IMAGERY AND VERBAL SYMBOLIC PROCESSES IN PAIRED-ASSOCIATE LEARNING TASKS AMONG YOUNG CHILDREN

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ABSTRACT

The present experiments attempted to assess the possible differential role played by visual versus verbal materials in children's learning of paired-associate items.

Experiment I was essentially a replication of the Dilley and Paivio (1968) study. The sample included 48 Ss from each of nursery school, kindergarten, and grade two, with equal numbers of boys and girls at each level. Picture and word presentation methods were varied factorially on both the stimulus and response sides of item pairs to give four experimental conditions. Ss were randomly assigned to one of these four conditions and to one of two paired-associate lists with instructions to learn a ten pair list using a learning - test - feedback method. A nonverbal recognition test method was used.

The major findings indicated that picture and word presentation methods were equally effective on the stimulus side of item pairs, but pictures significantly increased performance over words on the response side of item pairs. This latter finding may be seen to give indirect support to Paivio's hypothesis that children experience difficulty in decoding imaginally-stored information into verbal terms for response requirements. However, in the present experiment children experienced difficulty in decoding verbally stored information into nonverbal terms for response requirements. Thus, by comparing findings from this

experiment with those of Dilley and Paivio (1968) it would appear that for retrieval of information Ss use that mode which is congruent with response requirements.

The Ss for Experiment II included 48 children from each of pre-school, kindergarten, and grade two, with equal numbers of boys and girls at each level. Verbalization (no sentences versus sentences) was varied factorially with depiction (side-by-side line drawings versus interacting line drawings) to give four experimental conditions. Ss were randomly assigned to one of these four conditions and to one of two paired-associate lists with instructions to learn a 24-pair list according to a two-trial study-test method. This experiment also used a nonverbal recognition test method.

Significant main effects were found for verbalization, depiction, grade level, and trials. Overall performance increased as a function of grade increase. A significant interaction between verbalization and depiction demonstrated that whereas action significantly increased performance when added to still pictures, when action depiction was combined with still pictures linked in sentences, no increment was found.

Together these two experiments served to demonstrate that children within the 4 to 8 year age range are equally capable of utilizing pictorial and verbal or combined pictorial and verbal elaborations.

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INTRODUCTION

Imagery, at one time, played a major role in the interpretation of such phenomena as mediation, memory, associative meaning, etc. It was thought that imagery was the mental representation of concrete meaning. However, Watson (1913) and others began to argue this point and suggested instead that imagery had no functional significance. Therefore it became necessary to explain findings in terms of verbal processes. The behavioristic argument that imagery is both subjective and inferential, whereas words are manageable and objective began to take prominence. As Deese (1965) points out:

> The modern experimental psychologist works almost exclusively with linguistic associations for the good reason that these provide controllable material for his laboratory studies: (he) ignores the extra existence of perceptual imagery...Without necessarily denying either their reality or their importance, he finds images difficult to manage in empirical study. Partly for this reason and partly for others, association theory in modern psychology has become a theory of the succession of elements in verbal behavior (p. 4).

Thus, research has provided answers to only a few of the interesting questions which can be asked in connection with the role of imagery in learning. This is especially true of research directed toward learning in children.

The question of concern in this study was whether the visual mode is more effective than the verbal in facilitating paired-associate learning in children. By incorporating three grade levels, this study attempted to determine at

which age children come to prefer one mode over the other and at which age they can utilize simultaneously both visual and verbal information in elaborated learning activities. Of particular concern was whether both visual and verbal elaboration would be found to be facilitative in paired-associate learning tasks where the response method was non-verbal. By altering the response method in this way and by separating the pictorial from the verbal content more clearly than has been done in most studies of pair elaboration, the relative facilitative effect of verbal and imaginal representation both for the storage and retrieval of information was examined.

RESEARCH AND THEORY

It has been shown that paired-associate learning is easier when the stimulus and response items are presented as meaningful words than when they are presented as nonsense syllables (Goss & Nodine, 1965). The suggestion has been made that meaningful word pairs are easily transformed into visual interactions whereas nonsense syllable pairs do not lend themselves readily to such visual transformations, and it is those visual interactions which facilitate learning. Paivio and his associates (Paivio, 1969) showed that nouns rated high in their capacity for arousing imagery were easier to learn as paired-associates than low imagery nouns. Similarly, concrete noun pairs have been found to be easier to learn than abstract noun pairs (Paivio & Yuille, 1966).

Several other studies have demonstrated that noun pairs presented as pictures result in better performance than noun pairs presented as printed words (Dilley & Paivio, 1968; Rohwer, Lynch, Levin & Suzuki, 1967).

Demonstrations of the effects of varying the spatial locations of visually presented item pairs, and varying the syntactical frame within which item pairs have been embedded have been numerous. Memory for picture pairs presented as unitized scenes has been found to be greater than for picture pairs presented side by side (Davidson, 1964; Davidson & Adams, 1970; Horowitz, Lampel & Takanishi, 1969; Reese, 1965; Suzuki & Rohwer, 1968). Also, instructing subjects to search for or generate images from presented pairs has been found to greatly facilitate learning (Bobrow & Bower, 1969; Bower, 1970; Bower & Winzenz, 1970; Clarkson, Haggith, Tierney & Kobasigawa, 1973; Conway & Jones, 1973; Yuille & Paivio, 1968). The syntactical frame within which paired-associate items to be learned are embedded has been scaled for imagery and related to learning, with the result that high imagery ratings were associated with high performance (Jensen & Rohwer, 1965; Rohwer, Lynch, Levin & Suzuki, 1967). These kinds of data strongly support the conclusion that mental imagery plays a major role in learning. Experiments concerned with the role of imagery in paired-associate learning may be grouped into two major classes: those which have focused on the properties of the paired-associate items themselves, and those which have manipulated properties of

ways in which pair members can be elaborated.

Properties of Paired-Associate Items and Imagery

While the potency of noun imagery in determining the learning difficulty of paired-associate items has been shown for college students and adults, the property of noun imagery has rarely, if ever, been manipulated in learning experiments performed with children (Rohwer, 1970). However, there is evidence about the effect on children's learning of varying a related property of paired-associate items, namely, whether they are presented as words or as pictures. Dilley and Paivio (1968) tested the prediction that picture items, especially in the stimulus position, should be easier to learn than word pairs. Children from nursery school, kindergarten, and grade one served as subjects in this experiment. The picture-word contrast was manipulated independently for stimulus and response positions so that four experimental conditions emerged, namely: picture-picture pairs, picture-word pairs, word-picture pairs, and word-word pairs. Subjects were asked to learn a list of five pairs of items according to a study-test feedback paradigm. On test trials correct responses were given by the experimenter immediately following the response given by the subject for each test item presented separately. The experimental session was complete either at the end of ten test-feedback trials or at the point where the subject obtained perfect scores on two consecutive trials. The findings demonstrated that pictures as stimulus items significantly increased performance over words as stimulus

items, but pictures as response items had a negative effect on learning. Thus, stimulus and response modes interacted such that picture-word pairs were associated with more correct anticipations than any of the other three kinds of pairs. Age did not emerge as a significant factor as was expected, but it did enter into a significant interaction with trials and stimulus mode. This three-way interaction of age by stimulus mode by trials indicated that pictorial stimuli resulted in superior performance over verbal stimuli across trials for the nursery school group. This effect diminished for the kindergarten group and once again increased for the grade one group. However, Dilley and Paivio (1968) suggested that such a finding was of no theoretical import. Dilley and Paivio interpreted the stimulus by response interaction in terms of the conceptual-peg hypothesis in that the stimulus item functions as a "peg" to which the response, or associative, item is "hooked" during learning trials and from which, on recall trials it is retrieved. The strength of the peg is a function of the concreteness or imaginal value of the stimulus item. They further suggested that the preferred mode of storage for children is imagery but that young children encounter a problem during the retrieval (decoding) phase so that they have greater difficulty in decoding or transforming a nonverbal memory image into a verbal response thereby accounting for the superior effect of words as response items. They did admit that it could be argued that the children simply had poorer visual memory for pictures

than auditory memory for words, but hastened to add that such an interpretation would run counter to Bruner's (1964) view that the young child's thinking is predominantly iconic. Several other studies support Dilley and Paivio's findings that stimulus items presented as pictures or objects result in better performance than verbal presentation of the stimulus items (Rohwer, Lynch, Levin & Suzuki, 1967; Lynch & Rohwer, 1972; Paivio & Yarmey, 1966; Wimer & Lambert, 1959).

Results from an experiment by Csapo (1968) are in contrast to those cited above in that they showed pictures to be superior to words in both stimulus and response positions. In addition to this, picture-picture pairs were easier to learn than the picture-word pairs. Paivio (1971) comments:

> Why his (Csapo's) results differed from those obtained in the previous three studies remains unanswered, but it is in any case safe to conclude that pictures are not consistently facilitative and may even have a negative effect as response members of pairs (p. 271).

Rohwer (1970) has offered an opposing theoretical interpretation of Dilley and Paivio's (1968) findings, one that is based on the storage of verbal tags. He has suggested that pictures may be easier to remember than words but only when the verbal labels for the pictures are stored with them. The assumption was made that the superiority of picture to word stimuli is contingent upon the subject's propensity for representing in storage both the image evoked by the picture and an appropriate verbal label for it. The developmental

prediction which follows from this is that the superiority of picture to word stimuli will increase with age. Examining Dilley and Paivio's results as a function of age, Rohwer (1970) suggested that the capacity for deriving benefit from pictorial modes of representation develops later than the capacity for deriving benefit from verbal modes.

An experiment by Rohwer (1968) addressed this developmental issue. Kindergarten, first grade and grade three children were asked to learn five types of item pairs in a mixed list design. Three of these types are of importance in the present review: word pairs, in which a television screen displayed a textured grey picture while the word pairs were presented aurally; picture pairs in which the television screen displayed pictures of the objects in each pair; and combined pairs in which the television screen displayed the pictures of the objects and at the same time the noun labels of the objects were presented aurally. Learning was measured by the mean number of correct responses on each of two test trials. It was found that the superiority of picture pairs over word pairs increased with grade level. Also, supplying the child with the verbal label for the pictured object increased performance less as age increased. These developmental data were interpreted by Rohwer (1970) to mean that while pictures evoke imagery at all age levels, the ability to profit from stored images is contingent upon the subject's ability to store an appropriate verbal representation of the

object along with its image.

