THE ROLE OF IMAGERY IN CHILDREN'S LINKED NOUN PAIR LEARNING

by

Michael John Catchpole

B.A., University of British Columbia

1972

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF
THE REQUIREMENTS FOR THE DEGREE OF

Master of Arts

in the Department

of

Psychology

We accept this thesis as conforming to the
required standard

THE UNIVERSITY OF BRITISH COLUMBIA

May, 1974

In presenting this thesis in partial fulfilment of the requirements for an advanced degree at the University of British Columbia, I agree that the Library shall make it freely available for reference and study. I further agree that permission for extensive copying of this thesis for scholarly purposes may be granted by the Head of my Department or by his representatives. It is understood that copying or publication of this thesis for financial gain shall not be allowed without my written permission.

Department of Psychology

The University of British Columbia
Vancouver 8, Canada

Date May 28th 1974

ABSTRACT

An experiment was conducted in order to distinguish between semantic elaboration and interacting imagery theories of children's linked noun pair learning. Grades 2 and 6 students were presented with sixteen pairs of nouns linked by different types of connectives and following learning set presentation were required to recall the second noun of each pair upon presentation of the first. One third of the Ss in each grade were asked to form visual images of the two nouns of each pair (Imagery Prompting condition); one third were instructed to form interacting images of each pair (Imagery Training condition); and the remaining Ss were given no special instruction (No Training condition). Results from the experiment showed No Training and Imagery Training Ss to be unaffected by the type of connective employed to link the pairs. However, those Ss in the Imagery Prompting condition recalled significantly more pairs linked by interaction suggesting links (i.e., verbs and interaction suggesting prepositions) relative to pairs linked by connectives which did not suggest a physical interaction (i.e., conjunctions and non-interaction suggesting prepositions). The results were interpreted as favouring an interacting imagery rather than semantic elaboration theory of children's linked noun pair learning.

TABLE OF CONTENTS

ABSTRACT i

TABLE OF CONTENTS ii

LIST OF TEXT TABLES iii

LIST OF APPENDIX TABLES iv

LIST OF FIGURES viii

ACKNOWLEDGEMENTS ix

INTRODUCTION 1

METHOD 24

RESULTS 35

DISCUSSION 61

GENERAL CONCLUSION 77

REFERENCES 79

APPENDIX 85

LIST OF TEXT TABLES

Table 1. General Experimental Design 25

Table 2. Examples of the Types of Practice, Learning, and Recall Materials Employed in the Experiment 34

Table 3. Mean Number of Second Nouns Correctly Recalled in Each Cell of Design 1 37

Table 4. Mean Number of Second Nouns Correctly Recalled in Each Type of Training x Type of Connective Cell Averaged Over List and Grade - Design 2 41

Table 5. Mean Number of Second Nouns Correctly Recalled in Each Cell of Design 2 45

Table 6. Mean Number of Second Nouns Correctly Recalled in Each Type of Training x Type of Connective x Nature of Implied Interaction Cell Averaged Over List and Grade (Design 2) . . 47

Table 7. Mean Number of Connectives Correctly Recalled in Each Cell of Design 1 53

Table 8. Mean Number of Connectives Correctly Recalled in Each Cell of Design 2 56

LIST OF APPENDIX TABLES

Table 1. Practice Items Employed During Imagery Training, Imagery Prompting, and No Training Instructions 86

Table 2. List 1 - Learning Set Items (Presentation Order) 87

Table 3. List 2 - Learning Set Items (Presentation Order) 88

Table 4. List 3 - Learning Set Items (Presentation Order) 89

Table 5. List 4 - Learning Set Items (Presentation Order) 90

Table 6. Format of the Experimental Booklets 91

Table 7. Introduction and General Paired-Associate Instructions 92

Table 8. Imagery Training Instructions 93

Table 9. Imagery Prompting Instructions 94

Table 10. No Training Instructions 95

Table 11. Second Noun Recall Instructions 96

Table 12. Connective Recall Instructions 97

Table 13. Source Table for the Analysis of Variance of Design 1 (Second Noun Recall) 98

Table 14. Newman-Keuls Test of the Type of Connective

Effect in Design 1 (Second Noun Recall) 99

Table 15. Simple Main Effects Test and Subsequent Newman-Keuls Tests of the List x Connective Interaction in Design 1 (Second Noun Recall) . . 199

Table 16. Newman-Keuls Analysis of the Type of Training Effect in Design 1 - Second Noun Recall 102

Table 17. Simple Main Effects Test and Subsequent Newman-Keuls Test of the Training x Connective Interaction in Design 1 (Second Noun Recall) from the Point of View of a Comparison Among Connectives for Each Type of Training 103

Table 18. Simple Main Effects Test and Subsequent Newman-Keuls Analysis of the Training x Connective Interaction in Design 1 (Second Noun Recall) from the Point of View of a Comparison Among Training Procedures for Each Type of Connective 104

Table 19. Source Table for the Analysis of Variance of Design 2 - Second Noun Recall 106

Table 20. Newman-Keuls Test of the Type of Training Effect in Design 2 (Second Noun Recall) 108

Table 21. Simple Main Effects Test of the List x Connective Interaction in Design 2 (Second

Noun Recall) from the Point of View of a Comparison Among Connectives for Each List . . . 109

Table 22. Simple Main Effects Test and Subsequent Newman-Keuls Test of the List x Connective Interaction in Design 2 (Second Noun Recall) from the Point of View of a Comparison Among Lists for Each Connective 110

Table 23. Simple Main Effects Analysis of the Interaction of Type of Training x Nature of Implied Interaction for Prepositions - Design 2 (Second Noun Recall) from the Point of View of a Comparison of Interacting versus Non-Interacting Prepositions for Each Type of Training 111

Table 24. Simple Main Effects Analysis of the Interaction of Type of Training x Nature of Implied Interaction for Verbs plus Prepositions - Design 2 (Second Noun Recall) from the Point of View of a Comparison of Interacting versus Non-interacting Prepositions for Each Type of Training 112

Table 25. Simple Main Effects Analysis and Subsequent Newman-Keuls Tests of the Interaction of Training x Connective x Nature of Implied

Interaction in Design 2 (Second Noun Recall) from the Point of View of a Comparison Among Training Procedures for Each Type of Connective 113

Table 26. Source Table for the Analysis of Variance of Design 1 - Connective Recall 115

Table 27. Newman-Keuls Test of the Training Effect in Design 1 (Connective Recall) 116

Table 28. Newman-Keuls Test of the Connective Effect in Design 1 (Connective Recall) 117

Table 29. Simple Main Effects Test and Subsequent Newman-Keuls Analysis of the Connective x List Interaction in Design 1 (Connective Recall) from the Point of View of a Comparison Among Lists for Each Type of Connective 118

Table 30. Source Table for the Analysis of Variance of Design 2 (Connective Recall) 120

Table 31. Newman-Keuls Test of the Training Effect in Design 2 (Connective Recall) 122

Table 32. Simple Main Effects Analysis of the Implied Interaction x List x Connective Interaction in Design 2 (Connective Recall) 123

LIST OF FIGURES

Figure 1. Graphical Representation of the Type of Training x Type of Connective Interaction in the Design 1 Analysis of Second Noun Recall 42

Figure 2. Graphical Representation of the Nature of Implied Interaction x Type of Training x Type of Connective Interaction in the Design 2 Analysis of Second Noun Recall 48

ACKNOWLEDGEMENTS

I wish to express my gratitude to Dr. John Yuille for his advice and help in the preparation of this thesis. Also I would like to thank Dr. Chris Tragakis and Dr. Nancy Suzuki for their constructive criticisms and helpful suggestions. Finally I'd like to thank Mr. G. R. Philips and the Grades 2 and 6 students of Kingsford-Smith Elementary School for their kind co-operation in the acquisition of the experimental data.

INTRODUCTION

A number of researchers (e.g., Rohwer, 1966, 1967; Davidson and Adams, 1970; Suzuki and Rohwer, 1968; and Yuille, 1973) have reported that children presented with noun pairs embedded in a printed sentence frame will recall more of these pairs than will children who study the same pairs minus the sentence frame. This facilitative effect obtained when to-be-learned pairs of nouns are embedded in a sentence has been found to depend on the nature of the connective employed to link the pair. When a conjunction is inserted between the two nouns (e.g., the CAT and the BOOK), recall performance is no better than that obtained with a standard noun-noun type of presentation (e.g., CAT - BOOK), (Rohwer, 1966; Rohwer, Sheull and Levin, 1967; and Suzuki and Rohwer, 1968). However, if a verb is employed to join the nouns (e.g., the CAT chews the BOOK), then children's recall performance is greatly improved (e.g., Suzuki and Rohwer, 1968; and Yuille, 1973).

Two explanations have been forwarded to account for this ability of verbs to facilitate children's paired associate learning (PAL). One group of researchers (e.g., Rohwer, 1970, 1973; and Rohwer and Matz, 1974) have hypothesized that this improvement reflects the operation of <u>verbal-semantic</u> processes, while another group (e.g., Yuille, 1973, 1974) have proposed that verb links foster <u>interactive imagery</u> processes.

Specifically, Rohwer (1970) has proposed that verbs facilitate paired-associate learning by children because these types of connectives foster a process he calls "semantic elaboration". Presentation of the to-be-learned pair in a verb-linked sentence, says Rohwer, serves to modify the two nouns such that they come to share a common semantic aspect. This shared aspect mediates the pair and thus improves the likelihood of correct retrieval of the second item upon presentation of the first. For example, a pair like "DOG-BALL" might, if presented to an adult, automatically evoke a number of common semantic attributes shared by the two items. In the case of the child, however, this spontaneous "semantic elaboration" of the pair is not so likely to occur. Similarly, says Rohwer, embedding the noun pair in the phrase "the DOG and the BALL", also will not improve recall since conjunctive connectives like "and" do not encourage the generation of attributes shared by the two items. However, if the verb "chews", for example, is inserted between the pair of nouns, then the resultant phrase "the DOG chews the BALL" will foster or prompt the semantic elaboration process. In this example the verb "chews" says Rohwer, gives the two unrelated items "DOG" and "BALL" a common semantic attribute or relationship (i.e., the one who chews and the one who is chewed). This shared characteristic mediates the pair and greatly improves the likelihood that subsequent presentation of the noun "DOG" will evoke the response "BALL".

