture of a Boy kicking a Cup). The second practice pair was accompanied by line drawings of isolated pictorial representations of the two words with instructions to image an interacting picture, and no instructional aids accompanied the third practice pair. In the SG condition the first practice pair was accompanied by an E generated sentence similar to those used by Rohwer (1967) and Taylor and Black (1969). The procedures for the second pair consisted of having S generate a sentence using the two nouns, and no examples accompanied the third pair. For the R-C Ss, E provided verbal instructional aids by repeating the noun pairs over and over in the appropriate manner. After training, S was tested on the three practice pairs and asked to describe how he tried to learn the pairs.

S was then informed as to the procedure to be followed in the remaining portion of the experimental session and given an opportunity to ask questions, which E answered by repeating relevant portions of the instructional set. The instructional phase prior to presentation and testing of list 3 was essentially the same except that 3-tuples were employed, and only 2 practice 3-tuples were used.

Pilot testing revealed some attentional problems involved in the retarded children's maintaining concentration throughout the task. The major procedural change used to maintain attention involved seating S facing E rather than a blank wall (Taylor and Black, 1969; and Taylor, et al., 1970).

Rate of presentation and testing was originally set at 5 sec./word (10 sec./pair) on lists 1 and 2 and 15 sec./3-tuple on list 3. However, pilot testing revealed that Ss had trouble completing the task within these time constraints and often asked for words to be repeated, particularly on list 3; therefore, time was not controlled beyond an attempt to approximate the time intervals specified above. For example, if S was beginning to respond when the designated time period had elapsed, additional time was allowed without penalty in scoring. The order of presentation and testing was randomly determined and systematically varied within experimental conditions and for each list.

Results

The data was analyzed by a 3 x 2 (Instructional Set x Experimenters) analysis of variance. A separate analysis was computed for each of the three lists with the number of nouns correctly recalled as the dependent measure. In each analysis there was a non-significant main effect for Es ($F < 1.0$) and a non-significant Instructional Set x E interaction.

The data was then pooled across Es with the result being a one-way analysis of variance for each of the three lists. Table 26 shows the mean number of correct responses for each condition for each list. As expected non-significant differences obtained on list 1 ($F < 1.0$) where all groups were treated identically.

TABLE 26

Mean Number of Nouns Correctly Recalled as a Function of Instructional Set on 3 Lists: Experiment VIII

Lists	Instructional set			
	R-C	SG	IM	
1-(baseling P-A)	1.75	1.38	1.63	1.58
2-(12 P-A)	2.88	8.50	9.25	6.88
3-(8 3-tuple)	1.50	9.88	10.62	7.33
Total (2 + 3)	4.38	18.38	19.87	

The one-way analysis for list 2 revealed a significant difference between the groups, $F(2,21) = 17.33$, $p < .001$, which accounted for slightly over half the total variance in recall (est. $W^2 = .57$). Scheffé's test for multiple comparisons was applied to the means, and revealed that elaboration instructions (IM + SG), imagery instructions

(IM), and sentence generation instruction (SG) all facilitated recall when compared to the R-C group ($p < .01$). However, the test revealed that the mean of the IM group did not differ significantly from the mean of the SG group ($p > .05$).

The findings for list 3 were essentially the same as those for list 2. The one-way analysis revealed a significant main effect for instructional set, $F(2,21) = 28.22$, $p < .001$, which accounted for 69% of the total variance in recall for list 3. Scheffé's test revealed exactly the same differences and probabilities as for list 2. That is, that elaboration, IM, and SG all facilitated recall ($p < .01$) as compared to the R-C control, but the IM and SG did not differ.