In both the Dilley and Paivio and the Rohwer experiments the paired-associate task was essentially verbal in that verbal responses were required of the subject. Thus, the results of Rohwer's (1968) experiment could be interpreted in a manner similar to that provided by Dilley and Paivio (1968) for their results. This interpretation would be that pictures plus words are more effective than pictures simply because the younger subjects have difficulty in transforming a nonverbal memory image into a verbal response. Should this explanation be valid, picture-picture pairs in the context of both Dilley and Paivio (1968) and the Rohwer (1968) experiments should show superior performance where the subject is required to make a nonverbal as opposed to a verbal response. On the other hand, should Rohwer's thesis that the full benefit of pictorial representation is contingent upon simultaneous storage of visual and verbal elements be tenable, the word-picture combinations would be differentially superior for younger subjects.

It is generally held that the major difference between these two response methods, that is the recall method as used in the Dilley and Paivio (1968) study and the nonverbal recognition method used in the present experiment, is in terms of overall performance. The use of a recognition test method results in an increase in performance over and above that achieved using recall. This superiority of recognition over recall has been supported by early invest-

igations (e.g. Hollingworth, 1913; McDougall, 1904; Myers, 1914). This difference might be explained as Adams (1967) proposed. Accordingly, there are two independent memory states; the recall state being mediated by a simple associative connection between a stimulus and a response; whereas the recognition state is mediated by a perceptual trace, provided by the cue item and thereby regulating response selection. In effect an image is conditioned to the actual physical form of the items and thus later presentation of the stimulus item arouses the response item.

Item Pair Elaboration and Imagery

The question of the role of imagery in children's learning has been investigated in experiments which have manipulated properties of ways in which pair members can be elaborated. Various studies, mainly those by Rohwer and his associates, have investigated the effects of verbal and pictorial elaboration on learning efficiency. Representative studies which have directed attention specifically to the effectiveness of these kinds of elaboration for children are reviewed below.

Rohwer (1967, Exp. XI) performed an experiment using kindergarten, first, third, and sixth grade children. Using an independent groups design, subjects were asked to learn a paired-associate list of items according to one of four experimental conditions. Still (coincidental) pictures, in which pairs of pictures were shown side by side, were presented together with naming or with sentences (verbs) to

give two conditions: naming-coincidental and verb-coincidental. In the first condition the objects were aurally labelled and at the same time the pairs of pictures were exposed. In the second condition the picture pairs were exposed and at the same time a sentence incorporating the names of the objects was presented aurally. Action pictures, in which pairs of pictures were shown in some form of interaction, were presented together with naming or sentences to give the last two conditions: naming-action and verb-action. In the third condition the action depiction was exposed and the labels for the objects pictured were presented aurally. In the fourth condition the action pictures were shown and at the same time a sentence describing the action was presented aurally. At the kindergarten and first grade levels, the verb-coincidental condition produced more facilitation than the naming-action condition, while the reverse was true for the third and sixth grade levels. The author suggested that:

> ...the older children rather than the younger children can make better use of action depiction, and, by inference, of the action imagery it evokes (Rohwer, 1970, p. 399).

The fact that in the same experiment the younger children showed more improvement than the older children under the verb-action condition lends support to Rohwer's (1970) interpretation of the finding just indicated for the verb-coincidental and naming-action conditions. He states that:

> ...it is consistent with these data to conclude that action imagery, by itself,

> exerts a positive effect on learning, but that the capacity for deriving full benefit from such imagery develops later than the capacity to benefit from analogous verbal elaboration. Part of this developmental difference may lie in growth in the child's ability to store an appropriate verbal tag along with the action imagery (Rohwer, 1970, p. 399).

From the class of elaborative studies another experiment addressed itself directly to the developmental interaction which was reported for the study just reviewed. Using a mixed list rather than an independent groups design, and the same four elaboration conditions as for the Rohwer (1967, Exp. XI) study, Rohwer (1967, Exp. XII) investigated the learning efficiency of children in the age ranges 3.5 to 4.3 years, and 4.5 to 5.5 years. For the younger children the naming-action condition produced no facilitation over the control condition (naming-coincidental), while the verb-coincidental condition was facilitating. For the older children, the verb-coincidental condition was also more facilitative than the naming-action condition, but the latter was significantly better than the control.

Another mixed list experiment by Rohwer (1968) used kindergarten, first, and third grade subjects. He compared among other forms of elaboration, naming-action and verb-coincidental against naming-coincidental as a control. The naming-action pairs were learned more easily than the verb-coincidental pairs at the grade levels studied. The fact that the development interaction did not emerge clearly in this study may have resulted, Rohwer (1970) suggested,

from a ceiling effect in the third grade data.

On closer examination how convincing are the data on which Rohwer bases his conclusion concerning the developmental sequence of a preference for the visual mode in facilitating paired-associate learning? From the above three studies which used young children and compared naming-coincidental as a control against naming-action and verb-coincidental conditions, there appears to be conflicting evidence. Of the studies using kindergarten subjects (Rohwer, 1967, Exp. XI, Exp. XII, & Rohwer, 1968), one showed only a negligible difference between verb-coincidental and naming-action conditions. A second showed the verb condition to be more facilitative than the action condition. A third indicated that naming-action pairs were learned more easily than the verb-coincidental pairs. Two of the above studies reported evidence for grade one subjects. One, using an independent groups design, showed significantly better performance under verb-coincidental as compared with naming-action conditions. The second, using a mixed list design, showed the opposite effect. The one study which reported data for children of nursery school age, indicated that the naming-action condition produced no facilitation over the control condition, while the verb-coincidental was facilitative.

Additional evidence for this latter age group is available from a study by Milgram (1967) who presented subjects with a list of picture pairs either in a verbal context or in a visual-compound condition. Results showed that both

verbal and visual cues produced faster learning than a control condition without additional cues. Additionally the verbal condition was consistently superior to the visual condition, with this difference reaching significance level for four-year-old subjects. From these results Milgram (1967) concluded that his data:

> ...suggest that the verbal mode is both preferred and much more effective than the visual in facilitating PAL (paired-associate learning) in children (p. 602).

Further evidence for the conclusion that verbalization is the preferred process in young children comes from Reese (1965, 1970). After considering a number of alternative hypotheses Reese suggested that imagery was not effectively aroused in younger children because the pictures used lacked detail. He further explained that the young child may notice picture pairs but they arouse no meaning, in contrast to sentences which do arouse imagery because the necessary interactions are explicitly named. A recurring problem, however, with each of these studies has been in the procedures employed. Specifically in no case was there a condition in which pairs were presented only verbally. The implications of this problem are discussed in detail later but it is necessary to note here that the failure to employ a totally verbal condition seems to prevent an interpretation solely in terms of verbal processes. In the light of the evidence reviewed there appears to be a definite need for further study, especially at the nursery school through grade one levels. The aim of such research would be to establish

whether there is a developmental interaction with respect to the capacity of children to benefit from visual and verbal forms of representation (as Rohwer has suggested), or whether there is an overall preference for the verbal (as Milgram & Reese would suggest), or for the visual mode (as Paivio & Bruner maintain). As elaborated in the above review, Rohwer has offered a verbal interpretation of the child's increasing capacity to use visual imagery effectively. In other words, the failure on the part of younger children to make effective use of action depiction (which Rohwer feels is empirically substantiated) is explained by suggesting that younger children do not store an appropriate verbal tag along with the action image evoked. Support for this position was taken from findings showing an increment in performance on paired-associate learning tasks for young children by presenting sentences in the context of action pictures (Rohwer, 1967, Exp. XI; Rohwer, 1967, Exp. XII). Two comments may be made concerning the finding that sentences provided in conjunction with action depiction were facilitative. These comments are meant to draw attention to alternative theoretical interpretations for the developmental hypothesis advanced by Rohwer. They are also meant to support the merits of the experimental tasks which will later be proposed as being more appropriate for assessing the facilitative effect of imagery than those employed in the studies reviewed.

The pair elaboration experiments which have been reviewed were characterized by two verbal features. These

features, in the writer's opinion, need to be considered in an interpretation of the results. In the first place, verbal, pictorial, and combined elaboration conditions were compared against a control which had two components -- naming and pictures. One can speculate whether the combined elaboration was more facilitative by comparison with the verbal or with the pictorial conditions through facilitating the separate storage of the verbal and pictorial input. This type of interpretation would run counter to one which suggested that verbal tags were required to make imagery more memorable. The latter interpretation, it is suggested, would be more tenable should combined verbal and action elaboration be more effective when compared against a control which uses visual input only.

Secondly, the pair elaboration experiments required a verbal response. As was suggested for the item property experiments (Dilley & Paivio, 1968), it could be proposed that verbal elaboration is effective not through facilitating storage of pictorial material but rather through facilitating the retrieval of this material, that is, through facilitating the transformation of the nonverbal memory image into a verbal response. However, if this were true it is speculative whether naming would be just as or even more effective than sentences. Even though the above comments are tenuous, the point is nevertheless made that modifications in the design of pair elaboration experiments may allow one to make a more straightforward interpretation of the effect of both visual and

verbal elaboration in facilitating the storage of pictorial material. The modifications as implemented in the experiments of the present investigation tried to separate pictorial from verbal input across elaboration conditions and employed a non-verbal response method. It was hoped that the question of a preference on the part of young children for either a verbal or visual mode would be more adequately addressed through the proposed experiments.

Two studies addressed themselves more specifically to the above comments regarding response method and a separation of pictorial from verbal content. Davidson and Adams (1970) using second grade children as subjects employed the same procedure and recognition response method as that used by Davidson (1964). The experimental conditions included: (1) side by side (still) picture pairs plus naming; (2) still picture pairs connected by a preposition plus naming; (3) still picture pairs plus sentences suggesting an interaction of the item pairs; and (4) interacting picture pairs plus descriptive sentences. All verbalizations were given by the experimenter and the study-test method was employed. On test trials the stimulus item from each pair was presented and the subject was required to circle the correct response item on a sheet of paper which contained all possible response items. A new response display sheet was presented for each test item. Results showed that the latter three elaborated conditions resulted in superior performance over the first. They suggest that verbalization is more facilitative than

visualization in paired-associate learning among second-grade children. As Rohwer (1973) suggested, such an interpretation should be accepted with caution since the response method required was a recognition method, the importance of which he felt was made clear by another study carried out by Kee and Rohwer (1970) in which they extended the study of Davidson and Adams (1970). In addition to this Davidson and Adams (1970) did not completely separate pictorial and verbal input since in no condition did they present either modality alone; neither did their study address the developmental question.