In contrast to the semantic elaboration interpretation of the

sentence facilitation effect adopted by Rohwer (1970), is an imaginal processes hypothesis proposed by Yuille (1973). Yuille (1973, 1974) hypothesized that the recall improvement obtained when verbs are employed to link noun pairs reflects the operation of non-verbal imagery codes. Based on a similar proposal forwarded by Paivio (1971) and Bower (1972) to explain the greater ease of learning of interacting versus side-by-side object pairs (e.g., Milgram, 1967; Reese, 1965; Holyoak, Hogeterp, and Yuille, 1972; and Yuille and Catchpole, 1973), Yuille (1973) proposed that verbs encourage S to generate an interacting image of the object referents of the two nouns. This composite image facilitates recall since presentation of the first item of a pair cues the entire image and, therefore, the second item. Similarly, the lack of improvement in recall which results when conjunctive links are employed occurs because Ss generate two separate images of the pair items such that presentation of one item need not necessarily cue the second.

Holyoak, Hogeterp, and Yuille (1972) found support for an interactive imagery hypothesis in a study which compared verbs versus interacting line drawings as mediators for noun pair learning. Findings from the Holyoak et. al. (1972) experiments demonstrated that linking noun pairs with a verb connective was as effective for improving second noun recall as was a line drawing which depicted the two items in an interaction. This result coupled with data from Levin (1970, a), which showed that providing the original noun plus

verb to cue second noun recall was no more effective than cueing with the first noun only (i.e., no verb), led Holyoak et. al. (1972) to conclude that the specific nature of the verb used to link the pair of nouns is irrelevant. Rather, these authors concluded, the verb merely serves to suggest to S that he or she generate his or her own interacting image of the two items. A subsequent study by Yuille (1973) obtained further support for this conclusion. Yuille (1973) found trial-to-trial changes in the linking verb in no way affected second noun recall relative to Ss presented the same link on each trial. His conclusion from these results was that the verb merely encourages Ss to generate their own interacting images. Yuille (1974) replicated the Yuille (1973) findings that the verb serves merely an exemplar function for imagery coding. Furthermore, Yuille (1974) reported that Ss ability to correctly recall the original verb was unrelated to the likelihood of correct second noun recall. Though this result added further weight to the conclusion that the specific nature of the connecting verb is unimportant, it does not allow a definitive choice between interacting imagery and verbal semantic hypotheses of linked noun pair learning by children. A definite choice is not provided between these alternatives because it could be argued (though Rohwer does not do so) that the verb serves merely to suggest to Ss that they generate their own semantic link between the two items. That is, linking noun pairs with a verb may encourage Ss to generate his or her own semantic overlap which may or may not

relate to the specific linking verb.

Though somewhat less parsimonious than Yuille's (1973, 1974) interacting imagery hypothesis, the semantic elaboration alternative does weaken the definity of Yuille's conclusion that imaginal processes are solely responsible for the sentence facilitation effect. However, data from several other areas of research related to children's associative learning do favour an interacting imagery hypothesis. For example Jensen and Rohwer (1963, 1965) and Cooper (1968) reported an even stronger facilitative effect of verb versus conjunction connectives when the object referents of noun pairs are presented along with the printed linked nouns. Though it could be argued that the simultaneous object presentation somehow facilitated Ss generation of a common semantic attribute, it seems more appropriate to interpret this result as reflecting an increased prompting of imagery codes. Paivio (1970) hypothesized successful PAL of concrete noun pairs to involve a three stage process: first, S must generate images of the two items; secondly, these two images must be interacted; and thirdly, at recall, this composite image must be triggered and correctly decoded. Following Paivio's (1970) reasoning, it appears likely that simultaneous noun plus object presentation, by providing a more concrete stimulus for image generation, would aid Ss carrying out of the first of the three steps of interacting image generation and thus increase the likelihood of correct recall. The degree of this facilitation would be particularly high if S was unfamiliar with the object

referents of the two nouns since, in these cases, image generation would be impossible. Presenting the objects, therefore, would at least ensure that S generates the two separate images.

Further support for the proposal that interacting imagery processes are responsible for the potential of verbs for improving children's learning of noun pairs is found in a study by Reese (1969). While some researchers (e.g., Rohwer and Levin, 1968; and Reese, 1969) have reported that "semantically anomolous" phrases like "CATS jump SONGS" are no better recalled than unlinked pairs (despite the presence of the verb) it is important to note that such phrases are not only "semantically anomolous", but are also non-imageable. However, Reese (1969) reported that bizarre phrases like "the FISH talks on the TELEPHONE" do improve noun pair learning relative to unlinked or conjunctively linked control pairs. Though both "CATS jump SONGS" and "the FISH talks on the TELEPHONE" are clearly semantically anomolous, the critical difference between these two types of phrases seems to be in their ease of image formation. "CATS jump SONGS" is very difficult to image phrase (how can S image the noun "SONG") whereas to generate an imaginal representation of a fish talking on a telephone is possible. That is, following Yuille's (1973) reasoning, the inclusion of the verb "jump" between "CATS" and "SONGS" will not improve PAL because, since the noun "SONG" can not easily be transformed into a visual image, S will be unable to generate his or her own interaction of the two items. However, inserting the verb phrase

"talks on" between the nouns "FISH" and "TELEPHONE" is facilitative with respect to subsequent recall testing because both nouns can be represented as visual images and therefore the child is prompted to generate an interaction between the two items due to the presence of the verb.

Another body of research which provides stronger support to an interactive imagery rather than semantic elaboration interpretation of children's associative learning is found in a series of experiments designed to train children to form their own mnemonic mediation strategies. Based on the success of verb-linked E-supplied sentences for improving noun pair learning in children, Rohwer and his collegues attempted to train children to generate their own sentences. Despite extensive training, attempts to train children to generate their own facilitative sentences were unsuccessful (e.g., Rohwer, Ammon, and Levin, 1971; and Rohwer and Ammon, 1971) with the exception of a blocked presentation, in a study by Ammon and Ammon (1970). Rohwer's conclusion concerning these negative results was that "perhaps it would be more fruitful to delay training in the use of elaborative prompts (i.e., S-generated sentences) until preadolescence, and to ensure efficient learning at younger age levels by incorporating the prompts (i.e., E-supplied sentences) directly into the materials presented for learning" (Rohwer and Gerdes, 1971). Despite this somewhat pessimistic pronouncement, other researchers in the field (e.g., Levin and Kaplin, 1972; Taylor and Balck, 1969; and Yuille and Catchpole,

1973, 1974) have been successful in training children to improve their paired-associate performance. However, these highly successful training procedures were based on an interactive imagery rather than verbal elaboration hypothesis and, therefore, were designed to encourage the use of imagery rather than verbal codes. Impetus for these imagery induction procedures came from the previously mentioned finding that object pairs presented as interacting with each other are better recalled than object pairs presented in a non-interacting side-by-side fashion (Bower, 1972; Milgram, 1967; Reese, 1965; and Yuille and Catchpole, 1973). Given that children can benefit from E-supplied interacting presentation of paired-associates, Yuille and Catchpole (1973) tested the possibility that instructing Ss to think of their own interactions (i.e., interacting images) also would improve recall. Their experiment compared the recognition performance of three groups of kindergarten children presented with twenty pairs of objects. Group one was presented the object pairs in a side-by-side manner; group two studied the same pairs however E generated an interaction between the two items of each pair; and group three also received side-by-side presentation but was given interactive imagery training prior to learning set presentation. The comparison of the recognition scores for these three groups of children revealed that those Ss who generated their own interacting images (i.e., group three) and those Ss who viewed already interacting pairs (i.e., group two) performed equally well and significantly better than did Ss given an uninstructed

side-by-side presentation condition (i.e., group one). Thus it appeared from these results that kindergarten-age children are capable of forming interacting images if instructed to do so and these S-generated interacting images are as effective as interactions generated by E. Danner and Taylor (1973) also obtained evidence suggesting that children can benefit from instruction to generate interacting images. In the Danner and Taylor (1973) study it was found that children from grades one, three, and six who drew their own interactions of to-be-learned object pairs showed superior recall relative to Ss presented the same side-by-side items but not given such instruction. This study represents a test of learning between E-supplied interactions and S-generated interacting images. The fact that children can benefit from their own interacting line drawings of side-by-side object pairs lends further support to the Yuille and Catchpole (1973) hypothesis that children of this age can generate interacting images. That is, in order to generate the interacting line drawings, Ss in the Danner and Taylor (1973) experiments must have been capable of first forming interacting images.

Given that imagery training was effective for improving children's learning of object pairs, Yuille and Catchpole (1974) attempted to extend the range of application of their imagery training procedure. Results from their second study not only replicated the previous finding that imagery training improves children's recognition memory but also extended this improvement to tests of immediate and delayed

recall. Grade one Ss in the Yuille and Catchpole (1974) experiment who were trained to generate their own interacting images showed an immediate recall performance which was one-hundred percent higher than their untrained classmates. Furthermore this highly significant improvement persisted even after a one week delay. In addition, Yuille and Catchpole (1974) reported that Ss originally trained in the use of interacting images performed significantly better than the untrained Ss on a new paired-associate task administered one week after the original training session, even though these Ss were given no additional instructions to employ interacting imagery coding.