The means in Table 26 were converted into percentages (mean recall/total possible) in order to better compare the differences across lists, and these percentages are presented in Table 27. At least 2 points are of interest in Table 27. First the mean for the R-C group fell greatly from list 2 to list 3, and second the magnitude of the differences between IM and SG and the R-C group increase from about threefold on list 2 to about sevenfold on list 3. It seems from these percentages that the 3-tuple list was more difficult only for the R-C group. However, since lists were confounded with order of presentation this difference could be due to either of the following: a decline in attention from list 2 to list 3, or the increased difficulty of this novel task for the R-C group.

TABLE 27

Percent of Nouns Recalled on Each List as a Function of Instructional Set: Experiment VIII

Lists	Instructional set			
	R-C	SG	Image	
1-(P-A baseline)	21.8	17.2	20.3	19.8
2-(12 P-A)	23.9	70.8	77.0	54.9
3-(8 3-tuple)	9.3	61.7	66.4	45.8
Total (2+3)	16.6	66.2	71.7	

Discussion

Instructions to generate sentences or form images greatly improves the P-A recall of retarded children. The facilitative effects of these instructional sets are at least as great as those occurring when retarded children are presented with noun pairs embedded in a meaningful sentence (Milgram, 1968 and 1969; and Rohwer, 1970). The 70-80% recall exhibited by the Ss in the present study on a one-trial P-A task is equal to or higher than the recall of normals given similar instructional sets (Taylor and Black, 1969; Taylor, 1969; and Taylor, Peloquin, and Kenworthy, 1969). That no differences between IM and SG conditions were obtained is not surprising, in that several Ss in both conditions exhibited perfect recall on the 12-pair P-A list. However, contrary to previous findings with lower SES 7-year-old children (Montague, 1970), imagery instructions were found to significantly improve recall.

The facilitating effects of IM instructions for a recall task more complex than the traditional P-A task (Taylor, et al., 1970) were obtained with retarded children, with these Ss recalling more than 7 times as many nouns from the 3-tuple list as the R-C controls. The SG instructional set was also found to facilitate recall on the 3-tuple list, and the predicted difference between the IM and SG conditions was not significant. It seems that both types of mental elaboration facilitate the recall of retarded children on a relatively complex 3-tuple task, as well as a traditional P-A task, with Ss performing very well on a complex task on which they should be deficient (Jensen, 1968). Although normal controls were not tested in the present study, it seems highly unlikely that normal children would recall any more nouns than the retarded Ss. This differs from the results recently reported by Rohwer (1970), in which he found a widening deficit between normal and retarded Ss under conditions of imposed verbal elaboration. It seems that at least two hypotheses can account for the difference in results reported by Rohwer (1970) and those of the present study. First, it could be that there is no deficit in recall under conditions of mental elaboration, and that there is only a deficit in elaboration when the elaboration is imposed on S. As unlikely as this first hypothesis may be since mental elaboration seems to require more "thinking," or at least more complex behaviors, from S than does imposed elaboration, it is possible if the retarded S does not process the imposed sentence as a single meaningful unit (Semmel, 1967). The second hypothesis is related to the first in that it assumes the deficit resulting from imposed elaboration occurs because S fails to make use of this elaboration. Therefore, if highly structured instructional sets such as those in the present study were given to Ss along with imposed elaboration, there should be an increase in recall equal to that for mental elaboration. This hypothesis is generally consistent with the suggestion that retarded children may require special direction since they lack a natural learning set (Denny, 1964; and Semmel and Williams, 1968).

It seems that with young (CA = 4 - 6), disadvantaged, and retarded children (CA = 8 - 13) the importance of instructional sets is multiplied

(Semmel and Williams, 1968; and Denny, 1964). If the research question asked is--what are the naturally occurring differences between Ss or groups, then explicit instructional sets should not be used and the expected differences will probably be found. However, if the question deals with whether S has the ability to perform well on a task or whether he can learn to perform well, then instructional sets should be well controlled. The present study asks--can the retarded child perform well on a learning-memory task if given the chance? The answer is an unequivical--yes!