Kee and Rohwer (1970) using the same procedure as Davidson and Adams (1970) and subjects of second-grade level found results comparable to those of Davidson and Adams. However, the design included a recall as well as a recognition procedure and the results showed that the recognition task yielded similar results to those found by Davidson and Adams (1970), whereas the recall task resulted in a reversal of the findings: better performance was demonstrated for pictorial elaboration than for verbal elaboration. This latter study is in contrast to other studies which have found verbal elaboration to be more effective than pictorial in the context of a recall task. Such discrepancies once again point to the necessity of further research to more adequately address the question of the effectiveness of visual versus pictorial elaboration among young children.

Recent Investigations of Rohwer's Developmental Hypothesis--Item Property and Pair Elaboration Approaches

More recent studies have investigated the developmental hypothesis advanced by Rohwer. Two such studies (Holyoak, Hogeterp & Yuille, 1972; Jones, 1973), the former manipulating pair elaboration and the latter manipulating item properties, have sought, through certain procedural changes, to more adequately address this developmental question than had been done to date.

Holyoak, et al. (1972) may be cited in relation to the question of the significance of response method in paired-associate learning. Children from kindergarten and elementary school were asked to learn a mixed list of thirty item pairs. Two types of verbalization (verb and conjunction) were varied factorially with three types of depiction (still line drawings, interacting line drawings, and photographs of actual interactions between object pairs). A two-trial study-test method was used. Trial one consisted of a study phase followed by a recall of each response item when presented with a stimulus item, and a recognition phase during which each subject was required to point to the correct response item when presented with a stimulus item. Trial two consisted of a study phase followed by a recall phase. Verbalization and depiction emerged as significant main effects. Sentences were superior to conjunction connectives, and interacting line drawings provided greater learning than either noninteracting line drawings or interacting photographs. The age by procedure (recall and recognition on trial one) interaction

reached significance, demonstrating that the superiority of recognition over recall was obtained only with elementary school children. Holyoak, et al. (1972) suggested:

> ...the present results offer no support to the hypothesis that the capacity to utilize pictorial mnemonics effectively develops later in childhood than the capacity to utilize verbal mnemonics. The operations of presenting a sentence with a verb connective, or a line-drawn interaction, appear to afford parallel and equal facilitation for kindergarten and older children, under both recall and recognition procedures...Paivio's (1970) response availability hypothesis predicted that pictorial mnemonics would produce relatively greater facilitation under a recognition rather than a recall procedure for younger children. This difference did not emerge;...Rohwer (1970) has suggested that pictorial elaboration is maximally effective only when a verbal label for the action depicted is stored along with the image, and that the young child is less likely to store such a label...This interaction did not approach significance...the trend was in fact opposite to that predicted by Rohwer's hypothesis (p. 61-62).

Jones (1973) using three-year-old children investigated the use of non-verbal memory processes by preschoolers. Three stimulus modes (verbal, pictorial, and combined verbal and pictorial) and two response modes (requiring children to respond to either pictures or words) were varied factorially to yield six experimental conditions. Using a study-test procedure, four, six-item paired-associate lists were presented individually to each subject. The test trial consisted of a recognition paradigm in which the subject was presented with a stimulus item and was required to match it with an appropriate response item from a possibility of three items presented sequentially. All pictorial mat-

erials were presented as colour photographs. Each subject received a pre-training trial 48 hours prior to the experimental session. Results from this experiment showed that pre-schoolers were able to use visually-presented materials better than those materials presented verbally, thus contradicting Rohwer's (1970) hypothesis. Pictures as test items were superior to words as test items, even in instances where the material on a study trial had been presented verbally. This latter finding contradicted Paivio's decoding hypothesis, and instead demonstrated that the children were effectively using an imaginal system for memory irrespective of the original input mode.

In the two studies described above three problems arise in attempting to specifically determine the role of nonverbal processes, and the effectiveness of combined visual and verbal representations in a developmental paradigm. Rohwer maintains that the developmental trend in which young children use verbal over visual materials more effectively, occurs at about four years of age. Because the youngest children used in Holyoak's, et al. (1972) study were approximately five and one half years old their study failed to directly test this hypothesis. Jones (1973), on the other hand, included only three-year-old children making it impossible to suggest any developmental trends based on her findings. Since both these studies were very different in their experimental design, it is neither possible to meaningfully compare them nor to combine their results in an attempt

to reach conclusions based on developmental interactions. Holyoak, et al. (1972) failed to separate visual and verbal components in their presentation modes, and thus it becomes difficult to determine the effectiveness of each of these processes separately. Jones (1973) was successful in the attempt to separate clearly the visual and verbal components, but as she suggested, the particular item pairs (consisting of an animal picture and a picture of a common toy or object) which were presented as interesting, colourful photographs, may have held the child's attention longer than verbal sentences. This would negate an explanation of the positive effect of visual presentations in terms of a leveling process; instead, it would suggest an explanation in terms of the locus of attention or relevant details of the pairs. This suggestion would have relevance to the issue of picture-pair detail, but it does not adequately assess the use of visual as opposed to verbal processes by young children. Finally, the response method employed by Holyoak, et al. (1972) on trial one confounded recognition performance with recall, and their study consequently does not adequately address Paivio's hypothesis concerning recognition. These problems demonstrate the necessity for further experimentation to more adequately assess the effects of imaginal and visual processes in paired-associate learning.

STATEMENT OF PURPOSE

In an attempt to assess the role of imaginal and verbal processes in paired-associate learning among young

children two experiments were designed. The first experiment was essentially a replication of the Dilley and Paivio (1968) study. As such it was designed to determine whether, as Paivio has suggested, imagery is the preferred mode of storage among young children. By using a recognition response method, it was intended that the findings of Experiment I by comparison with those of Dilley and Paivio's experiment using a recall method, would clarify whether the effectiveness of the response stimulus is determined by the response method used, as opposed to being determined by the child's differential ability to process one or the other material forms. It was further intended that the present modified replication of Dilley and Paivio's experiment would clarify the relative validity of the conceptual-peg hypothesis as contrasted with a developmental interpretation of Dilley and Paivio's original findings.

Whereas Experiment I manipulated item properties, the second experiment attempted to determine the effects of visual and verbal processes in tasks where properties of pair elaborations were manipulated. Experiment II also employed a nonverbal recognition response method, and once again was, in general, intended to address the question of the relevance of response method in explaining the effectiveness of task materials. More specifically, the conditions studied within Experiment II were designed to determine whether there is a developmental interaction with respect to the capacity of young children to benefit from visual and

verbal forms of elaboration. Taken together these two experiments were designed to separate more clearly the visual component of the learning task from the verbal component, and consequently to permit a more straightforward analysis of the possible differential role played by verbal versus pictorial material in the context of children's learning of paired-associate items.

EXPERIMENT I

Method

Subjects. A total of 147 children, from nursery school, kindergarten, and grade two, with a mean age of 4.6, 6.0, and 7.9 years respectively, served as subjects for this experiment. Three subjects were deleted from the study; one because of electrical power failure during the testing session, one for failure to comprehend the task, and one who had attended both nursery school and kindergarten during the same year. The remaining 144 children consisted of 48 children from each of the three grade levels, with equal numbers of boys and girls at each level. The subjects from each grade were divided into four groups of 12 subjects each (six boys and six girls in each group) and randomly assigned to one of four experimental conditions. Within each condition subjects were further assigned to one of two paired-associate lists. The kindergarten and second grade subjects were drawn from a school serving mainly middle-class families in a town on the outskirts of St. John's. Nursery school subjects were initially selected from a school serving upper middle-class families within the St. John's area. In an attempt to balance whatever differences in socioeconomic status as did exist, some of the nursery school children were taken from a school serving lower middle-class families. It is believed that this sampling procedure did equate socioeconomic status across grade levels. Random assignment of nursery school subjects to conditions was stratified on the

basis of socioeconomic status, thus ensuring negligible socioeconomic status differences across conditions.

Design. A 2x2x3x10 design was used in the present experiment. Stimulus item type (line drawing - picture versus verbal labelling - word) was factorially varied with response item type (line drawing - picture versus verbal labelling - word) to give four experimental conditions. Each condition consisted of one original learning trial, and a maximum of 10 test-feedback trials, or perfect score on two consecutive trials whichever occurred first. The response method used was a nonverbal recognition method. By response method is meant the form in which the subject made his or her response and not the method by which the response item was presented. The four experimental conditions were:

Condition 1: P-P

Original learning trial -- The stimulus and response members were presented as side by side pictures plus labelling.

Test -- The stimulus item was presented as a picture without verbal labelling and the subject responded by "pointing out" the correct response item from a response array which contained 15 response pictures including five distractors.

Feedback -- The stimulus and response items were presented visually without labelling, after the response had been made.

Condition 2: P-W

Original learning trial -- The stimulus member

was presented visually as a picture plus verbal labelling of the item. The response member was presented only verbally without any visual representations.

Test -- The stimulus item was presented as a picture without verbal labelling and the subject responded by "pointing out" the correct response item from the response array which contained 15 response pictures.

Feedback -- The stimulus item was presented visually without verbal labelling and the response member was presented verbally without any visual representation.

Condition 3: W-P

Original learning trial -- The stimulus member was presented verbally without any visual representation and the response member was presented as a picture plus verbal labelling.

Test -- The stimulus item was presented verbally without visual representation and the subject responded by "pointing out" the correct response item from the response array which contained 15 response pictures.

Feedback -- The stimulus item was presented verbally without any visual representation and the response member was presented visually without any verbal labelling.

Condition 4: W-W

Original learning trial -- Both stimulus and response members were presented verbally without any visual representation.

Test -- The stimulus item was presented verbally without any visual representation and the subject responded by "pointing out" the correct response item from the response array which contained 15 response pictures.

Feedback -- The stimulus and response members were presented verbally without any visual presentation.

The third factor of grade consisted of three levels--nursery school, kindergarten, and grade two. The final factor of trials consisted of 10 test-feedback trials.