In view of their high degree of success with regard to training Ss to formulate their own interacting images of object pairs, Catchpole and Yuille (1974) decided to investigate the potential of imagery training for improving children's noun-pair learning. Since Rohwer, Ammon, and Levin (1971) and Rohwer and Ammon (1971) had achieved no success in training children to generate effective semantic elaboration strategies (i.e., S-generated sentences) to improve noun pair learning, Catchpole and Yuille (1974) were interested to see if training children to generate interacting images of the object referents of noun pairs would be effective in this type of learning situation. Results from the grades two and five Ss in this experiment revealed imagery training to be a highly effective procedure for increasing the recall of noun pairs as well as of noun pairs accompanied by their object referents. Furthermore, simultaneous object presentation along

with the noun pairs resulted in no better performance than noun pairs alone. This result was interpreted by the authors as indicating that Ss of these ages were capable of forming maximally effective images of the nouns employed in the experiment (if instructed to do so) and received no additional image generation benefit from the presence of the object referents of the nouns. The recall improvement of imagery trained Ss in the noun and noun-plus-object conditions in this experiment was equal to that obtained by untrained Ss presented with nouns plus (already) interacting objects. In contrast, for the untrained Ss, noun plus interacting objects were learned significantly better than either nouns or nouns plus side-by-side objects. Thus it appears from the Catchpole and Yuille (1974) experiment that training children to generate interacting images of the object referents of noun pairs will improve recall of the pairs to the same degree as will presenting the object referents of these nouns in an interaction. One further result from the Catchpole and Yuille (1974) study apparently reflected some developmental changes in Ss ability to employ interactive imagery codes. For grade two Ss the brief training session in the use of interacting images also improved recall performance in the nouns plus interacting objects condition relative to the untrained Ss. However, for grade five Ss no such improvement was obtained. Thus, concluded the authors, not only does imagery training improve children's noun pair and noun plus object pair learning but also, for younger Ss, it increases Ss ability to recall already in-

teracting object pairs. Since no such improvement difference occurred between trained Ss presented with nouns versus nouns plus objects this improvement must have reflected an effect of imagery training for prompting Ss to focus on the interaction of the two items. Having demonstrated that imagery training is a highly effective method for improving children's learning of noun pairs, Catchpole and Yuille (1974) then compared the relative effectiveness of their imagery training procedure, a verbal elaboration training procedure similar to that employed by Ammon and Ammon (1970), and a no training control condition. To test for possible interactions between the training materials and the training procedures, Catchpole and Yuille (1974) trained half of the Ss in each of the three training conditions with objects and the other half with nouns. The learning materials for each S consisted of a mixed list of noun and object pairs. Ss ability to recall these items was tested both immediately after learning set presentation and one week later. Consistent with the findings of a study by Levin, Davidson, Wolff, and Citron (1973) Catchpole and Yuille (1974) found that for immediate recall both verbal and imagery training procedures were equally facilitative and resulted in significantly superior recall to the untrained control condition. Also, at immediate recall, equal numbers of noun and object pairs were recalled. However, after the one week delay, Ss trained in the use of interactive imagery recalled significantly more of the original pairs than did the verbal training Ss though this latter group still

correctly recalled significantly more items than the no training Ss. Also after one week significantly more of the original object pairs were recalled relative to the noun pairs. Finally, Catchpole and Yuille (1974) found that imagery trained Ss recalled more of the object pairs than noun pairs, whereas for the verbally trained Ss no difference was found between recall for objects versus nouns. Catchpole and Yuille interpreted the greater decrease in recall of the verbally trained Ss relative to the imagery trained Ss to the notion that verbal training results in the generation of some verbal codes which although salient at immediate recall fade more rapidly over time than do the imaginal codes generated by Ss trained in the use of interactive imagery. Though this proposal offered a parsimonious explanation of the data collected by these authors, Catchpole and Yuille (1974) did not attempt to explain the reason for their success with verbal training compared to the lack of success obtained by Rohwer (e.g., Rohwer and Ammon, 1971). The discrepancy between the performance of verbally trained Ss in the Catchpole and Yuille and Levin et.al. (1973) experiments and the performance of verbally trained Ss in the Rohwer et. al. (1971) and Ammon and Ammon (1970) studies is puzzling. However one possible explanation is that the mixed object and word pair list employed by Catchpole and Yuille (1974) and Levin et. al. (1973) provided a necessary prompt to generate imagery codes for the verbal training Ss in these experiments, while the pure noun pair presentation employed in the Rohwer experiments did not evoke imaginal coding.

That is, though imagery training automatically prompts Ss to generate interacting imaginal representations of noun pairs, verbal training may not automatically prompt Ss to image presented noun pairs. Thus inclusion of object pairs as well as noun pairs may have facilitated this first image generation step of improved noun pair learning and thus allowed Ss to proceed with the second step of cognitively interacting these images. This image facilitation potential of simultaneous object presentation might be likened to the greater sentence facilitation effect obtained when object referents are presented along with linked noun pairs (c.f. Jensen and Rohwer, 1963, 1965).

The Yuille and Catchpole (1973, 1974) and Catchpole and Yuille (1974) experiments add further support to the hypothesis that the facilitative effect of verbs with respect to linked noun pair learning reflects the operation of interactive imagery codes. However, the equal immediate recall performance obtained with verbal elaboration and imagery training still prevents a conclusive decision as to the relative importance of semantic elaboration and interactive image generation in children's associative learning. One further experiment by Rohwer, Lynch, Levin, and Suzuki (1967) may provide the basis for the development of a critical test to distinguish between these two theoretical positions. Rohwer et. al. (1967) found prepositions also were capable of facilitating PAL though not to the same extent as verbs. Verbs afforded maximal facilitation, prepositions gave intermediate facilitation, and conjunctions did not improve PAL re-

lative to an unlinked control condition. This result leads to two obvious questions: first, what property of prepositions causes them to facilitate children's learning of noun pairs, and second, why is this facilitation significantly less than that which is obtained from verbs? From the point of view of Rohwer's (1970) semantic elaboration hypothesis it is not immediately obvious why prepositions should fall between verbs and conjunctions in terms of their ability to foster a semantic link. However, if one turns to Paivio's (1971) and Bower's (1972) explanation of the improvement in recall that occurs when object pairs are presented in an interacting fashion a possible explanation is suggested. Paivio (1971) states that the critical factor for the facilitation obtained when object pairs are presented in an interacting fashion is that this interaction of the two items permits S to encode them as a single compound image. This storage of the two items in one compound image facilitates recall since presentation of the first item at the time of recall cues the entire image and thus the second item. Yuille (1973, 1974) has called upon an identical process to explain the ability of verbs to facilitate children's noun pair learning. That is, presentation of the two items as linked by a verb causes S to generate a single interacting image of the object referents of the two nouns. If Yuille (1973, 1974) is correct then why are prepositions also effective for improving noun pair learning but not to the same degree as are verbs? A possible explanation lies in the fact that prepositions fall into two

categories: those that suggest a physical interaction between the two items in question (e.g., "on", "in", and "around") and those that imply a non-touching physical relationship (e.g., "above", "beside", "between"). Therefore, Rohwer et. al. (1967) may have employed (in their preposition condition) some prepositions which suggested an interaction between pair members and some which did not. Following Paivio's (1971) reasoning, those prepositions which suggest a single interacting image of the two nouns should be as facilitative as verbs, while those that imply a side-by-side or over-under relationship (i.e., two separate images) should be no more facilitative with respect to recall performance, than are conjunctions. Thus perhaps the Rohwer et. al. (1967) finding that prepositions did not facilitate PAL as much as verbs, reflected the presence of some non-interacting prepositions in the preposition condition which deflated the mean facilitative effect of this type of connective. If this proposal that interacting prepositions will improve children's noun pair learning and non-interacting prepositions will not, is correct, then strong support for an interacting imagery hypothesis of linked noun pair learning will be provided. That is, from the point of view of Rohwer's (1970) semantic elaboration hypothesis, there is no reason why prepositions which suggest a distanced spatial relationship should provide any less recall facilitation than do those prepositions which imply an actual physical interaction of the two items. However, from an interactive imagery point of view, this distinction between

the two classes of prepositions is vital because according to Paivio (1971), Bower (1972), and Yuille (1973), recall facilitation occurs only if the two items can be stored in a single compound imaginal representation. In order to investigate this possibility, the current research replicated, in part, the Rohwer et. al. (1967) experiment, however, the degree of interaction suggested by the connectives in the preposition condition was systematically manipulated. That is, noun pairs were linked by verbs, conjunctions, or prepositions, and half of the prepositions implied a physical interaction between the two items for each pair and half did not. In addition to these three types of connectives (i.e., verbs, conjunctions, and prepositions) a fourth type of connective (verb plus preposition) was also included. If an implied interaction between the two items is necessary to improve recall performance then only those verbs which are coupled with an interacting preposition should facilitate learning. For example, a linked noun pair like "the BULL runs under the FLAG" should not be as readily recalled as "the BULL runs into the FLAG" because the former does not suggest a physical interaction between the pair members while the latter does. Therefore to explore the possibility that the suggestion of a physical interaction is critical to recall improvement of verb plus preposition linked pairs, one-half of the verbs in the verb plus preposition condition were paired with interacting prepositions while the other half were paired with non-interacting prepositions.

To summarize the above discussion four types of connectives were employed to link the to-be-learned noun pairs: one quarter were linked by verbs, one quarter by conjunctions, one quarter by prepositions, and one quarter by verbs plus prepositions. In addition, within the preposition condition, one half of the members of this connective category suggested a physical interaction between the two pair items and one half suggested a distanced spatial relationship. Similarly, for the pairs linked by verbs plus prepositions, half employed a verb plus interacting preposition and half employed a verb plus non-interacting preposition. If the suggestion or implication of a physical interaction is the critical condition for improving noun pair learning then pairs linked by verbs, interacting prepositions, and verbs plus interacting prepositions, should be better recalled than are pairs linked by conjunctions, non-interacting prepositions, or verbs plus non-interacting prepositions.

A further probe into the role of imagery in children's learning was incorporated into the experiment through a manipulation of the type of training given to Ss. Catchpole and Yuille (1974) found that Ss instructed to form an interacting imaginal representation of noun pairs showed superior recall to Ss not given such instruction. They concluded that children have the potential to form interacting images of noun pairs but will not do so unless provided with appropriate instruction. Presumably, therefore, in a linked noun pair learning situation, interacting imagery training would be beneficial for only

those pairs which do not already have an interaction of the two items suggested by the particular connective. Thus, while interacting imagery training should improve recall of conjunction, non-interacting preposition, and verb plus non-interacting preposition linked pairs all other pairs in the learning set should be no better learned than they would be in the absence of any special training. To test this hypothesis E trained some Ss in the use of interacting images while other Ss received no special training. If uninstructed children automatically employ imagery coding in linked noun pair learning situations then these Ss should perform better when connectives which suggest an interaction are used to link the pairs (because an interacting image would be stored) rather than when connectives which suggest a distanced spatial relationship are employed (because separate images will be generated). On the other hand for Ss trained to generate their own interactions (i.e., imagery training) no difference in recall scores should occur among the connectives because these Ss generate their own interaction of each pair regardless of the connective. Therefore, assuming S generated and E-supplied interactions to be equally facilitative it would be expected that imagery trained Ss would show superior recall to untrained Ss in the case of pairs linked by connectives which do not suggest an interaction. However, for those pairs which already have an interaction suggested by the connective (i.e., verb, interacting preposition, and verb plus interacting preposition links) performance under imagery training should

equal performance under no training. This prediction is based on two assumptions which may prove to be incorrect. Firstly, untrained Ss may not automatically employ imagery codes when presented with printed linked noun pairs (c.f. Yuille and Pritchard, 1969; Levin, Kaplan, and Horvitz, 1971). If this should occur then in terms of interactive imagery coding the nature of the connective employed (i.e., interacting versus non-interacting) would be irrelevant because there would be no S generated images to combine into a compound imaginal representation. Secondly, S and E generated interactions may not be equally facilitative and therefore differential recall might occur between imagery training and no training for pairs linked by interaction suggesting connectives. That is, while both E-supplied (e.g., No Training - Verb links) and S-generated (e.g., Imagery Training - Verb links) interactions of pair members should be better recalled than non-interacted pairs (e.g., No Training - Conjunction links) it may be the case that either S-generated or E-supplied interactions will be extra facilitative. On one hand presentation of interactions might be better than having Ss generate their own since an interaction of every pair is ensured in the case of E-supplied links but not necessarily for S-generated links. On the other hand, however, by having Ss generate separate images and then interact them (i.e., Imagery Training) imaginal coding might be more likely to be evoked relative to E-supplied interactions which may not automatically prompt imagery processes.