CONCLUSIONS

The conclusions appropriate to each study in this series have been presented earlier, and all that is needed here is a concise summary of these conclusions. This series of studies could be broken down on the basis of several key variables: elaboration (mental vs. imposed and imagery vs. verbal); Ss (age, SES, IQ); task (P-A recall, maze learning, or free recall); or the concreteness of the nouns to be learned. However, the organization of the conclusions presented is based on the nature of the learning task (verbal--mixed P-A list of concrete and abstract nouns, P-A list of concrete nouns, and 3- or 4-tuple P-A list, and non-verbal--maze learning).

The first five studies in this series involve the learning and recall of a mixed list of concrete and abstract nouns, and what follows is a concise statement as to what has been discovered about children's recall of concrete and abstract nouns from these studies.

i. Children consistently recalled more concrete than abstract nouns.

ii. The embedding of noun pairs in meaningful sentences facilitated the recall of concrete but not abstract nouns.

iii. Verbally implied action did not have a general facilatory effect, that is, that nouns embedded in sentences connected by action verbs were not recalled significantly more than the same nouns connected by non-action verbs.

iv. Presentation of the complete original sentence context (N + V) at testing was relatively more facilitative than the presentation of the stimulus noun (N) alone at testing, when the nouns were concrete but not when the nouns were abstract.

v. The conditions found to result in the most nouns recalled were: the presentation of concrete nouns in action sentences; the presentation of the N + V context as the test stimulus; and instructional sets to form images.

vi. However, no support was found for the hypothesis that imagery instructions are differentially more effective with concrete nouns and action verbs.

vii. Instructions to form images facilitated the recall of normal and retarded children (CA = 10 - 13).

viii. No consistent differences in recall were found between groups given imagery instructions and those given sentence generation instructions.

ix. However, when noun pairs were embedded in sentences, instructions to generate sentences decreased recall while instructions to form images facilitated recall.

x. Children seem to continue to effectively use imagery to learn concrete pairs even when they report difficulty in constructing images for abstract pairs from the same list.

xi. Instructions which guide children toward the decision rule - form images where appropriate (concrete nouns), but generate sentences when images are inappropriate (abstract nouns) - produced the most facilitation of children's P-A recall.

xii. Rather than broad generalizations about the relative merits of types of imposed elaboration and/or mental elaboration, it is generally the case that particular variables (e.g., verbally implied action, imagery instructions, and sentence generation instructions) facilitate children's recall of a mixed list of noun pairs only when they provide an appropriate relation between the nouns to be learned.

xiii. In order to validate the consistent findings with respect to noun concreteness it is necessary to obtain norms similar to those of Paivio, et al. (1968), but with normal and retarded children. Are the same nouns concrete or picturable for children and adults?

xiv. No individual difference variables (e.g., age, IQ, and SES) have been found to be consistently related to the P-A recall of a mixed list of nouns or to the effectiveness of mental and imposed elaboration.

xv. It seems that there may be a time limit (i.e., 5 sec. or less) within which imagery or sentence generation instructions do not result in consistently functional elaborative mediators for noun pairs to be recalled by children.

The following set of conclusions are relevant to the learning and recall of lists of concrete nouns by children. Three of the studies (experiments III, IV and V) on which these conclusions are based involved the initial presentation of a mixed list followed by one or more concrete lists.

xvi. A combination of imposed sentences and instructions to generate sentences did not facilitate the recall of concrete nouns.

xvii. Only Ss given both imagery instructions and sentences during original learning show facilitation on learning a transfer list of concrete noun pairs.

xviii. Both instructions to form images and generate sentences facilitated the recall of normal and retarded children.

xix. Although no consistent differences have been found between instructions to generate sentences or form images, it seems that imagery instructions are slightly more facilitative (for both normal and retarded children) with a list of concrete nouns.

xxi. Instructions to use images-or-sentences (I or S) facilitated the recall of concrete nouns, but (I or S) training on a decision rule to only make up sentences for abstract nouns did not facilitate recall when all nouns were concrete.