Materials. Twenty line drawings of familiar objects and their concrete noun labels were used to construct two paired-associate lists of 10 pairs each. Two lists were used to control for effects due to ease or difficulty of learning specific noun pairs. List I contained the five pairs used by Dilley and Paivio (1968) with the remaining five pairs being selected randomly from a list used by Rohwer, Lynch, Levin & Suzuki (1967). List II was constructed by randomly pairing the twenty items. The increase in the number of pairs from the five pairs originally used by Dilley and Paivio (1968) to the 10 pairs used in the present experiment was necessitated for two reasons. Dilley and

Paivio's (1968) results showed a ceiling effect at the grade one level. Since the present study used subjects up to the second grade an increase in list size was intended to eliminate any possible ceiling effect for subjects at the higher grade levels. Whereas the Dilley and Paivio (1968) study used an anticipation test method the present experiment employed a recognition test method, which was expected to result in a general increase in performance.

All line drawings were photographed onto 35 mm. slides and projected onto a screen by use of a Kodak Carousel Projector. Separate sets of slides were prepared for each condition and each list which contained visual representations so that six sets of slides were needed. No slides were prepared for the W-W condition since it involved only verbal presentations. Each set of slides consisted of an original learning trial which contained slides for the item pairs to be learned. This was followed by test-feedback trial one which consisted of a slide for each test item in conditions where the test item was a picture, otherwise the test item was presented aurally, followed by a slide appropriate for immediate feedback. This procedure was repeated for 10 test-feedback trials so that a condition contained 210 slides. Eleven random orderings of items were prepared for each list. One ordering was used for the original learning trial and the remaining 10 orderings were used for the 10 test-feedback trials. The same random orderings were used for all conditions. All verbalizations were presented aurally by the

experimenter on the original learning trial and for test-feedback presentations where required. Appendix A contains the item pairs used for a pre-training session, the pairs for Lists I and II, as well as examples of the line drawings.

Two response displays were prepared, one for each list. Each display, a 35 mm. slide, contained 15 response items including five distractors. This array was projected onto a plexi-glass screen placed slightly to the right of the subject so that he was able to "point out" appropriate responses on test trials. The experimental setup required the use of two projectors, one for projection of the response array and the other for the learning and test-feedback trials. A schematic diagram of the setup is also presented in Appendix A.

Individual scoring sheets were used on which the experimenter recorded both correct and incorrect responses for each trial, as well as the number of trials to criterion. The criterion was either the maximum of 10 test-feedback trials or the point at which the subject received perfect score on two consecutive trials.

Three additional paired-associates were prepared for use in a pre-training session which consisted of one original learning trial and three test-feedback trials. One response array containing six response items including three distractors was also prepared. The same pre-training pairs were used for both lists.

The line drawings which had been used for photographing purposes were taped each to a 3x5-inch file card

for use on a recognition task given at the beginning of the session. During the recognition task, subjects were required to verbally label each of the 26 line drawings as they were presented individually. If the subject was unable to complete this task he/she was excluded from the study, otherwise the pre-training session was begun.

Procedure. Subjects were tested individually during the months of May and June, in rooms provided by the particular schools. Each subject was randomly assigned to one of four experimental conditions and to one of the two paired-associate lists. As previously mentioned, the session consisted of one original learning trial and a test-feedback paradigm which continued for a maximum of 10 trials, or until the subject had recognized all responses correctly on two consecutive trials. The experimenter spoke briefly with each subject to ensure that he/she was at ease. The task was introduced as a kind of game with pictures and words which children enjoy.

> Do you like to play games?...We are going
> to play a game with pictures and words.
> It is going to be a kind of guessing game.
> But before we begin let's make certain that
> you know all of the pictures in the game.
> O.K....I will show you these pictures
> (experimenter pointed to the 26 line drawings)
> one at a time and I want you to tell me what
> each picture is. Let's begin.

If the subject successfully completed the recognition task, a pre-training session was begun. This pre-training session was included to ensure that the subject understood the instructions prior to manipulating task parameters, and to further ensure that failure to comprehend the instructions would not interact with conditions. It might be noted that Dilley and Paivio (1968) did not report the use of such a pre-training phase. Successful completion of the pre-training session was followed by the experimental session with appropriate instructions given for each condition. Exposure time for item pairs during the original learning trial was set at five seconds. Verbal presentations in the W-W condition were repeated twice on the original learning trial only, to allow for the five-second interval. Inter-item interval was set at one second. On test trials subjects were self-paced up to a maximum of 13 seconds during which time the subjects searched the picture array for the correct response item. This time interval was an increase of five seconds over that used by Dilley and Paivio (1968). This was necessary to ensure that each subject had ample time to search all items in the response array. When the subject had responded, the response array was turned off and the feedback was given. Feedback was presented for two seconds, to allow sufficient time for any verbalizations which might be required. The interval between the test-feedback trials was set at eight seconds. Two dependent measures were used in the analyses: the number of correct recognitions per trial, and trials to criterion.

Results

The dependent measure used in the first analysis was the number of correct recognitions out of 10 on each of 10 trials. The data were analyzed using a 2x2x3x10 analysis of variance. Factors analyzed included stimulus mode (picture versus word), response mode (picture versus word), grade level (nursery school, kindergarten, and grade two), and trials (10 test-feedback trials). Table 1 gives the means and standard deviation values at each grade level for each of the four experimental conditions. Significant main effects were found for response mode and trials as shown in Table 2. The number of correct recognitions was greater with pictures in the response position. As with the Dilley and Paivio (1968) findings, grade level did not reach significance level in the present experiment. Contrary to the results reported by Dilley and Paivio (1968) the main effect of stimulus mode did not emerge as significant in the present experiment. The stimulus mode by response mode interaction which was significant in the Dilley and Paivio (1968) study also did not emerge as significant in the present experiment. A comparison of the performance associated with this interaction between the Dilley and Paivio (1968) study and the present experiment is demonstrated in Figure 1. The only significant interaction, in the present experiment, was that between response mode and trials. However, this interaction is of no theoretical importance.

TABLE 1

Means and Standard Deviations of Correct Recognitions at Each Grade Level for Stimulus and Response Modes

Grade Level	Stimulus Mode	Response Mode: Picture Mean	Picture S.D.	Word Mean	Word S.D.
	Picture				
Nursery		7.13	2.59	6.11	1.62
Kindergarten		6.51	2.95	5.13	2.65
Grade Two		7.87	2.47	5.45	2.95
	Word				
Nursery		7.96	2.30	4.75	2.10
Kindergarten		7.34	2.82	5.73	3.06
Grade Two		8.32	2.26	5.56	2.73

TABLE 2

Analysis of Variance Summary Table for Correct Recognitions Per Trial

Source		df Num	Mean Square	F Ratio
Grade	A	2	46.8755	1.28
Stimulus	B	1	21.0249	0.57
Response	C	1	1533.45	41.93**
A x B		2	29.3312	0.80
A x C		2	35.4644	0.97
B x C		1	76.5474	2.09
A x B x C		2	35.9180	0.98
Subjects	S	132	36.5688	
Trials	D	9	360.399	217.44**
A x D		18	2.47921	1.50
B x D		9	0.446126	0.27
C x D		9	3.90799	2.36*
A x B x D		18	1.48397	0.90
A x C x D		18	1.66819	1.01
B x C x D		9	2.40104	1.45
A x B x C x D		18	1.52431	0.92
D x S		1188	1.65749	

*p<.05

**p<.001

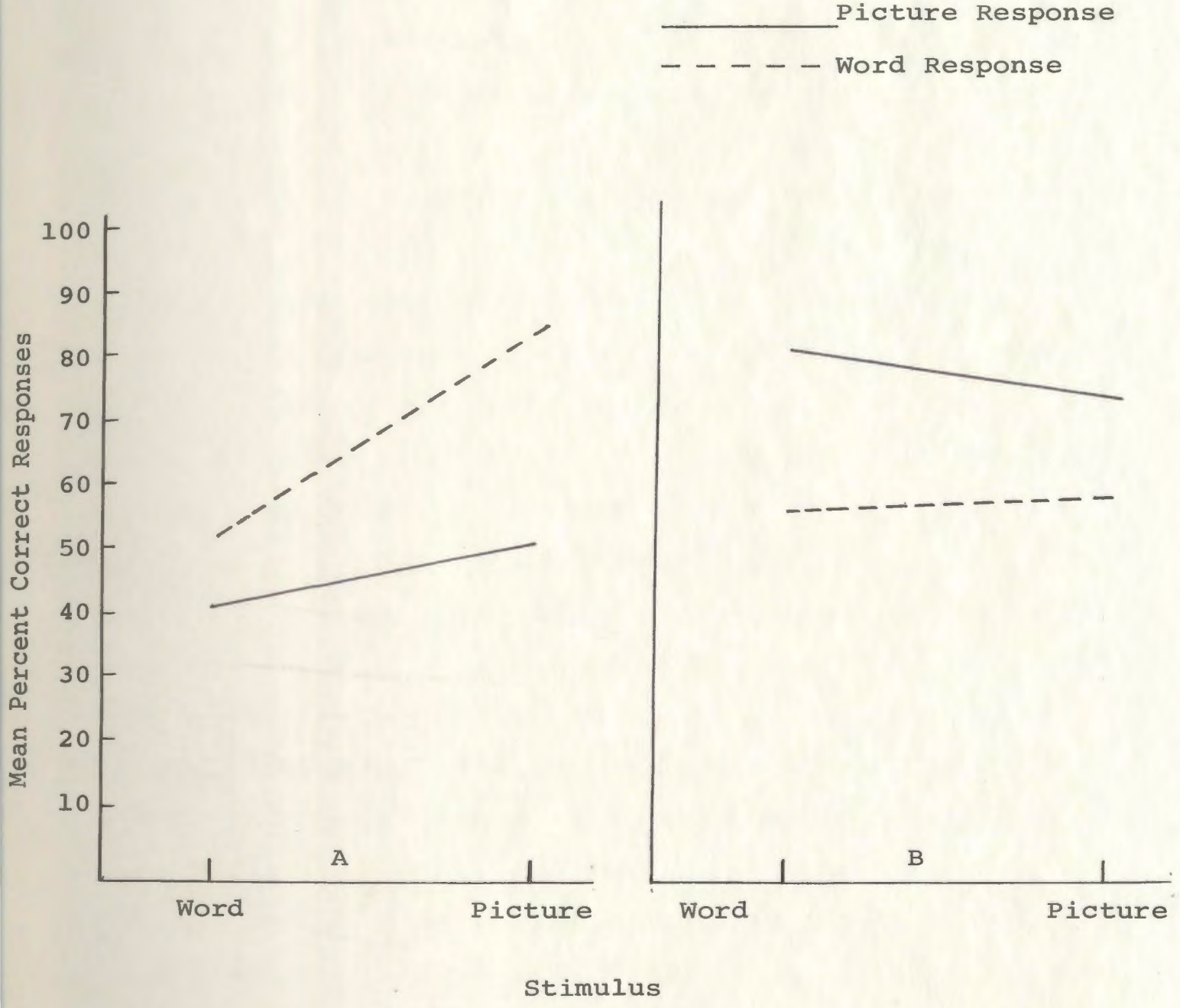

FIG. 1. Mean percentage correct responses as a function of stimulus and response modes. (A) Dilley and Paivio (1968) study, and (B) present experiment.