To partially control for the possibility that no sentence facilitation effect will occur for the untrained Ss (c.f. Yuille and Pritchard, 1969) and to investigate the effectiveness of non-interacting imagery induction for linked noun pair learning, a third instructional condition (Imagery Prompting) was included in the experimental design. The Imagery Prompting condition involved training Ss to generate imaginal representations of the two nouns of each pair (just as was done with Imagery Training) however no additional instruction to interact these images was given. Thus the inclusion of the Imagery Prompting condition was designed to serve two purposes. First, what effects will prompting non-interacting image generation have on second noun recall relative to interacting image generation for the various types of connectives. Second, as has occasionally been reported in other linked noun pair learning studies (e.g., Davidson, Schwenn, and Adams, 1970; Levin, 1970(a); and Yuille and Pritchard, 1969) should no sentence facilitation effect occur in the current experiment, the inclusion of a group of Ss prompted to image the two nouns should increase the likelihood of imagery coding and therefore (according to Yuille, 1973, 1974) ensure a facilitative effect of interacting as opposed to non-interacting connectives. This inclusion of an imagery prompting condition designed to increase the likelihood of Ss generating images of to-be-learned noun pairs might be likened to a simultaneous linked noun pair plus object referent presentation which has been found to give a stronger and more

consistent sentence facilitation effect than linked noun pairs alone (c.f. Jensen and Rohwer, 1963, 1965). Therefore if, as is generally reported (e.g. Rohwer, 1967; Rohwer et. al., 1967; and Yuille, 1973) a sentence facilitation effect occurs for the No Training Ss then the performance of these and the Imagery Prompting Ss should be roughly equal. However, if for some reason Ss in the No Training group do not automatically employ imagery codes and therefore no sentence facilitation effects occur, then the inclusion of the Imagery Prompting Ss will hopefully ensure such a facilitative effect and thus allow comparisons with those Ss given (interactive) Imagery Training.

For those Ss given Imagery Training equal recall was expected for every type of connective because these Ss were trained to generate interacting images of every pair regardless of the connective. However, for Imagery Prompting and most likely also for No Training, differences in the recall facilitation of connectives was expected with interacting connectives giving greater recall than non-interacting connectives.

One further variable to be manipulated in the proposed research will be the Ss' age. Catchpole and Yuille (1974) found that for younger Ss (Grade 3), training in the use of interacting images significantly improved these Ss recall of object pairs presented in an already interacting fashion. For the sixth grade Ss, however, no such improvement was obtained. Catchpole and Yuille's (1974) conclusion

regarding this result was that apparently for the younger Ss, interacting imagery training encouraged the Ss to focus greater attention on the interaction if the two items, whereas the older Ss were already receiving maximum benefit from the interacting presentation. Based on this result, the current research further investigated possible developmental changes in children's ability to employ interactive imagery codes. Should linked noun pair recall performance show a similar pattern to noun plus interacting object learning, it may be the case that for younger Ss interactive imagery training will increase the already facilitative effect of joining pairs with connectives that suggest an interaction. That is, by causing Ss to focus on the interaction implied by certain connectives, the younger Ss may store more facilitative interacting images of to-be-learned nouns.

In addition to second noun recall the proposed research also tested Ss' ability to correctly recall the connective employed to link each pair. Yuille (1973) found that children's ability to recall the original connective was in no way related to second noun recall. The current research will test the generality of Yuille's result and will also determine if any relationship exists between the recall of connectives other than verbs and correct second noun recall.

METHOD

Subjects

A total of 72 Ss participated in the experiment. Thirty-six of these Ss were in Grade 2 and 36 were in Grade 6. Ss were drawn from one lower middle class school in the Vancouver School District. The study involved both males and females and the number of members of each sex were roughly equated for each cell of the design.

Design

A schematic representation of the experimental design is provided in Table 1. The experiment employed a 2 x 3 x 4 x 4 factorial design with one two-level nested factor. One variable (two levels of which contained the nested factor) was manipulated within Ss, the remaining three were between Ss variables. The first between Ss variable was Grade. One-half of the Ss were Grade two students and the other half were in Grade six. Type of Instruction was the second between Ss variable. One-third of the Ss within each grade were given a brief session of interacting imagery training with thirteen practice pairs. A second third of the Ss within each grade were given an imagery prompting session with the same thirteen pairs. The remaining Ss within each grade also viewed these thirteen practice pairs, however, they were given no special instruction. List was the third between Ss variable. One-fourth of the Ss in each of the six

TABLE 1

General Experimental Design

			Type of Connective				
			Preposition		Verb	Conjunction	Verb plus Preposition
			Inter-acting	Non-Inter-acting			Inter-acting / Non-Inter-acting
GRADE 2	Imagery Training	List 1					
		List 2					
		List 3					
		List 4					
	Imagery Prompting	List 1					
		List 2					
		List 3					
		List 4					
	No Training	List 1					
		List 2					
		List 3					
		List 4					
GRADE 6	Imagery Training	List 1					
		List 2					
		List 3					
		List 4					
	Imagery Prompting	List 1					
		List 2					
		List 3					
		List 4					
	No Training	List 1					
		List 2					
		List 3					
		List 4					

Grade x Type of Instruction cells studied List 1, one-quarter studied List 2, one-quarter studied List 3, and the remaining Ss studied List 4. The within Ss variable was Type of Connective. Four of the sixteen to-be-learned pairs were linked by a preposition, four pairs were linked by a conjunction, four of the pairs were linked by a verb, and four of the original sixteen pairs were linked by a verb plus a preposition. In addition a fifth variable was nested within the preposition and the preposition plus verb conditions. This variable was Nature of Implied Interaction. Two of the four prepositions in each list suggested a physical interaction of the two items and two did not. Similarly, in the verb plus preposition condition, two of the four prepositions implied an interaction and two implied no physical interaction.

Two measures of learning were employed in the experiment: second noun recall and connective recall. Following presentation of the sixteen to-be-learned pairs, Ss were presented with the first noun of each pair one at a time and then attempted to write down the correct second noun. Next, Ss were presented with the original pairs minus the connective. Ss' task was then to attempt to fill in the original connective. Results from these two dependent measures were analyzed by means of two separate 2 x 3 x 4 x 4 analyses of variance. In addition the nested factor was analyzed by first eliminating the verb and conjunction conditions and then analyzing remaining 2 x 3 x 4 x 2 x 2 design. Thus the analysis of the nested factor involved

three between Ss variables: Grade (2 and 6), Type of Instruction (Imagery Training, Imagery Prompting, and No Training), and List (1, 2, 3, and 4), and two within Ss variables: Type of Connective (prepositions and verbs plus prepositions) and Nature of Implied Interaction (interacting prepositions and non-interacting prepositions).

Materials

The experimental materials consisted of the names of 94 objects or animals familiar to children. Four of these items were selected to form two practice pairs which were employed during the explanation of the paired associate procedure, ten of the items formed the five practice pairs employed during the first stage of instruction (i.e. Imagery Training, Imagery Prompting or No Training), and sixteen items were selected to form eight pairs which were used in the second stage of instruction. The materials employed for the instructional conditions are presented in the Appendix (Table 1). Since the actual to-be-learned materials were linked by one of four types of connectives (i.e. verb, preposition, conjunction, or verb plus preposition), the eight instructional pairs were also linked by these four connective types in order to familiarize Ss with the specific nature of the learning set items. Therefore, of the eight instructional pairs, two were linked by verbs, two were linked with prepositions, two with the conjunction "and", and the remaining two pairs were linked by a verb

plus a preposition. The order of these connectives was randomized among the eight instructional pairs, with two restrictions: (a) one type of connective did not appear twice in a row and; (b) connectives were fitted with pairs only if the resultant phrase was not semantically anamolous. Also the article "the" was inserted in front of each of the two nouns in order to increase the ease of reading of each phrase.

The procedure for the creation of the learning set items was the same as that used to generate the eight linked instructional pairs, except that in order to control for possible list specific effects four lists were formed (Appendix, Tables 2 - 5). These four lists were generated from the remaining 64 nouns plus eight words from each of the four connective categories (i.e. eight verbs, eight prepositions, and eight conjunctions). Each of the eight members from one connective category was unique with the exception of the conjunction links where, in every case, the conjunction "and" was employed. In addition, due to the limited number of familiar prepositions, prepositions used by themselves in one list were used as prepositions in the verb plus preposition condition in another list and vice versa. Thus, in fact, the learning set connectives consisted of one conjunction, eight prepositions, and sixteen verbs so arranged as to not overlap within one list and forming two independent sets of sixteen connectives (four of each type). In addition, in the preposition and verb plus preposition conditions, within each list two of these

prepositions implied a physical interaction (e.g., "on", "in", and "around") and two implied a distanced spatial relationship (e.g., "above, "below" and "under"). Lists 1 and 3 were created by randomly pairing 32 of the remaining 64 nouns. The same pairs were used in these two lists though these pairs were in a different order in each list. Similarly Lists 2 and 4 were created from the remaining 32 nouns and also contained indentical pairs. In addition, to further control for possible list specific effects, Lists 1 and 4 employed the same sixteen connectives. Lists 2 and 3 also employed sixteen connectives none of which appeared in Lists 1 and 4. All pairs employed in the experiments were created randomly with the restriction that obviously related items (e.g., pencil-eraser) were excluded.