xxii. Whether compared to repetition or standard P-A controls, mental elaboration instructions have been consistently shown to facilitate the recall of concrete nouns.

xxiii. The P-A recall of retarded children is increased by about three-fold when these Ss are given mental elaboration instructions.

xxiii. The variance in the scores for Ss given mental elaboration instructions seems to be negatively related to the amount of control built into the instructional sets, and individual differences (Age, IQ, SES) seem to be relevant only when the instructions are less strictly controlled (e.g., experiment III).

xxiv. Norms are needed on the related picturability (and possibly other characteristics) of both nouns and noun pairs by normal and retarded children.

The next set of conclusions are concerned with the recall of concrete nouns from a presentation more complex than the traditional paired-associate. These conclusions are based on the results of two studies (experiments VII and VIII); with the first involving the P-A recall of noun 4-tuples by normal sixth-grade children, and the other involving the P-A recall of noun 3-tuples by retarded children (CA = 10 - 13).

xxv. Imagery instructions greatly facilitate the P-A recall of normal children given noun 4-tuples to learn.

xxvi. Imagery instructions result in more and better organized recall than repetition instructions, and it is suggested that imagery functions in memory as a relational organizer.

xxvii. Additional instructions to make up one integrated picture further increases the degree to which recall is organized but does not significantly increase the number of nouns recalled.

xxviii. It seems that very long lists, which may require as many as 45 responses per list, are necessary to insure that children given imagery instructions do not produce perfect recall in one-trial.

xxix. The number of nouns recalled by retarded children given imagery or sentence generation instructions is 6 to 7 times that of retarded

children instructed to repeat 3-tuples, with rote repetition being an even less efficient strategy for learning 3-tuples than it is for learning noun P-As.

xxx. Retarded children can recall a majority of the words from a complex 3-tuple task, when they are trained to construct images or stories and use their mental elaborations as mediators.

The final set of conclusions involve the effects of mental elaborations instructions on a non-verbal spatial task (Maze learning). These conclusions are relatively more speculative than the previous ones since they are based primarily on the results of one experiment (VI).

xxxi. Children and adults learn a finger maze in approximately the same number of trials when given no elaboration instructions.

xxxii. Instructions to form an image of the correct path through the maze did not facilitate learning and may have even interfered with the learning of children.

xxxiii. Further, it seems that a previously learned model is necessary for imagery to function efficiently as a learning strategy; and that imagery may be more appropriate for recalling previously learned relations than learning new representations.

xxxiv. A verbal code approach was relatively more effective for adults than children for learning a finger maze.

IMPLICATIONS and RECOMMENDATIONS

Since it was demonstrated that instructing children in mental elaboration (imagery and sentence generation) greatly increased the recall of nouns, it seems that instructing children in <u>how to learn</u> (learning strategies) may be appropriate for several school learning tasks. One of the more obvious applications for the teaching of learning strategies is in the area of basic language skills. Many of the basic language skills (phonetics, reading, vocabulary building, etc.) require the establishment of associations between two or more things. We have begun some work in this problem area at the Center for Educational Research and Development in Mental Retardation, and it seems training in strategies may be very effective for teaching phonetic, grammatical, and meaning relations. The imagery instructions developed in this series of studies seems appropriate for teaching the meaning of new words or strengthening the association between words and pictorial representations. One other area where imagery seems to be particularly appropriate to school learning is in geography (e.g., map reading, and boundaries). Some preliminary development of instructional sets and laboratory activities to be used in teaching map reading to culturally disadvantaged ninth-grade children seem particularly promising, and future research is soarly needed to follow up these beginning efforts.