A second analysis, in which the dependent measure was trials to criterion, was carried out on the data. Once again the factors analyzed included grade level (nursery school, kindergarten, and grade two), stimulus mode (picture versus word), and response mode (picture versus word). Means and standard deviation values for this analysis are presented in Table 3. The only main effect to reach significance level was that of response mode as shown in Table 4. No other main effects and no interactions were found to be significant in this analysis. In accordance with the findings from the first analysis, the number of trials to criterion was less with pictures in the response position.

A final analysis, using as a dependent measure the number of correct recognitions on trial one, was carried out on the data. This analysis served a dual purpose. Firstly, through a comparison of the results of the first analysis, that is performance on each of ten trials, with this analysis, it was hoped to determine whether subjects were merely learning the spatial location of pictures as opposed to learning specific responses. Secondly, since test trial one followed immediately the original learning trial any effects due to the verbal labelling of visually presented materials which was done on the learning trial could be assessed through this final analysis. Mean and standard deviation values for this analysis are presented in Table 5. As demonstrated in Table 6 the findings correspond very well with and strengthen those of the first analysis. However, unlike the first

TABLE 3

Means and Standard Deviations of Trials to Criterion, for Stimulus and Response Modes at Each Grade Level

Grade Level	Stimulus Mode	Response Mode: Picture Mean	Picture S.D.	Word Mean	Word S.D.
	Picture				
Nursery School		7.58	2.50	8.92	1.42
Kindergarten		9.00	1.65	9.92	0.29
Grade Two		7.00	3.44	9.17	1.59
	Word				
Nursery School		7.50	2.32	10.00	0.00
Kindergarten		8.00	2.17	9.17	1.64
Grade Two		6.42	3.02	9.50	1.73

TABLE 4

Analysis of Variance Summary Table for Trials to Criterion

Source		df Num.	Mean Square	F Ratio
Grade	A	2	12.0624	2.23
Stimulus	B	1	1.17360	0.22
Response	C	1	175.562	32.43**
A x B		2	7.92358	1.46
A x C		2	6.27081	1.16
B x C		1	10.5625	1.95
A x B x C		2	1.52084	0.28
Subjects	S	132	5.41339	

**p<.001

TABLE 5

Means and Standard Deviations of Correct Recognitions at Each Grade Level for Stimulus and Response Modes on Trial One

Grade Level	Stimulus Mode	Response Mode: Picture Mean	Picture S.D.	Word Mean	Word S.D.
	Picture				
Nursery School		4.00	2.09	1.92	1.44
Kindergarten		2.75	2.01	2.75	1.66
Grade Two		5.58	2.47	2.83	2.08
	Word				
Nursery School		4.50	1.98	2.25	1.86
Kindergarten		3.58	1.78	3.17	2.21
Grade Two		5.67	2.46	2.83	1.53

TABLE 6

Analysis of Variance Summary Table for Trial One

Source	df Number	Mean Square	F Ratio
Grade A	2	20.0069	5.06*
Stimulus B	1	4.69444	1.19
Response C	1	106.778	26.99**
A x B	2	1.04861	0.27
A x C	2	21.7985	5.51*
B x C	1	0.444366	0.11
A x B x C	2	0.903244E-01	0.23
Subjects S	132	3.95573	

*p<.01
**p<.001

analysis this analysis demonstrated a significant grade effect and further a significant interaction between grade and response mode such that pictures increased performance over words as response items at all grade levels. This difference, however, was more pronounced at the nursery school and grade two levels and less so at the kindergarten level.

Discussion

The results of this experiment failed to support the thesis as suggested by Rohwer (1970) that the child's capacity to effectively utilize pictorial representations is an increasing function of age, while verbal representations are able to be effectively used by young children. Rather this experiment showed that the children at all age levels tested were able to use visual and verbal presentations equally well on the stimulus side of item pairs, and further, these children showed a preference for visual presentations on the response side of item pairs. This failure to support a developmental trend in terms of visual and verbal capabilities of children is in accordance with several other failures, for example, (Holyoak, et al., 1972; Jones, 1973; Reese, 1965).

Additionally, the suggestion as made by Dilley and Paivio (1968), that pictures would be more effective than words as stimulus members of item pairs was not supported. It was found that children were able to store picture and word representations equally well. Both of these modes were

equally effective as retrieval cues on test trials. This finding is generally in opposition to findings by other investigators. However, since all of the stimulus items were highly concrete and easily "imaginable" nouns it might be that subjects were transforming verbally presented information into visual correlates. This being the case the conceptual-peg-hypothesis is once again supported. It might likewise be argued that the conceptual-peg-hypothesis is a response dependent phenomenon. Specifically in tasks requiring verbal recall of response items subjects might need a strong peg to which they connect the response item in order to facilitate recall of the correct item. However, in tasks requiring nonverbal recognition a different or simpler process may be involved such that the subject does not need a strong visual peg and is able to recognize the appropriate response item when cued by a word as well as a visual cue. Dilley and Paivio (1968) further suggested that words were effective as response items because young children were unable to transform imaginally stored information into verbal terms for response purposes. This suggestion finds indirect support from findings of the present experiment, where pictorial presentation of response items was found to be superior to verbal presentation. The superiority of pictures in the response position may, in similar fashion, be ascribed to a lack of ability to transform verbally stored information into pictorial form. It is perhaps not so much a matter of lack of ability as decreased efficiency when such

transformation is required. Thus, the suggestion of Dilley and Paivio may be generalized, as a result of present findings, to the hypothesis that the presentation mode most effective for response position is that which is congruent with the mode required for making a response. The comparison of Dilley and Paivio's (1968) findings with those of the present experiment suggests, in other words, that when items are to be retrieved from memory, the response method used determines the effectiveness of the mode used for storing response members.

The grade by response item interaction which emerged as significant in the trial one analysis emphasizes, once again, the facilitative effects of pictures as response items in paired-associate learning tasks involving a non-verbal recognition test method. It also weakens any suggestion that subjects were simply responding to a spatial location as opposed to pictorial response representations since test trial one would prevent any such associations.

Results from this experiment suggest that children can use either the imagetic or verbal modes equally well for the storage of information as well as for retrieval cues. This would suggest that the stimulus item is not as potent a factor in paired-associate learning, as other researchers have suggested (Goss & Nodine, 1965; Noble & McNeely, 1957; etc.) but rather that response factors are more relevant. This experiment, especially by comparison with that of Dilley and Paivio (1968), has served to demonstrate that the differ-

ential effectiveness of one mode over the other relates to the retrieval of information as distinct from the storage of information. The present experiment seems to clearly demonstrate that both pictorial and verbal modes are equally effective for presenting paired-associate items to children from pre-school to the grade two level.

In order to explore further the question of a developmental preference for one mode over the other a second experiment was designed to investigate whether children make differential use of elaboration conditions for paired-associate learning. While Experiment I may be taken to support the view that minimal prompts (conditions where no elaboration is provided) are equally effective if presented in either pictorial or verbal mode (as suggested by Rohwer, 1973) the question of a developmental preference for one mode over the other may be evident under more elaborated prompting conditions. Consequently, Experiment II looks at the performance of children across elaboration conditions designed to provide a clear separation of pictorial from verbal components on both the presentation and the elaboration of items.

EXPERIMENT II

Method

Subjects. Boys and girls from kindergarten and grade two were selected from two schools serving the St. John's area; one school would be considered upper middle-class and the second school lower middle-class. The pre-school subjects were either children whose brother or sister had served as a subject in either the kindergarten or grade two category, or children who were registered to begin kindergarten (September, 1973) in the schools initially used. These pre-schoolers had not attended any school prior to taking part in this experiment. A total of 147 children from these three levels were tested, with three children being deleted from the study; two for failure to comprehend the task, and one classed as a slow learner by the classroom teacher. The remaining 144 children consisted of 24 boys and 24 girls from each of pre-school, kindergarten, and grade two with mean ages of 4.7 years, 6.0 years, and 7.9 years respectively. Subjects from each grade level were divided into four groups of 12 subjects each and randomly assigned to one of four experimental conditions. Within each condition, subjects were randomly divided and assigned to one of two paired-associate lists.

Design. A 2x2x3x2 design was used in the present experiment. A verbalization factor (no sentences versus sentences - verb) was varied factorially with a depiction factor (side by side line drawings - still picture pairs

versus interacting line drawings - action picture pairs) to give four experimental conditions:

Condition 1:

Still picture pairs, no sentences -

Still Pictures

Condition 2:

Still picture pairs, plus sentences -

Verb-Still Pictures

Condition 3:

Action picture pairs, no sentences -

Action Pictures

Condition 4:

Action picture pairs, plus sentences -

Verb-Action Pictures

The third factor of grade included pre-school, kindergarten, and grade two. The fourth factor of trials consisted of two study-test trials.

Comparison of the verb-still picture pairs against the control of still picture pairs, and further comparison of the action picture pairs against the control served to address the question of a preference for either verbal or pictorial modes of elaboration. Additionally, comparison of verb-still picture pairs and action picture pairs with verb-action picture pairs served to demonstrate whether the combination of verbal and pictorial elaboration was superior to either elaboration singly.