Materials for the second noun recall consisted of the first noun of each pair plus a blank space for the Ss' response. Recall order was randomized relative to presentation order. Connective recall was tested after second noun recall and involved presenting Ss with the original learning set pairs (randomly) one at a time and asking them to fill in the missing connective in a provided space between the two nouns.

All learning, instructional, and recall materials were typed on 4 in. x 5 in. sheets of paper and formed into booklets (see Appendix, Table 6 for the format of the experimental booklets). Each Ss studied three different types of booklets. Booklet one contained the two demonstration pairs, two demonstration recall pages, five

unlinked instructional pairs, and eight linked instructional pairs. Booklet two contained the sixteen linked learning set pairs followed by the first noun of each pair and a blank space. Booklet three contained the sixteen original pairs minus the original connective. Noun pairs were typed in capitals, all other words were typed in lower case letters.

Procedure

In order to maximize E's control over the experimental testing session, Ss were tested in groups of four in a separate room during regular classroom periods. These four Ss represented one-third of the number of Ss tested in each of the six original Grade x Type of Instruction cells. Within each grade, one-third of the Ss in each of the three Type of Instruction conditions was tested before a second or third group of four Ss was tested. Thus a total of 72 Ss participated in the experiment and these Ss were tested in eighteen groups of four Ss each. Each of the four Ss in a particular testing session studied one of the four lists. Thus in each of the six between Ss cells of the design there were twelve Ss, three of which studied List 1, three List 2, three List 3, and three studied List 4. Since the requirement of 36 Ss per grade involved drawing Ss from two classes at each grade level, a testing group contained one male and one female from each of two classes. Assignment of lists to each of the four Ss in a testing group was latinized such that, for example, girls

from Class A did not always study List 1. That is, assignment of lists to Ss was latinized with respect to Ss' sex and homeroom class. Ss were called to the testing room alphabetically with the restriction that a testing group contained one male and one female from each class.

In the testing room Ss were seated beside one another at a long table facing E. E sat about four feet in front of and facing the Ss behind another table. Following E's introduction of himself, Ss were told they were going to participate in a "game" to see how much they can remember (for the 6th Grade Ss the word "experiment" was substituted for the word "game"). Ss were assured that their performance bore no relation to their report card marks (See Appendix, Table 7 for the Introduction and General Paired-Associate Instructions).

The experimental procedure consisted of six parts. Part 1 involved an explanation of the paired associate task. In order to familiarize Ss with the procedure they were presented with two practice pairs for fifteen seconds each. Next they viewed the first noun of each of these pairs and attempted to write down the correct second noun. Part 2 began with instruction in the type of learning procedure to be employed by Ss in a particular group. One-third of the Ss were given a brief training session in the use of interacting imagery mnemonics (See Appendix, Table 8). Ss in this condition were asked to imagine the two members of each pair as "playing together". Five seconds after Ss read each pair E suggested a

possible interaction for the two items. One-third of the Ss within each grade received imagery prompting instructions (See Appendix, Table 9). These Ss were asked to think of pictures of the two nouns on each page. The remaining Ss received no special training (See Appendix, Table 10). They were merely told that the Part 2 pairs were examples of the type of pairs to follow. Part 3 of the experimental procedure served two purposes: (a) it familiarized Ss with the exact nature of the learning set items and (b) it ensured that Ss were familiar with the learning procedure they were to attempt to employ. Therefore, Imagery Trained Ss were asked to picture the two nouns of each sentence and interact these images. Imagery Prompted Ss were asked to think of a picture of the two nouns in the sentence, and Ss in the No Training condition were merely asked to read the sentence.

Following presentation of the thirteen practice items Ss were reminded of the learning procedure they were to attempt to employ and then were presented with the actual to-be-learned materials (Part 4). Due to differences in reading ability between the grade two and six students the grade two's studied each of the sixteen linked pairs for twenty seconds while the grade six Ss were given only fifteen seconds for each page. E paced the Ss by asking them to "turn the page" at appropriate intervals.

Part 5 of the experimental procedure followed the second noun recall session and required Ss to read the first noun of each pair

one at a time and then to attempt to write down the correct second noun. Sixth grade Ss were given fifteen seconds per page while grade two Ss proceeded to subsequent pages every twenty seconds. Complete second noun recall instructions are provided in the Appendix (Table 11).

After second noun recall was tested the Ss were given a third booklet containing the original pairs minus the original connective(s) (Part 6). They were then instructed to try to write down the word or words which they recall went between the two nouns on each page (see Appendix, Table 12). Once again grade two Ss were given twenty seconds per page and grade six's were given fifteen seconds per page. During both second noun and connective recall testing Ss were encouraged to guess. Some examples of the types of practice, learning, and recall materials employed in the experiment are provided in Table 2.

Following the testing session Ss were given a brief explanation of the purposes of the experiment and then returned to their classrooms.

TABLE 2

Examples of the Type of Practice, Learning, and Recall Materials Employed in the Experiment

I. Example of Paired Associate Demonstration Pairs

Presentation	AIRPLANE	THIMBLE
Recall	AIRPLANE	_____

II. Example of Phrase I Training, Prompting, or Practice Pairs

Presentation	RULER	STRING

III. Examples of Each of the Four Types of Linked Training, Prompting or Practice Pairs

Presentation:	Preposition	1. The FLY above the ASHTRAY
	Conjunction	2. The PLATE and the COMB
	Verb	3. The ALLIGATOR splashes the FLOWER
	Verb plus Preposition	4. The HAIRCLIP rusts within the JUG

IV. Examples of the Four Types of to-be-Learned Pairs

Presentation:	Preposition	1. The ELASTIC around the BOOK
	Conjunction	2. The BRACELET and the CAR
	Verb	3. The BIRD smashes the WHISTLE
	Verb plus Preposition	4. The BULL runs under the FLAG
Recall:		1. BIRD _____
		2. ELASTIC _____
		3. ALLIGATOR _____
		4. HAIRCLIP _____

V. Example of Presentation for Connective Recall

The BIRD _____ the WHISTLE

RESULTS

The independent variables were: Grade (2 vs 6), Type of Training (Imagery Training vs Imagery Prompting vs No Training), List (1 vs 2 vs 3 vs 4), and Type of Connective (Prepositions vs Conjunctions vs Verbs vs Verbs plus Prepositions) with a fifth variable (Nature of Implied Interaction - Interacting versus Non-Interacting) nested within the Preposition and Verb plus Preposition conditions. The Training, List, and Grade variables were analyzed between Ss and the Connective and Nature of Implied Interaction variables were analyzed within Ss.

Two dependent variables were employed in the experiment: second noun recall and connective recall. For each dependent variable two separate analyses of variance were performed. The first analysis involved collapsing over the Nature of Implied Interaction while the second included this variable but dropped the Verb and Conjunction connective categories. The results of the former two analyses (i.e., one for second noun recall and one for connective recall) are presented under Design 1 and the latter pair of analyses are presented in Design 2.

Presentation of the results of these four analyses occasionally includes the reporting of F ratios with $.05 < p < .075$ rather than the usual $p < .05$. The reason for the selection of this unusually high alpha level was because two vital interactions emerged with $p < .075$.

Due to the importance of these predicted interactions in interpreting the results of the experiment, a decision was made to subject all F ratios with $p < .075$ to subsequent post hoc analysis. In fact, as follows in the results section, most of the predicted pairwise comparisons were found within these two marginal interactions and many of these comparisons were associated with satisfactorily small probabilities, e.g., $p < .01$.

A. Second Noun Recall

Ss responses in the test of second noun recall were scored by a loose criterion method such that synonyms of the appropriate responses and misspelled words were counted as correct.

1. Design 1 - Grade x Type of Training x List x Type of Connective

The mean number of second nouns correctly recalled in each cell of the Design 1 analysis are presented in Table 3. For the purposes of this analysis, scores in the P and V+P conditions were collapsed over the two levels of the Nature of Implied Interaction variable. Thus, since each S studied sixteen pairs of nouns, a maximum score of four was possible for each of the four types of connectives. Results from the analysis of variance performed upon the second noun recall scores are presented in the Appendix (Table 13).

Grade emerged as a significant source of variation, $F(1, 48) = 4.09$, $p < .05$. Grade 6 Ss correctly recalled significantly more of the second nouns than did the Grade 2 Ss. The Grade variable was

TABLE 3

Mean Number of Second Nouns Correctly
Recalled in Each Cell of Design 1 - 2 x 3 x 4 x 4

			Prepositions	Conjunctions	Verbs	Verbs plus Prepositions
GRADE 2	Imagery Training	List 1	0.67	0.33	1.33	1.33
		List 2	0.67	0.67	1.00	2.00
		List 3	0.67	1.00	1.00	0.33
		List 4	1.33	0.67	0.67	1.00
	Imagery Prompting	List 1	0.33	0.33	0.33	1.00
		List 2	2.00	1.00	1.00	2.33
		List 3	1.33	1.00	1.00	1.33
		List 4	1.33	0.33	1.33	1.33
	No Training	List 1	0.67	0.33	0.67	0.33
		List 2	0.33	0.67	1.00	0.67
		List 3	0.67	0.67	0.67	1.00
		List 4	1.00	0.00	0.67	0.33
GRADE 6	Imagery Training	List 1	0.67	0.67	0.67	1.00
		List 2	1.00	2.00	2.00	2.00
		List 3	2.00	1.33	1.33	1.67
		List 4	0.67	0.67	1.33	1.00
	Imagery Prompting	List 1	2.67	1.00	1.67	1.33
		List 2	0.67	0.67	1.33	3.33
		List 3	0.67	0.33	0.33	1.67
		List 4	2.33	1.33	2.67	2.67
	No Training	List 1	1.67	0.67	0.67	0.67
		List 2	0.33	0.33	0.67	1.33
		List 3	0.33	1.67	1.00	0.67
		List 4	0.00	0.00	1.00	0.33

not involved in any significant interactions suggesting that children of both age groups possessed the required skills to learn noun pairs under the various experimental conditions. That is, although grade 2 Ss performed at a lower level than grade 6 Ss, the fact that this difference did not interact with other variables suggests that the younger Ss were merely less efficient in utilizing the same learning skills possessed by the sixth grade Ss. Possible explanations for the overall superior performance of the older Ss might be improved reading skills or an increased ability to attend to the task. Since the purpose for the inclusion of the age manipulation in the current research was to test for developmental changes in learning strategies and since no such differences emerged no further discussion of the main effect of Grade will be undertaken.