A critical appraisal of research in learning strategies (elaboration, imagery, verbally implied action, etc.) reveals a pressing need for both basic and applied research. This research is needed to test the limits of these very promising new research areas, and extend the research in the following directions.

a. Little is known as to the long term retention of strategies learned through elaboration instructions;

b. The problems of combining strategies (e.g., imagery and verbal) have only been given minimal attention (Taylor and Schneller, 1969, experiment V), and it is obvious that the real world requires both children and adults to select between alternate strategies or combinations of strategies to solve most learning problems;

c. The critical area of transfer of learning strategies is generally untested (Samuels, 1969) and only one study (Taylor, 1969) has investigated transfer of imagery strategies;

d. The developmental primacy and functioning of imagery and verbal processes is nearly virgin territory (Rohwer, 1969, in press; Reese, 1969 a and b), and Palermo (1969) has expressed doubt as to whether the right questions are being asked about children's imagery.

e. The crucial area of individual differences in elaboration has resulted in some interesting hypotheses (Jensen, 1968; Rohwer, 1968, 1970, in press; and Jenkins, 1935), but minimal research has been conducted to determine the individual differences related to imagery (Kuhlman, 1960; Sheehan, 1966; Sheehan and Neisser, 1968; and Anderson and Sammuels, 1970).

f. The need for norms on children, similar to those of Paivio, Yuille and Madigan, 1968 and others (i.e., Gorman, 1961; Tulving, McNulty, and Ozier, 1965; Underwood and Schultz, 1960; and Spreen and Schultz, 1968) obtained on adults, is critical for valid and generalizable research in imagery and mental elaboration. The norms obtained should be on both normal and educable mentally retarded populations, and these norms should optimally cover the age range of (CA = 4 to 13). The type of norms needed would involve both stimulus characteristics and relationships of nouns (possibly even verbs and adjectives); and conceivably could be on verbally implied action, strength of relation, and pictuability, as well as concreteness, specificity, imagery, and meaningfulness.

g. As Bower (1970) has suggested there is a great need for applying imagery and other mnemonic learning strategies to instruction and educational problems, and as far as I know there is no research yet reported in this area.

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APPENDICES

Appendix A-1

Summary Analysis of Variance Table for Mean Number of Nouns Correctly Recalled: Experiment 1.

Source	df	Mean square	F
Between Ss			
Form Class (F)	3	7.65	2.69
Subjects/F	28	2.84	
Within Ss			
Test-trial Context (T)	1	1.12	3.97
F x T	3	0.48	1.69
Subjects x T/F	28	0.28	
Noun Concreteness (C)	1	75.03	46.49**
F x C	3	4.76	2.63*
Subjects x C/F	28	1.61	
T x C	1	1.53	6.79*
F x T x C	3	0.22	1.0
Subjects x T x C/F	28	0.23	

APPENDICES

A - Experiment I

B - Experiment II

C - Experiment III

D - Experiment IV

E - Experiment V

F - Experiment VI

G - Experiment VII

H - Experiment VIII

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

Appendix B-1

Summary Analysis of Variance Table for
Mean Number of Nouns Correctly Recalled:
Experiment II, N = 96.

Source	df	Mean square	F
Between Ss			
Instructional Set (I)	1	27.63	3.93*
Form Class (F)	3	1.26	1.0
I x F	3	8.19	1.16
Subjects/I x F	88	7.03	
Within Ss			
Test-trial Context (T)	1	3.19	13.28**
I x T	1	0.00	1.0
F x T	3	1.90	7.93**
I x F x T	3	.06	1.0
Subjects x T/I x F	88	.24	
Noun Concreteness (C)	1	211.52	74.22***
I x C	1	0.44	1.0
F x C	3	3.04	1.07
I x F x C	3	2.45	1.0
Subjects x C/I x F	88	2.85	
T x C	1	1.38	5.80*
I x T x C	1	.06	1.0
F x T x C	3	.76	3.20*
I x F x T x C	3	.21	1.0
Subjects x T x C/I x F	88	.24	

Appendix B-2

Summary Analysis of Variance Table for
Mean Number of Nouns Correctly Recalled:
Experiment II, N = 48.