Materials. Forty-eight line drawings of objects, those used by Rohwer, Lynch, Levin & Suzuki (1968), were used in this experiment. To control for the effects due to ease or difficulty of associating specific pairs two lists were constructed. List I was the original 24 pairs used by Rohwer, et al. (1968); List II was constructed by randomly pairing the 48 line drawings. The item pairs for both lists are presented in Appendix B. Four different random orderings of the materials were prepared for each list, two each for study and test trials. The same random orderings were used for each of the four experimental conditions.

All line drawings were photographed onto transparencies and projected onto a neutral gray wall via an overhead projector. Two sets of transparencies were prepared for each of the two lists. Since the drawings for Conditions 1 and 2 (still picture pairs, verb-still picture pairs) were identical, one set of transparencies served both conditions. Also, since Conditions 3 and 4 (action picture pairs and verb-action picture pairs) consisted of identical line drawings, one set of transparencies served both conditions.

Transparency rolls were used for the still picture pairs (Conditions 1 and 2). Each roll contained transparency photographs for two study trials and two test trials arranged such that a study trial was followed immediately by a test trial. On study trials the items from each pair were photographed side by side, while on test trials only the stimulus member of each pair was photographed onto the transparency.

Transparency rolls were also used for the action picture pairs (Conditions 3 and 4). Once again each roll contained transparency photographs for two study trials and two test trials arranged such that a test trial immediately followed a study trial. On study trials the items from each pair were photographed side by side onto the upper portion of the transparency and the line-drawn interaction was photographed onto the lower portion of the transparency. The side by side line drawings were included with the interacting line drawings to avoid confusion of the two objects to be paired which might have resulted from simply presenting non-labelled interacting line drawings alone. On test trials only the stimulus member of each pair was photographed onto the transparency.

The control condition of still picture pairs and the condition of action picture pairs were totally nonverbal, that is, the pairs were presented pictorially without any labelling.

In the verb conditions the verbalization component was added by the experimenter. The sentences which were used were of the form: article stimulus item verb article response item. These sentences were read aloud by the experimenter on study trials only. The sentences used in this experiment are presented in Appendix B, as well as samples of the line drawings which were used.

A response display for List I consisted of the 24 line drawings (response items from each pair) which had been

used for photographing purposes. Each picture measured approximately $2\frac{3}{4}$ inches by $3\frac{1}{2}$ inches and was pasted to one side of a cardboard 15 inches by 18 inches. The 24 response items for List II were pasted to the reverse side of the cardboard.

In addition to the materials for the experimental conditions three pairs of items were prepared for use in a pre-training session.

Procedure. During July and August each child came to Memorial University where testing was done individually in a small testing room. The experimenter spoke briefly with each child to ensure that he/she was at ease. The task was introduced as a kind of game which children enjoy and the details were explained according to the particular experimental condition to which the subject had been assigned. The following instructions were used for each condition:

> On this wall (experimenter pointed at the display wall) I am going to show you pairs of pictures, that is, two pictures side by side. The two pictures which you will see side by side always go together - wherever one is the other should be also. I will show you many pairs of pictures and I want you to try to remember the pictures which you see together. When you have seen all of the pairs of pictures then we will find out how many you are able to remember. I will show

you only <u>one</u> picture from each pair. Then I will show you a cardboard like this (subject was shown the pre-training response display) and I will want you to show me the picture which goes with the one you will be looking at on the wall. Before we start let's do a few to make sure you understand the game. O.K.?

The pre-training session which followed consisted of three paired-associates and two study-test trials. As each pair was presented the subject was reminded that the two pictures which he/she was looking at belonged together. At the end of study trial I the experimenter said:

Now let's see how many you are able to remember.

This signalled the beginning of a test trial on which the subject was presented with each stimulus item separately and the response array from which he was required to find the correct response item. When the subject had searched the response array and decided on the response item he/she indicated so by "pointing out" the appropriate item. This nonverbal response method was essentially a recognition task in which the subject was to point to the correct response item each time he/she was presented with a stimulus test item. During the test trial, the experimenter said:

Can you find here (the experimenter pointed at the response array) the picture you saw

> with this one (the experimenter pointed at the stimulus item which was projected onto the wall)? Would you "point out" for me the picture here which you saw with this one on the wall?

If the subject did not know the response he was asked to "guess at it", otherwise the next stimulus item was presented. This procedure was repeated for all three pairs of items. Study trial II was then started with no further instructions except to alert the subject to the beginning of another study trial. Also, no further assistance was given to the subject on test trial II except to signal its beginning. If the subject was unable to successfully complete the pre-training session he was excluded from the study. Successful completion of the pre-training session was followed by the experimental session which was begun by saying:

> O.K. Let's start the game. Are you ready? Remember this time you will see <u>many</u> pairs of pictures. Let's begin.

No further verbalizations were made except to introduce the beginning of either a study or test trial.

Essentially the same procedure was followed for all conditions. However, for the action picture pairs subjects were told that to help them to remember the pictures each pair would be shown "doing something together". Subjects in the verb-action condition were also told that a sentence would be given which would describe what the pictures were

"doing together" and that this would also help them to remember the pairs. Similarly, subjects in the verb-still condition were told that the word names for each pair would be put in a sentence to help them to remember the picture pairs.

Study trial exposure time was set at five seconds to allow sufficient time for verbalizations. Inter-item interval was set at one second and the inter-trial interval was approximately eight seconds. During test trials subjects were self-paced up to a maximum of 16 seconds per item. The stimulus item was exposed for the entire time span during which the subject searched the response array for the correct item.

The dependent measure used in the analysis was the number of correct recognitions out of 24 possible on each of two trials.

Results

A 2x2x3x2 analysis of variance was carried out on the data. Factors analyzed included verbalization (no sentences versus sentences), depiction (still picture pairs versus action-picture pairs), grade level (pre-school, kindergarten, and grade two), and trials (two study-test trials). The means and standard deviations for this analysis are presented in Table 7. All main effects were found to be significant as demonstrated in Table 8. Specifically, verbalization was shown to be a significant factor such that the addition of sentences significantly increased performance

TABLE 7

Means and Standard Deviations for Performance Across Two Test Trials for Each Experimental Condition at Each Grade Level

Grade Level	No Sentences Still Pictures		Sentences Still Pictures		No Sentences Action Pictures		Sentences Action Pictures		Overall Mean
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	
Pre-School	5.79	3.82	10.88	6.39	11.29	6.27	14.79	6.11	10.69
Kindergarten	8.29	5.46	17.71	4.36	13.92	6.99	15.67	7.01	13.90
Grade Two	11.17	5.16	18.67	4.06	16.54	6.13	18.33	5.02	16.18
Overall Mean	8.42		15.75		13.92		16.26		13.59

TABLE 8

Analysis of Variance Summary Table

Source		df Num	Mean Square	F Ratio
Grade	A	2	730.125	15.49**
Depiction	B	1	650.999	13.81**
Verbalization	C	1	1686.83	35.78**
A x B		2	55.2969	1.17
A x C		2	10.6945	0.23
B x C		1	447.504	9.49**
A x B x C		2	57.8555	1.23
Subjects	S	132	47.1506	
Trials	D	1	1638.77	312.29**
A x D		2	13.8904	2.65
B x D		1	13.7888	2.63
C x D		1	12.9280	2.46
A x B x D		2	5.46497	1.04
A x C x D		2	13.50000	2.57
B x C x D		1	0.312500E-01	0.60
A x B x C x D		2	5.19141	0.99
D x S		132	5.24766	

**p<.001

over no sentences. The significant main effect of depiction demonstrated that visual elaborations in the form of interacting line drawings significantly increased performance over the presentation of still picture pairs. A Newman-Keuls analysis was carried out on the means for the significant effect of grade level and it was found that performance was significantly different at each grade level such that overall performance increased as a function of grade increase. Finally, the main effect of trials indicated that performance significantly increased over trials. As evidenced in Table 8 the only interaction to reach significance level was that between verbalization and depiction. These two factors interacted such that visual elaboration (action picture pairs) in the absence of verbalization added to the presentation of side by side picture pairs, whereas such visual elaboration did not add anything to side by side picture pairs in the context of verbal elaboration (sentences). This interaction is depicted in Figure 2.

A Newman-Keuls analysis was carried out on the means of the four experimental conditions and it revealed that each of conditions 2, 3, and 4 significantly increased performance over the control condition of still picture pairs, no sentences. Additionally, these three experimental conditions (verb-action picture pairs, verb-still picture pairs, action picture pairs) were equally effective, at all age levels tested, in facilitating performance. This analysis supports the conclusion as discussed with reference to the depiction