Type of Connective also emerged as a significant source of variation, $F(3, 144) = 5.10$, $p < .01$. Subsequent analysis of this main effect by the Newman-Keuls procedure (Appendix, Table 14) revealed three significant pairwise comparisons. First, in agreement with previous work, noun pairs linked by Verbs were significantly better recalled than were Conjunction linked pairs ($p < .055$). Secondly also consistent with past research, Prepositions gave higher recall scores than Conjunctions ($p < .055$). Thirdly, the combination of Verbs plus Prepositions also gave superior second noun recall relative to Conjunctions ($p < .01$). Thus the overall pattern of recall facilitation obtained with each of the four types of connectives was

$C < P = V = V+P$. These results are consistent with previous research except that unlike Rehwer et. al. (1967) no Verb over Preposition superiority was found in the current research. Since the main effect of Connective interacted with Type of Training further discussion of the Connective effect must await presentation of this interaction.

The main effect of Connective was somewhat qualified by a significant interaction with List, $F(9, 144) = 2.10$, $p < .05$. Subsequent analysis of simple main effects (see Appendix, Table 15) revealed a significant difference among the four types of connectives for Lists 2 and 4 only. Further analysis by the Newman-Keuls procedure showed that for List 2 the connective pattern was $V+P > V = P = C$, whereas for List 4 the pattern was $V+P = V = P > C$. Despite the failure to reach significant levels the trend of the connective pattern for Lists 1 and 3 was identical to that found in List 4 (see List x Connective summary table in the Appendix, Table 15).

Type of Training also emerged as a significant source of variance, $F(2, 48) = 6.79$, $p < .01$. Subsequent analysis by the Newman-Keuls procedure (Appendix, Table 16) revealed that Ss in the No Training condition performed significantly poorer than either the Imagery Training ($NT < IT$, $p < .05$) or Imagery Prompting ($NT < IP$, $p < .01$) Ss. No significant differences were found between the performance of Ss given these latter two types of training.

Presentation of the results of the analysis of Design 1 now turns to a most important interaction, involving Connective and

Training, $F(6, 144) = 1.92$, $p < .075$. The mean number of second nouns correctly recalled in each of the twelve Training x Connective cells are presented in Table 4. In addition a graphical presentation of this interaction is provided in Figure 1. Two approaches to a statistical simplification of the Training x Connective interaction were undertaken. First, from the point of view of a comparison among connectives for each type of training, analysis of simple main effects (Appendix, Table 17) revealed no significant differences among the connectives for either the Imagery Training ($F(3, 144) = 1.07$) or No Training ($F(3, 144) = 0.37$) Ss. However for the Imagery Prompting Ss a significant effect of Type of Connective was obtained, $F(3, 144) = 7.49$, $p < .01$. Subsequent pairwise comparisons by the Newman - Keuls procedure showed that for Ss trained in Imagery Prompting, Conjunction connectives were significantly less facilitative than those of any other category (i.e. $C < P$, $p < .055$; $C < V$, $p < .055$; and $C < V+P$, $p < .01$). Furthermore the facilitative effect of Verb plus Preposition connectives was significantly greater than any other type of connective (i.e. $V+P > C$, $p < .01$; $V+P > P$, $p < .05$; and $V+P > V$, $p < .055$). Prior to relating these results to the experimental predictions the results of the same Training x Connective interaction will now be presented from the point of view of a comparison among training procedures for each of the four types of connectives (Appendix, Table 18). For noun pairs linked by Conjunctions no significant differences were found among the three types of training, $F(2, 144) = 0.92$. Similarly

TABLE 4

Mean Number of Second Nouns Correctly Recalled in Each Cell of the Design 1 Training x Connective Interaction

	Prepositions	Conjunctions	Verb	Verbs plus Prepositions
Imagery Training	0.96	0.92	1.17	1.29
Imagery Prompting	1.42	0.75	1.21	1.88
No Training	0.63	0.54	0.79	0.67

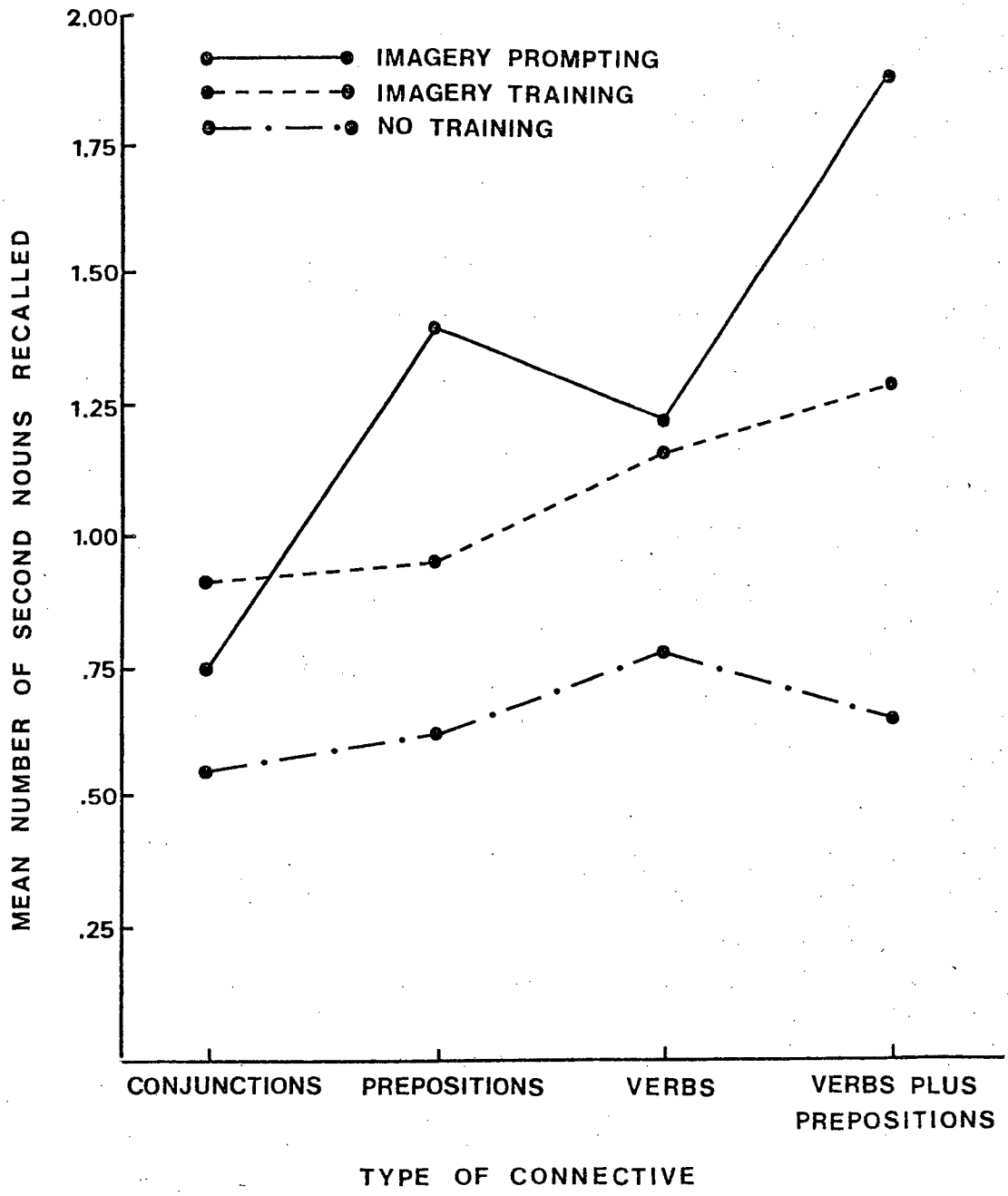

FIG. 1. Graphical Representation of the Type of Training x Type of Connective Interaction in the Design 1 Analysis of Second Noun Recall

for Verb linked pairs no significant differences among training procedures were obtained, $F(2, 144) = 1.38$. However for noun pairs linked by Prepositions a significant effect of training was obtained, $F(2, 144) = 4.14$, $p < .05$. Subsequent Newman-Keuls analysis determined that for Preposition linked noun pairs Imagery Prompting was significnatly more facilitative than No Training with the performance of Imagery Training Ss falling roughly in the middle of the other two training conditions. A significant effect of training was also found for those pairs linked by Verb plus Preposition connectives, $F(2, 144) = 9.56$, $p < .01$. Subsequent Newman-Keuls analysis of this simple main effect revealed Imagery Prompting to give maximum performance (i.e., IP > IT, $p < .05$; and IP > NT, $p < .01$), Imagery Training to give intermediate recall (IT > NT, $p < .05$), and No Training to be significantly poorer than the other two training conditions.

To summarize, the results of the analysis of the Training x Connective interaction revealed the following results. No significant differences were found across connectives for either the Imagery Training or No Training Ss. However, for the Imagery Prompting Ss, a differential pattern of connectives was obtained such that Conjunctions gave the poorest second noun recall, Verbs and Prepositions resulted in intermediate performance, and the combination of Verbs plus Prepositions gave significantly superior recall relative to the other three types of connectives. A comparison among training procedures for each of the four types of connectives revealed no signif-

icant differences among types of training for either the Conjunction or Verb linked noun pairs. However, for noun pairs linked by Prepositions, significant differences among training procedures were obtained such that Ss in the No Training condition performed significantly poorer than Imagery Prompting Ss. Performance of the Imagery Training Ss in combination with Preposition links fell between that of the other two training procedures. A similar pattern of training was obtained for noun pairs linked by Verbs plus Prepositions. Imagery Prompting was most effective with V+P links, Imagery Training gave intermediate recall, and the No Training condition was significantly poorer than either of the other two types of training.

Due to the complexity of these findings and the importance of the results from the Design 2 analysis (especially the effects of the Nature of Implied Interaction variable), no interpretation of the Training x Connective effect will be undertaken until the entire second noun recall results have been presented.