Source	df	Mean square	F
Between Ss			
Form Class (F)	3	4.10	1.0
Imagery Reported (R)	1	41.26	6.12*
F x R	3	6.69	1.0
Subjects/F x R	40	6.74	
Within Ss			
Test-trial Context (T)	1	1.50	7.41**
F x T	3	0.69	3.38*
R x T	1	0.13	1.0
F x R x T	3	0.14	1.0
Subjects x T/F x R	40	0.20	
Noun Concreteness (C)	1	115.63	37.87**
F x C	3	1.14	1.0
R x C	1	1.50	1.0
R x F x C	3	2.52	1.0
Subjects x C/F x R	40	0.20	
T x C	1	0.42	1.69
F x T x C	3	0.41	1.64
R x T x C	1	0.42	1.69
R x R x T x C	3	0.08	1.0
Subjects x T x C/F x R	40	0.25	

Appendix C-1

Summary Analysis of Variance Table for Mean Number of Nouns Correctly: Experiment III, List 1-Original Learning.

Source	df	Mean square	F
Between Ss			
Instructional Set (1)	2	29.72	8.76**
Form Class (F)	2	8.72	2.58
I x F	4	3.76	1.11
Subjects/I x F	81	3.38	
Within Ss			
Noun Concreteness (C)	1	69.69	36.44***
I x C	2	2.61	1.36
F x C	2	5.14	2.69
I x F x C	4	3.98	2.08
Subjects x C/I x F	81	1.91	

Appendix C-2

Summary Analysis of Variance Table for Mean Number of Nouns Concretely: Experiment, List 2-Transfer

Source	df	Mean square	F
Between Ss			
Instructional Set (I)	2	24.10	6.31**
Form Class (F)	2	1.63	1.00
I x F	4	7.28	1.91
Subjects/I x F	81	3.82	

Appendix C-3

Summary Analysis of Variance Table for
Mean Number of Nouns Correctly Recalled:
Experiment III, List 3-Relearning

Source	df	Mean square	F
Between Ss			
Instructional Set (I)	2	2.58	1.0
Form Class (F)	2	2.04	1.0
I x F	4	0.88	1.0
Subjects/I x F	54	2.88	
Within Ss			
Noun Class (N)	3	75.22	34.52***
I x N	6	2.53	1.15
F x N	6	2.44	1.11
I x F x N	12	0.99	1.0
Subjects x N/I x F	162	2.18	

Appendix D-1

Analysis of Variance Table for the Number of Abstract and Concrete Nouns Recalled by 60 Fourth- and Fifth-grade Ss: Experiment IV; List 1

Source	df	Mean square	F
Between Ss			
Instructional Set (I)	2	6.43	1.18
Form Class (F)	1	7.76	1.41
I x F	2	7.55	1.37
Subjects/I x F	60	5.50	
Within Ss			
Noun Concreteness (C)	1	66.94	52.91***
I x C	2	0.78	1.0
F x C	1	0.27	1.0
I x F x C	2	1.66	1.31
Subjects x C/I x F	60	1.26	

Appendix D-2

Analysis of Variance Table for the Number of Nouns Correctly Recalled by 60 Fourth- and Fifth-Grade Children: Experiment IV, Lists 2 and 3

Source	df	Mean square	F
Between Ss			
Instructional Set (I)	2	42.83	3.81*
Form Class (F)	1	0.92	1.0
I x F	2	14.32	1.27
Subjects/I x F	60	11.24	
Within Ss			
Lists (L)	1	49.70	15.39***
I x L	2	6.43	1.99
F x L	1	0.92	1.0
I x F x L	2	2.14	1.0
Subjects x L/I x F	60	3.23	

Appendix E-1

Analysis of Variance Table for the Number Abstract and Concrete Nouns Correctly Recalled: Experiment V, List 1