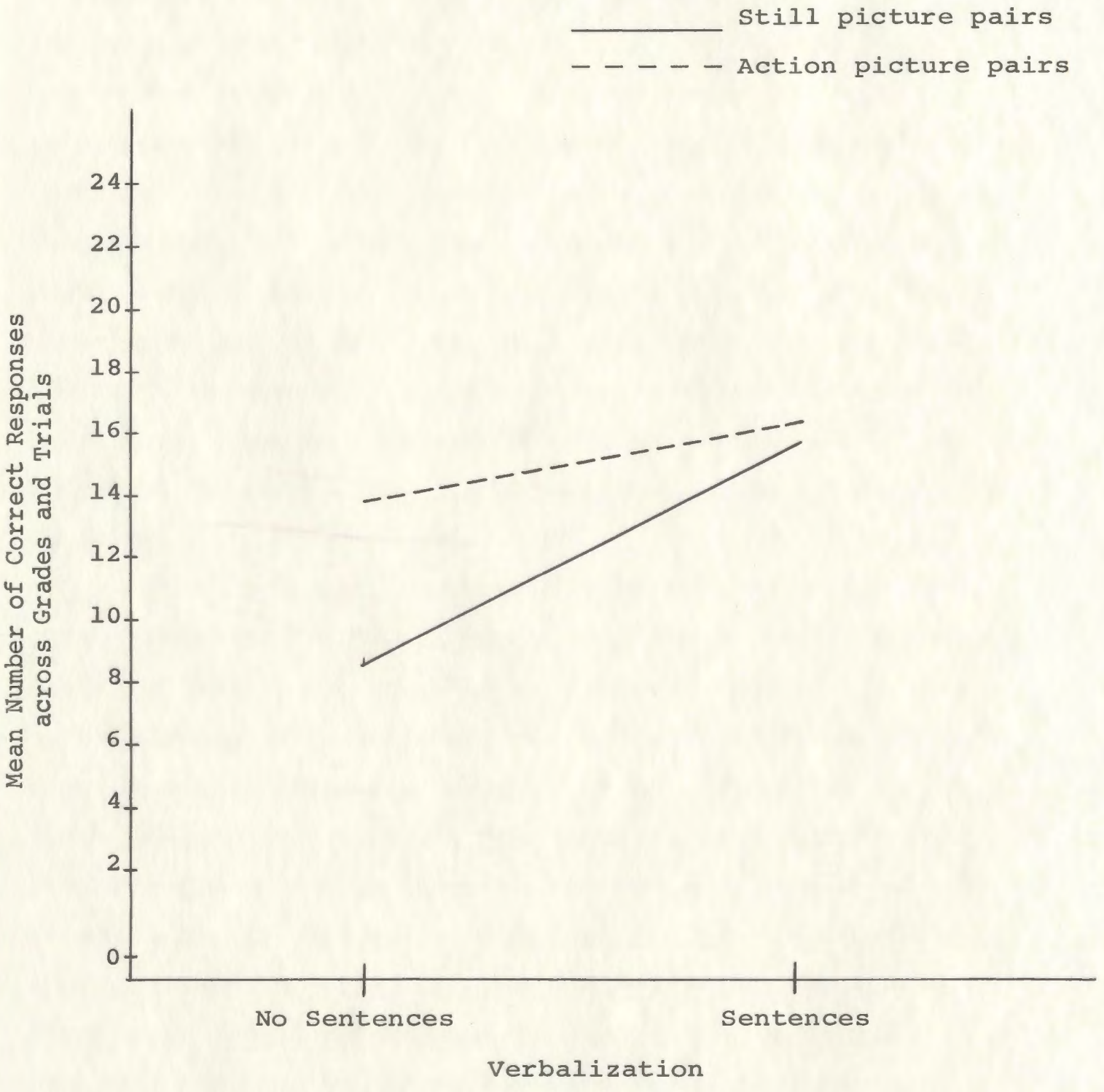

FIG. 2. Mean number of correct responses, collapsed across grades and trials, as a function of verbalization condition.

by verbalization interaction. While action depiction increased performance over the control condition of still picture pairs without sentences, it did not produce a significant increment in performance when compared with still pictures with sentences. Additionally, this analysis demonstrates that either sentences or action depiction increases performance over still pictures alone, and that the combination of action depiction and sentences is no more effective than either singly. Of particular importance is the fact that these findings are constant across age level, as supported by the non-significant verbalization by depiction by grade interaction, as well as by the Newman-Keuls analysis.

Discussion

That grade level emerged as significant in this experiment adds further support to previous findings relative to an increase in performance on paired-associate learning tasks as a function of grade increase. However, the failure of grade level to enter into a significant interaction with either depiction or verbalization served to demonstrate that children at all age levels tested were equally capable of utilizing visual and verbal or combined visual and verbal elaborations. This finding contradicts prior suggestions that early childhood is characterized by either a shift in underlying cognitive processes or an acquisition of abilities differentially related to visual or verbal processes. Such suggestions have operated on the assumption that the appropriate associative processes in paired-associate learning are

less likely to be aroused or effectively utilized by pictorial materials in younger children than in older ones. Essentially the proponents of these suggestions were indicating the necessity of verbal processes among younger as opposed to older children. However, the findings from the present experiment suggest that the age range 4.5 years to approximately 8 years appears to be characterized not so much by a developmental change in the nature of cognitive processes as by a refinement or increasing development of such processes which are a part of the child's capacilities within this age range. This was evidenced in the present experiment by an overall increase in performance associated with grade increase.

While, as Experiment II illustrated, subjects at all age levels utilized both pictorial and verbal elaboration equally well, and showed no additional increase in performance under combined elaboration, there was a tendency for the preschool subjects to profit from the addition of sentences to pictorial elaboration. While this tendency was not strong enough in the present data to lead to a significant interaction with age, it might be taken to suggest that further study with children below the mean age of 4.5 years perhaps would support the suggestion that the effectiveness of pictorial elaboration for very young children is determined by the availability of appropriate verbalization.

It has been suggested that a necessary component to image formation is the actual manipulation of the objects. Support for this suggestion has come from Wolff and Levin

(1972) and Wolff, Levin and Longobardi (1972) who found that the learning of objects improved when subjects were permitted to manipulate those objects. However, Yuille and Catchpole (1973) found that manipulation had no effect on learning. Rather, they suggested that the Wolff, et al. procedure indicated a confusion of contact (direct manipulation versus no manipulation) and interaction (some type of presented interaction versus side-by-side presentation) such that any effects Wolff, et al. attributed to contact were due instead to interaction. More recently McCabe, Levin, and Wolff (1974) have also shown that contact is not a significant factor. They demonstrated that performance did not improve when nursery school subjects were permitted motor involvement. McCabe, et al. suggested instead that overt sentence production is itself a motor activity and thus sentence plus manipulation required the child to produce two motor activities simultaneously - which the authors maintain causes a conflict situation. However, the act of presenting a sentence simultaneously with interacting line drawings as was done in the present experiment tended to facilitate the learning of pairs by nursery school children. Thus, whereas the young child may be unable to produce and effectively use two manipulations simultaneously because of conflict, he may nonetheless be able to effectively utilize both manipulations when they are presented to him as was demonstrated by the tendency toward increased performance on the verb-action condition among pre-school subjects in the present experiment.

The interaction of verbalization by depiction demonstrated that visual elaboration was more effective than side-by-side presentation of item pairs but this effect was equalized when verbal elaboration was added to side-by-side pictures. This finding supports Rohwer (1973) to the effect that elaboration, in either pictorial or verbal form, is more effective than a condition where no elaboration is provided, as was the case with the side-by-side pictures.

As already indicated, the finding of a significant verbalization by depiction interaction in the absence of a three-way interaction with age lends no support to the suggestion that the effective use of imagery by young children requires the simultaneous storage of appropriate labels. At this point it is appropriate to comment that the position of Rohwer (1970) relative to this developmental hypothesis seems to have altered as is evidenced by a recent paper on elaboration in paired-associate learning (Rohwer, 1973). One of the experiments cited by Rohwer in this paper is somewhat similar to that of the present experiment and its results seem to have influenced Rohwer's conclusion which currently is more supportive of the present findings.

The experiment by Rohwer, Kee and Guy (cited in Rohwer, 1973) studied the performance of four, five and seven-year-old subjects on a paired-associate learning task involving 20 pairs. The experimental conditions included: condition 1 - still pictures plus naming; condition 2 - still pictures plus naming supplied with a prepositional link;

condition 3 - action pictures plus naming; and condition 4 - action pictures plus naming supplied with a prepositional link. The design was replicated for the recall and recognition test methods. The main findings from this study were: an overall increase in performance with increased age; greater superiority of elaboration to the control condition among the older than the younger children; and, thirdly, no significant differences between conditions 2 and 3 in either the recall or recognition tasks. Based on these and other data, Rohwer (1973) concluded:

> In summary, the age range from 4 to approximately 11 years apparently does not subsume any marked shifts in the relative effects of minimal (non-elaborated) and augmented (elaborated) prompts. Across studies, the trend is toward an ever-increasing superiority of augmented (elaborated) prompts, whether verbal or pictorial versions are used. Hence it seems warranted to conclude that during childhood, minimal (non-elaborated) prompts are not sufficient to activate elaboration in a systematic or reliable manner. Nevertheless, children in this age range are clearly capable of elaboration since augmented (elaborated) prompts produce remarkably high levels of performance (p. 45-46).

The findings of Experiment II support Rohwer's conclusion to the effect that children in the age range 4.5 to 8.5 years are capable of elaboration since the elaborated conditions, either pictorial or verbal, produced significantly higher levels of performance than did the control condition. Findings from the present experiment, however, do not support the conclusion of an ever-increasing superiority of elaborated prompts, whether verbal or pictorial versions are used. In

the present experiment, pictorial elaboration increased performance over the control condition equally well for pre-school as for grade two children, and there was a tendency, as already stated, for the pre-schoolers to make comparatively greater use of combined elaboration than either of the other age groups. It thus may be said that the recent statement of a developmental hypothesis for the effective use of elaboration (Rohwer, 1973) as supplanting an earlier developmental hypothesis regarding the differential effectiveness of verbal versus pictorial elaboration (Rohwer, 1970) is taken into question by findings of the present experiment.

SUMMARY AND GENERAL DISCUSSION

Experiment I showed that children at the three age levels tested were able to use visual and verbal presentations equally well on the stimulus side of item pairs. These children did show a preference for visual presentations on the response side of the paired-associates. Thus, the hypothesis that young children are better able to store pictorial material and that such material is more effective as retrieval cues on test trials would appear not to be supported by present findings. The finding of a preference for visual presentations on the response side was taken to suggest that the presentation mode most effective for response position is that which is congruent with the mode required for making a response. The comparison of Dilley and Paivio's (1968) findings with those of Experiment I thus suggests that

when items are to be retrieved from memory, the response method used determines the effectiveness of the mode used for storing response members.

The failure of age level to interact significantly with either stimulus or response mode on Experiment I casts doubt on the presence of a developmental sequence for the effective use of either the imagetic or verbal mode in paired-associate learning under non-elaboration or minimal prompt conditions. To the extent that Experiment I, dealing with characteristics of item presentation as distinct from those of elaboration, nevertheless represents minimal prompting conditions (as defined by Rohwer, 1973), its findings may be related to a conclusion drawn by Rohwer to the effect that minimal (non-elaborated) prompts are "not sufficient to activate elaboration in a systematic or reliable manner" (Rohwer, 1973, p. 46). The non-significant effect of grade level in Experiment I would seem to support the view that neither of the four non-elaborated conditions was any more successful in activating elaboration among the grade two subjects than with those from nursery school. The minimal prompting conditions of Experiment II did, however, show the same general increase in performance across grade levels as did the experimental elaboration conditions. The inconsistency of this finding across the two experiments may relate to the differences in the procedure for the two experiments. The first used a feedback paradigm as opposed to the study-test procedure of Experiment II. It might well be that under

conditions of the latter procedure where a large number of paired-associates is presented for learning together, the subject, especially the older one, is more motivated to engage in self-initiated elaboration. The question of what activity the subject does engage in under varying non-elaborated conditions is in need of further research, especially as this question relates to grade level. By incorporating several grade levels, further research would attempt to determine at which age children are motivated to engage in self-initiated elaboration. The form of such elaboration, for example, whether overt or covert rehearsal, and its relationship to performance should be investigated. Through manipulating such factors as list length, response procedure, and possibly pacing rate, their relative facilitative effects for subject-initiated elaboration could also be determined.