2. Design 2 - Grade x Type of Training x List x Type of Connective x Nature of Implied Interaction

The mean number of second nouns correctly recalled in each cell of Design 2 are presented in Table 5. Results from the 2 x 3 x 4 x 2 x 2 analysis of variance performed upon these data are presented in the Appendix (Table 19). Since the Design 2 analysis merely involved dropping the Verb and Conjunction connective conditions and partitioning the Preposition and Verb plus Preposition conditions

TABLE 5

Mean Number of Second Nouns Correctly Recalled in Each Cell of Design 2

			Prepositions		Verbs plus Prepositions	
			Interacting	Non-Interacting	Interacting	Non-Interacting
GRADE 2	Imagery Training	List 1	0.33	0.33	1.00	0.33
		List 2	0.00	0.67	1.00	1.00
		List 3	0.33	0.33	0.33	0.00
		List 4	0.33	1.00	0.33	0.67
	Imagery Prompting	List 1	0.33	0.00	0.67	0.33
		List 2	1.33	0.67	1.33	1.00
		List 3	1.00	0.33	0.33	1.00
		List 4	0.67	0.67	0.33	1.00
	No Training	List 1	0.33	0.33	0.00	0.33
		List 2	0.33	0.00	0.33	0.33
		List 3	0.67	0.00	0.33	0.67
		List 4	0.67	0.33	0.33	0.00
GRADE 6	Imagery Training	List 1	0.33	0.33	1.00	0.00
		List 2	0.67	0.33	1.00	1.00
		List 3	1.00	1.00	1.00	0.67
		List 4	0.33	0.33	0.33	0.67
	Imagery Prompting	List 1	1.33	1.33	0.67	0.67
		List 2	0.33	0.33	1.67	1.67
		List 3	0.67	0.00	0.33	1.33
		List 4	1.33	1.00	1.67	1.00
	No Training	List 1	0.33	1.33	0.33	0.33
		List 2	0.00	0.33	0.33	1.00
		List 3	0.00	0.33	0.33	0.33
		List 4	0.00	0.00	0.33	0.00

into two separate parts (i.e. Interacting Prepositions and Non - Interacting Prepositions), many of the effects obtained in this analysis were already analysed in Design 1. Therefore presentation of the results from the analysis of Design 2 focuses upon those results not already extracted from Design 1. For the sake of completeness, simple main effects and Newman - Keuls analysis of those findings overlapping with Design 1 are presented in the Appendix (Tables 20, 21, and 22).

The only unique outcome of the Design 2 analysis of second noun recall was a most important three - way interaction of Training x Connective x Nature of Implied Interaction, $F(2, 48) = 2.68$, $p < .075$. The mean number of second nouns correctly recalled in each of the twelve Training x Connective x Implied Interaction cells are presented in Table 6. In addition a graphical presentation of this Interaction is provided in Figure 2.

Several different approaches to a statistical simplification of this three - way interaction were undertaken. First, and most important, two analyses of simple main effects were performed on the Implied Interaction x Training interactions; one analysis for Prepositions and one analysis for Verbs plus Prepositions. Both of these analyses were conducted from the point of view of a comparison of Interacting versus Non - Interacting connectives for each type of training (Appendix, Tables 23 and 24). The results from the simple main effects analysis conducted on Prepositions is presented first. Neither the No Training ($F(1, 48) = 0.06$) nor the Imagery Training

TABLE 6

Mean Number of Second Nouns Correctly Recalled in Each Type of Training x Type of Connective x Nature of Implied Interaction Cell Averaged Over List and Grade - Design 2 (Second Noun Recall)

	Prepositions		Verbs plus Prepositions	
	Interacting	Non-interacting	Interacting	Non-interacting
IT	0.42	0.54	0.75	0.54
IP	0.88	0.54	0.88	1.00
NT	0.29	0.33	0.29	0.38

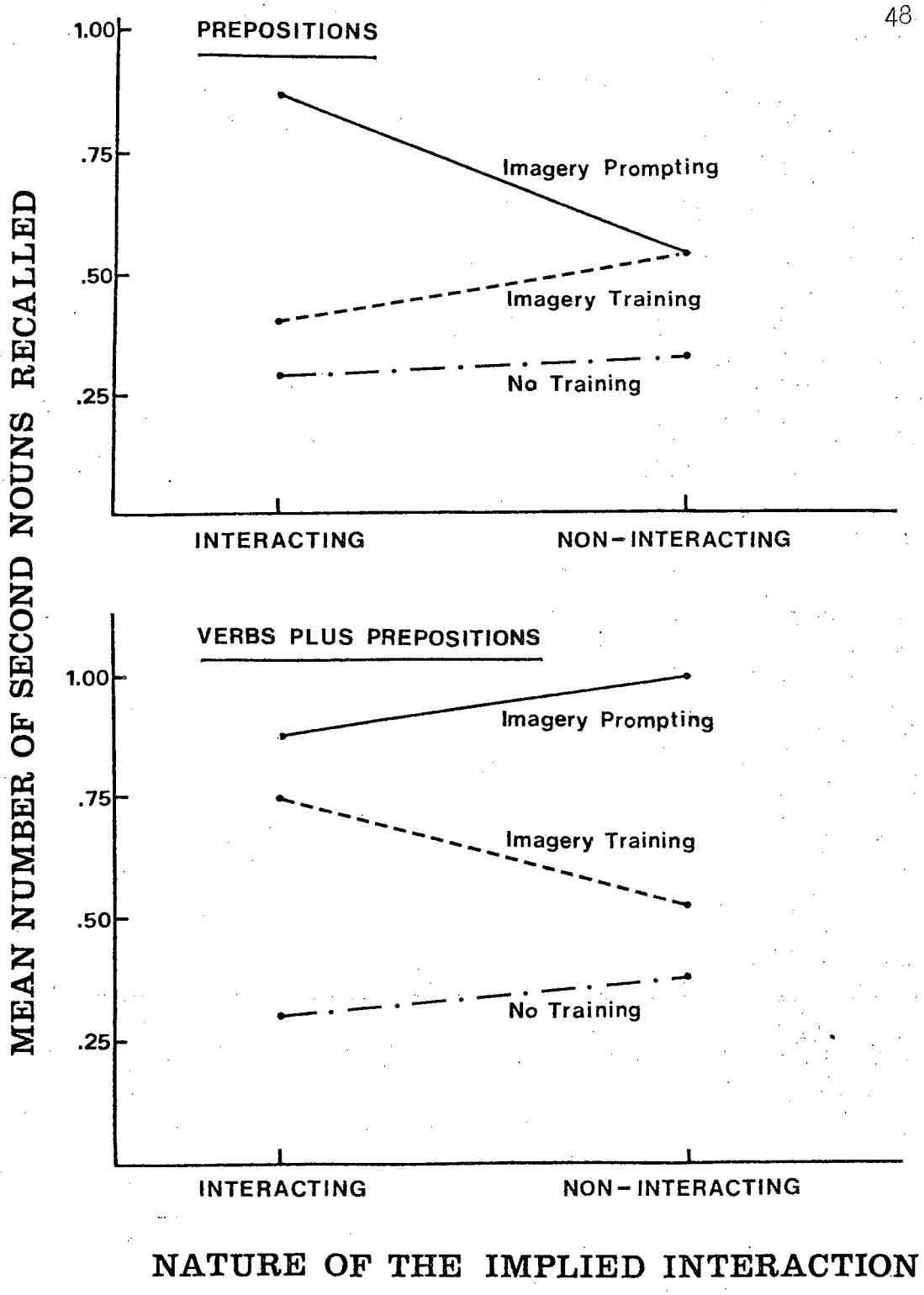

FIG. 2. Graphical Representation of the Nature of Implied Interaction x Type of Training x Type of Connective Interaction in the Design 2 Analysis of Second Noun Recall

($F(1, 48) = 0.53$) Ss showed significant differences in their second noun recall of pairs linked by Interacting versus Non-Interacting Prepositions. However, for the Imagery Prompting Ss significantly more pairs linked by Interacting Prepositions were recalled relative to pairs linked by Non-Interacting Prepositions. Consistent with the results of the Design 1 analysis, these results show differential connective facilitation (in favor of interacting links) only for those Ss given Imagery Prompting instructions.

For noun pairs linked by Verb plus Preposition connectives, no difference was obtained with respect to the Nature of Implied Interaction variable for any of the three types of training. Inconsistent with the experimental predictions, Verbs plus Interacting Prepositions did not result in higher second noun recall relative to Verbs plus Non-Interacting Prepositions.

In order to further clarify the Implied Interaction x Connective x Training interaction, four analyses of simple main effects were performed to compare the relative effectiveness of the training procedures for each of the four types of connectives (i.e., Interacting Prepositions, Non-Interacting Prepositions, Verbs plus Interacting Prepositions, and Verbs plus Non-Interacting Prepositions). Results from these analyses are presented in the Appendix (Table 25). For Interacting Prepositions a significant effect of Training was obtained, $F(2, 48) = 6.45$, $p < .01$. Subsequent Newman-Keuls analysis of this effect showed Imagery Prompting to result in significantly higher

recall than Imagery Training (IP > IT, $p < .05$) or No Training (IP > NT, $p < .05$) with no significant difference between these latter two conditions. For Non - Interacting Prepositions no significant differences were found among the three types of training, $F(2, 48) = 0.99$.

Turning now to the two Verb plus Preposition conditions, for Verbs plus Interacting Prepositions significant differences were found among the three training conditions ($F(2, 48) = 6.46$, $p < .01$) such that the Imagery Prompting and Imagery Training conditions gave equal performance and both were superior to the No Training condition (i.e. IP = IT > NT, $p < .05$). For Verbs plus Non - Interacting Prepositions significant differences were also found among the three types of training, $F(2, 48) = 7.17$, $p < .01$. Subsequent Newman - Keuls analysis of this effect revealed Imagery Prompting to result in superior second noun recall relative to Imagery Training or No Training with no significant difference between these latter two conditions (i.e. IP > IT = NT, $p < .05$).

To summarize, the results of the analysis of the Implied Interaction x Connective x Training interaction were as follows. Interacting and Non - Interacting Prepositions resulted in equal second noun recall for both Imagery Training and No Training Ss, however, for Ss in the Imagery Prompting condition recall was significantly higher with Interacting as opposed to Non - Interacting Prepositions.