Source	df	Mean square	F
Between Ss			
Instructional Set (I)	4	13.36	2.31
Subjects/I	45	5.78	
Within Ss			
Noun Concreteness (C)	1	57.76	31.06***
I x C	4	2.38	1.28
Subjects x C/I	45	1.86	

Appendix E-2

Analysis of Variance Table for the Number of Concrete Nouns Correctly Recalled: Experiment V, List 1

Source	df	Mean square	F
Between Ss			
Instruction Set (I)	5	11.24	3.05*
Subjects/I	54	3.69	

Appendix E-3

Analysis of Variance Table for the Number of Nouns Correctly Recalled: Experiment V, List 2

Source	df	Mean square	F
Between Ss			
Instructional Set (I)	5	30.26	2.75*
Subjects/I	54	12.83	

Appendix F-1

Analysis of Variance Table for Trials to Criterion: Experiment VI

Source	df	Mean square	F
Between Ss			
Age (A)	1	176.33	4.24*
Instructional Set (I)	2	47.58	1.14
Experimenter (E)	1	6.75	1.0
A x I	2	20.58	1.0
A x E	1	108.00	2.59
I x E	2	23.25	1.0
A x I x E	2	9.25	1.0
Subjects/A x I x E	36	41.60	

Appendix F-2

Analysis of Variance Table for Time to Criterion: Experiment VI

Source	df	Mean square	F
Between Ss			
Age (A)	1	114.08	4.79*
Instructional Set (I)	2	63.00	2.64
Experimenter (E)	1	56.33	2.37
A x I	2	28.08	1.18
A x E	1	12.00	1.0
I x E	2	5.33	1.0
A x I x E	2	3.25	1.0
Subjects/A x I x E	36	23.82	

Appendix F-3

Analysis of Variance Table for Errors to Criterion: Experiment VI

Source	df	Mean square	F
Between Ss			
Age (A)	1	1900.08	3.39
Instructional Set (I)	2	425.69	1.0
Experimenter (E)	1	3675.00	6.54*
A x I	2	228.27	1.0
A x E	1	48.00	1.0
A x E	2	163.31	1.0
A x I x E	2	351.81	1.0
Subjects/A x I x E	36	561.56	

Appendix G-1

Analysis of Variance Table for the Number of Nouns Correctly Recalled as a Function of Lists, Organization and Instructional Set: Experiment VII, Immediate Recall

Source	df	Mean square	F
Between Ss			
Instructional Set (I)	1	2667.04	83.57***
Organizational Set (O)	1	1.50	<1.0
I x O	1	51.04	1.60
Subjects/I x O			
Within Ss			
Lists (L)	1	121.50	15.28***
I x L		3.38	
O x L		0.67	
I x O x L		0.38	
Subjects x L/I x O		7.96	

Appendix G-2

Analysis of Variance Table for the Number of Categories Recalled as a Function of Lists, Organization and Instructional Sets: Experiment VII, Immediate Recall

Source	df	Mean square	F
Between Ss			
Instructional Set (I)	1	345.04	66.35***
Organization Set (O)	1	1.04	<1.0
I x O	1	0.38	<1.0
Subjects/I x O	44	5.19	
Within Ss			
Lists (L)	1	12.04	9.05**
I x L	1	0.04	<1.0
O x L	1	0.38	<1.0
I x O x L	1	0.04	<1.0
Subjects x L/I x O	44	1.33	

Appendix G-3

Analysis of Variance Table for the Number of W/C Recalled as a Function of Lists, Organization and Instructional Set Experiment VII, Immediate Recall

Source	df	Mean square	F
Between Ss			
Instructional Set (I)	1	12.72	48.30***
Organization Set (O)	1	0.08	1.0
I x O	1	3.69	14.04***
Subjects/I x O	44	.26	
Within Ss			
Lists (L)	1	1.44	8.00**
I x L	1	0.36	2.01
O x L	1	0.00	<1.0
I x O x L	1	0.26	1.41
Subjects x L/I x O	44	0.18	