The findings of Experiment II clearly reinforce those of the first experiment. The failure once again of grade level to enter into a significant interaction with either depiction or verbalization served to demonstrate that children within the four to eight year age range are equally capable of utilizing pictorial and verbal or combined verbal-pictorial elaborations. It is of particular interest to note that the combined elaboration was not differentially more effective than either singly, as this finding provides valuable evidence against the suggestion that the effective use of imagery by young children requires the simultaneous

storage of appropriate labels. (It will be remembered that the action picture condition of Experiment II involved no labelling). Experiment II supports the general conclusion that children from pre-school to grade two can effectively use both pictorial and verbal elaboration, and brings into question the validity of a developmental hypothesis for increasing effectiveness with respect to either or both modes.

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APPENDIX A

Paired-associate items used in Experiment I for pre-training and experimental sessions: List I

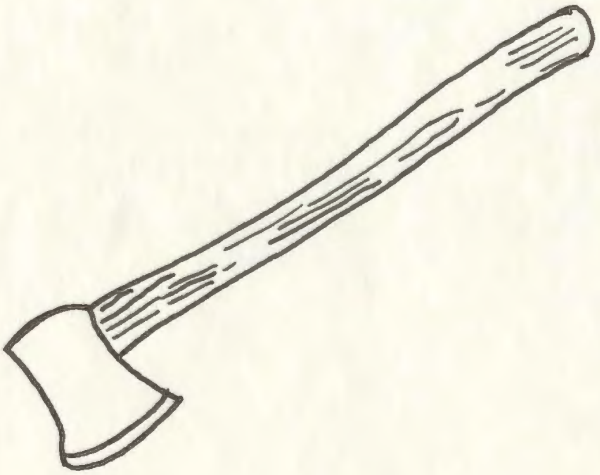
Session	Stimulus Item	Response Item
Pretraining	spoon	egg
	pencil	paper
	bat	cup
Experimental	cat	log
	boat	ball
	hat	star
	dog	gate
	bird	shoe
	tree	hand
	car	wagon
	airplace	flower
	man	chair
	needle	balloon

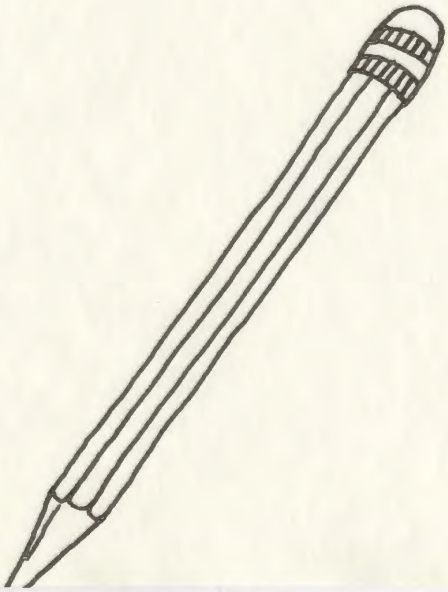
Paired-associate items used in Experiment I for pre-training and experimental sessions: List II

Session	Stimulus Item	Response Item
Pretraining	spoon	egg
	pencil	paper
	bat	cup
Experimental	needle	airplane
	bird	car
	tree	dog
	gate	shoe
	log	man
	flower	star
	hat	ball
	balloon	boat
	chair	wagon
	hand	cat

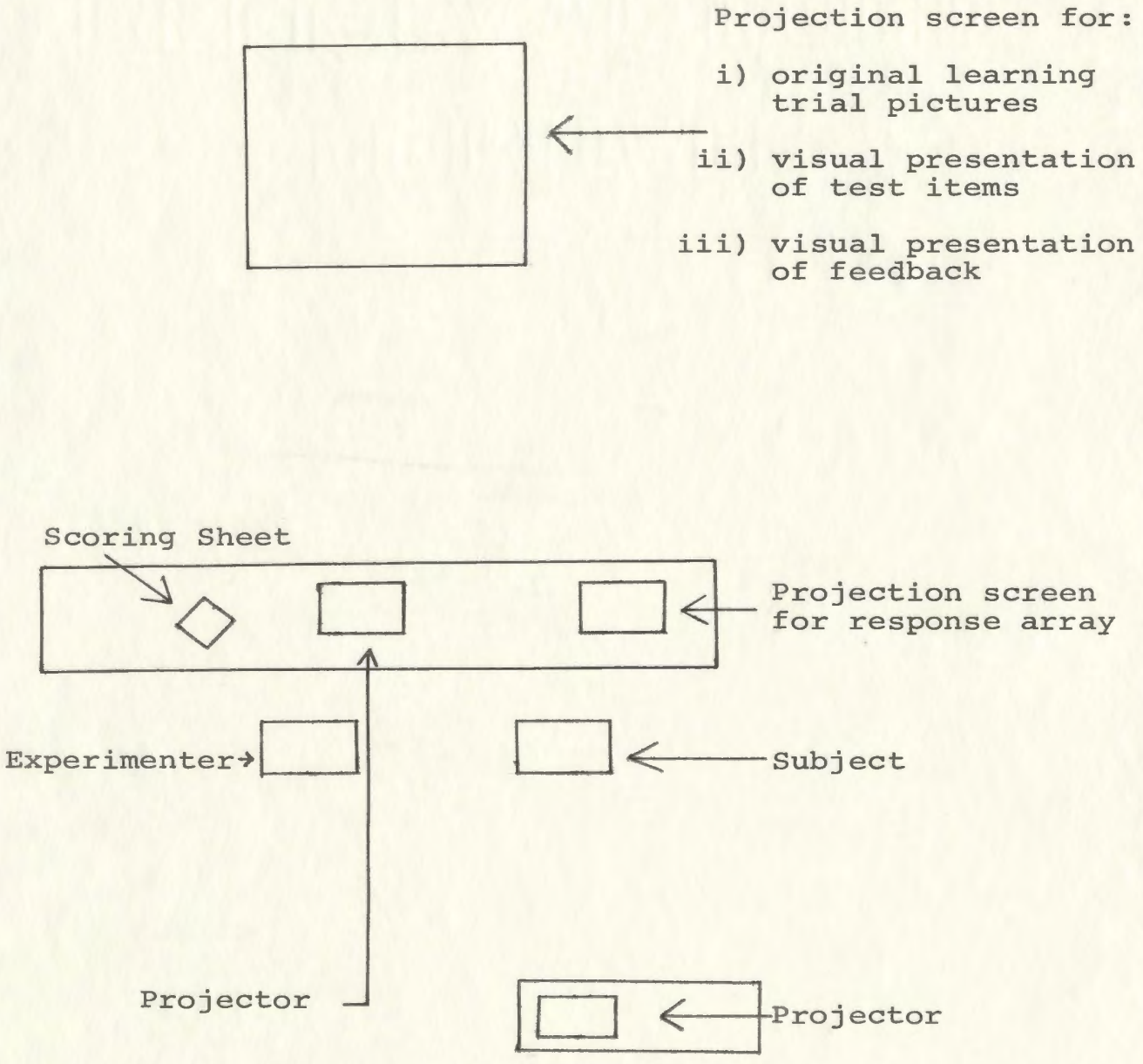
Examples of Item Pairs for Experiment I

P-P Condition





Schematic Diagram of the Setup for Experiment I



APPENDIX B

Item pairs and sentences for Experiment II for pretraining and experimental sessions: List I

Session	Stimulus Item	Response Item	Sentence
Pretraining	fish	pin	The fish covers the pin.
	star	table	The star strikes the table.
	cow	bus	The cow kicks the bus.
Experimental	hand	hat	The hand throws the hat.
	milk	bowl	The milk fills the bowl.
	bat	cup	The bat breaks the cup.
	girl	book	The girl opens the book.
	teeth	apple	The teeth bite the apple.
	needle	balloon	The needle bursts the balloon.
	fire	bed	The fire burns the bed.
	ax	wood	The ax chops the wood.
	towel	plate	The towel wipes the plate.
	spoon	egg	The spoon holds the egg.
	knife	flower	The knife cuts the flower.
	cat	log	The cat jumps the log.
	rope	eye	The rope touches the eye.
	hammer	bell	The hammer pulls the bell.
	rock	bottle	The rock breaks the bottle.
	pencil	paper	The pencil marks the paper.
	foot	house	The foot kicks the house.
	dog	gate	The dog closes the gate.
	shoe	chair	The shoe taps the chair.
	car	wagon	The car upsets the wagon.
	man	pole	The man bends the pole.
	fork	cake	The fork cuts the cake.
	blanket	tree	The blanket covers the tree.
	boat	ball	The boat hits the ball.

Item pairs and sentences for Experiment II for pretraining and experimental sessions: List II

Session	Stimulus Item	Response Item	Sentence
Pretraining	fish	pin	The fish covers the pin.
	star	table	The star strikes the table.
	cow	bus	The cow kicks the bus.
Experimental	hand	rope	The hand pulls the rope.
	balloon	milk	The balloon spills the milk.
	cat	bat	The cat throws the bat.
	gate	fire	The gate touches the fire.
	shoe	cup	The shoe strikes the cup.
	book	flower	The book bends the flower.
	rock	eye	The rock cuts the eye.
	fork	bell	The fork holds the bell.
	car	log	The car bumps the log.
	blanket	cake	The blanket covers the cake.
	man	knife	The man throws the knife.
	chair	house	The chair upsets the house.
	foot	hat	The foot kicks the hat.
	needle	egg	The needle breaks the egg.
	paper	pole	The paper covers the pole.
	hammer	tree	The hammer hits the tree.
	towel	teeth	The towel wipes the teeth.
	girl	bed	The girl touches the bed.
	boat	ax	The boat breaks the ax.
	pencil	wood	The pencil marks the wood.
	plate	dog	The plate hits the dog.
	spoon	bowl	The spoon taps the bowl.
	bottle	apple	The bottle strikes the apple.
	wagon	ball	The wagon rolls the ball.

Examples of Item Pairs for Experiment II

Action-Picture Condition