Verb plus Interacting Preposition and Verb plus Non - Interacting Preposition links gave equal second noun recall for each of the three types of training. From the point of view of a comparison among training procedures for each connective, no significant differences were found among the three types of training for noun pairs linked by Non - Interacting Prepositions. However for pairs linked by Interacting Prepositions a significant effect of training was found such that Imagery Prompting gave superior recall to either Imagery Training or No Training with these latter two conditions resulting in equal performance. For Verbs plus Non - Interacting Prepositions an identical pattern of results to that found with Interacting Prepositions was obtained (i.e. IP > IT = NT), however for Verb plus Interacting Preposition linked pairs both Imagery Prompting and Imagery Training gave superior recall to No Training.

Following a brief presentation of the connective recall analysis a complete summary of the Designs 1 and 2 second noun recall analysis will be provided.

B. Connective Recall

The outcome of the connective recall analysis will be presented only briefly and will largely serve to confirm or weaken hypotheses forwarded on the basis of the second noun recall results. The reasons for the de-emphasis of the connective recall results are as follows.

First, because all four connectives in the Conjunction condition were "and" (while unique connectives were employed in the other three connective conditions), the connective recall scores for the Conjunction links are extremely unreliable due to the increased probability of Ss obtaining a correct response by guessing. This unreliability is further increased due to a tendency on the part of Ss to frequently guess "and" as the correct response. Second, because correct recall of Verb plus Preposition links required the Ss to recall two words rather than one, the performance in this condition is, presumably, artificially deflated. Third, since it was necessary to adopt an unusually strict scoring procedure (because many synonyms of the correct connectives occurred elsewhere in the learning materials) the recall of Preposition links may have been lowered relative to the Verb link recall because most of the synonyms employed were of the Prepositions rather than of the Verbs. That is, due to the limited number of prepositions available in English (relative to the large number of verbs) it was necessary to employ synonyms of prepositions (e.g., "under" and "below") in the learning set whereas all the verbs employed were relatively unique. Thus a strict scoring procedure would be more likely to favor Verb rather than Preposition recall because of the greater response competition for the Preposition links.

1. Design 1 - Grade x Type of Training x List x Type of Connective

The mean number of connectives correctly recalled in each cell of the Design 1 analysis are presented in Table 7. Results from the

TABLE 7

Mean Number of Connectives Correctly Recalled in Each Cell of Design 1 - 2 x 3 x 4 x 4 - Grade x Training x List x Connective

			P	C	V	V+P
GRADE 2	Imagery Training	List 1	0.00	1.33	1.33	0.33
		List 2	0.33	1.00	2.00	0.00
		List 3	0.67	0.33	0.67	0.67
		List 4	0.67	3.00	1.00	0.67
	Imagery Prompting	List 1	1.33	1.00	1.33	0.67
		List 2	0.00	3.33	2.67	1.00
		List 3	0.67	1.67	0.67	0.67
		List 4	0.33	0.33	0.33	0.33
	No Training	List 1	0.33	3.00	1.00	0.00
		List 2	0.33	1.00	1.33	0.00
		List 3	0.67	1.67	0.67	0.67
		List 4	0.33	0.67	2.00	0.33
GRADE 6	Imagery Training	List 1	2.00	0.67	1.67	0.33
		List 2	0.33	2.33	2.00	1.00
		List 3	0.67	0.00	1.33	0.33
		List 4	1.00	1.00	1.00	0.67
	Imagery Prompting	List 1	1.00	2.00	1.33	1.00
		List 2	0.00	1.00	3.00	0.33
		List 3	1.00	1.67	1.00	0.67
		List 4	1.33	2.33	2.00	0.33
	No Training	List 1	0.00	1.00	1.67	0.67
		List 2	0.33	0.67	1.00	0.33
		List 3	0.33	1.67	1.33	0.33
		List 4	0.33	1.67	0.67	0.00

analysis of variance performed upon these data are presented in the Appendix (Table 26).

Unlike the second noun recall analysis Grade did not emerge as a significant source of variation in the connective recall analysis, $F(1, 48) = 0.56$. One tentative conclusion based on this result is that the superior second noun recall of the older Ss does not reflect their greater attention to the E-supplied connectives. Beyond this simple conclusion no interpretation of this result will be attempted.

Type of Training emerged as a significant source of variation, $F(2, 48) = 3.27$, $p < .05$. Subsequent analysis by the Newman-Keuls procedure (Appendix, Table 27) revealed only one significant pair-wise comparison: Imagery Prompting resulted in higher connective recall than No Training ($p < .05$) with Imagery Training falling between the other two conditions. The performance of the Imagery Prompting Ss is consistent with their training in that instruction to generate separate images, combined with an E-supplied link, would be expected to result in maximum connective recall relative to Ss trained to form their own links (i.e., Imagery Training) or Ss not prompted to generate images (i.e., No Training). Further discussion of this Training effect will follow the presentation of Design 2 connective recall analysis.

Type of Connective emerged as a significant effect, $F(3, 144) = 23.93$, $p < .01$. Subsequent Newman-Keuls analysis (Appendix, Table 28) showed Conjunction and Verb links to be equally well recalled rela-

tive to each other and to be better recalled than either Preposition of Verb plus Preposition connectives with recall of these latter two links not differing significantly (i.e., C = V > P = V+P). Due to the problems involved in comparing these connectives (as discussed in the introduction to the connective recall results) no interpretation of this outcome is provided.

The other three significant sources of variation in the Design 1 connective recall analysis all involved the List variable: List x Connective, $F(9, 144) = 2.02$, $p < .05$; Grade x Training xList, $F(6, 48) = 2.88$, $p < .05$; and Grade x Training x Connective x List. A breakdown of the List x Connective interaction by analysis of simple main effects (Appendix, Table 29) revealed a significant difference among lists for the verb linked pairs only, $F(3, 144) = 4.48$, $p < .01$. Subsequent Newman-Keuls analysis showed that for Verb linked pairs List 2 > List 3 = List 1 = List 4. Statistical analysis of the other two interactions involving the list variable revealed no systematic interpretable effects.

2. Design 2 - Grade x Type of Training x List x Type of Connective x Nature of Implied Interaction

The mean number of connectives correctly recalled in each cell of the Design 2 analysis are presented in Table 8. Results from the analysis of variance performed upon these data are presented in the Appendix, Table 30). Aside from a main effect of Training ($F(2, 48) = 4.19$, $p < .05$), which is analyzed in the Appendix (Table 31)

TABLE 8

Mean Number of Connectives Correctly Recalled in Each Cell of Design 2 - 2 x 3 x 4 x 2 x 2

			Prepositions		Verbs plus Prepositions	
			Interacting	Non-Interacting	Interacting	Non-Interacting
GRADE 2	Imagery Training	List 1	0.00	0.00	0.33	0.00
		List 2	0.33	0.00	0.00	0.00
		List 3	0.33	0.33	0.67	0.00
		List 4	0.67	0.00	0.00	0.67
	Imagery Prompting	List 1	1.00	0.33	0.33	0.33
		List 2	0.00	0.00	1.00	0.00
		List 3	0.33	0.33	0.67	0.00
		List 4	0.33	0.00	0.00	0.33
	No Training	List 1	0.33	0.00	0.00	0.00
		List 2	0.00	0.33	0.00	0.00
		List 3	0.33	0.33	0.67	0.00
		List 4	0.33	0.00	0.33	0.00
GRADE 6	Imagery Training	List 1	1.67	0.33	0.00	0.33
		List 2	0.00	0.33	1.00	0.00
		List 3	0.33	0.33	0.33	0.00
		List 4	0.67	0.33	0.33	0.33
	Imagery Prompting	List 1	0.67	0.33	0.33	0.67
		List 2	0.00	0.00	0.33	0.00
		List 3	1.00	0.00	0.33	0.33
		List 4	1.00	0.33	0.33	0.00
	No Training	List 1	0.00	0.00	0.33	0.33
		List 2	0.00	0.33	0.33	0.00
		List 3	0.33	0.00	0.33	0.00
		List 4	0.33	0.00	0.00	0.00

all other significant effects in Design 2 were unique to this analysis.

Nature of Implied Interaction emerged as an significant source of variation, $F(1, 48) = 16.25$, $p < .01$. Ss correctly recalled significantly more of the connectives which suggested an interaction between the two nouns (i.e., Interacting Prepositions and Verbs plus Interacting Prepositions) relative to connectives which implied a non-interacting relationship (i.e., Non-Interacting Prepositions and Verbs plus Non-Interacting Prepositions).

This result was somewhat qualified by a significant Implied Interaction x List x Connective interaction, $F(3, 48) = 5.99$, $p < .01$. Results from subsequent simple main effects analysis of this interaction are presented in the Appendix (Table 32). A general summary of the outcome of these post hoc analyses is as follows: interacting links were either better or equally well recalled relative to non-interacting links and this effect interacted with List such that for Lists 1 and 4 Interacting Prepositions were better recalled than Non-Interacting Prepositions whereas for Lists 2 and 3 Verbs plus Interacting Prepositions were better recalled than Verbs plus Non-Interacting Prepositions.

Due to the complexity of the second noun and connective recall results a summary of the important findings is now presented.

SUMMARY OF RESULTS

List effects, interdesign replications, and unreliable findings (e.g., the connective comparison for connective recall) will be omitted from this summary since these findings were already dealt with in the Results section. This summary focuses upon only those results to be interpreted in the Discussion.

A. Connective Recall

The comparison among training procedures for the connective recall showed Imagery Prompting to result in superior recall relative to No Training with Imagery Training falling between these other two conditions. In addition, Ss recall of connectives which implied a physical interaction of the two items was significantly higher than their recall of connectives which implied a distanced spatial relationship.

B. Second Noun Recall

Since all significant main effects which emerged in the second noun recall analysis were involved in one of two significant interactions, presentation of the second noun recall results summary will report the breakdown of these interactions.

From the point of view of a comparison among connectives for each training procedure neither the Imagery Training nor the No Training

Ss performed better with any one type of connective relative to any other. However for the Imagery Prompting Ss results from Design 1 showed Conjunction linked pairs to be significantly poorer recalled than Verb or Preposition linked pairs which in turn were not as well recalled as Verbs plus Preposition linked pairs. Furthermore, as shown in Design 2, Imagery Prompting Ss recalled significantly more pairs linked by Interacting Prepositions than by Non-Interacting Prepositions. This greater recall, on the part of Imagery Prompting Ss, for pairs linked by interaction suggesting links was a major finding of the current research. Unexpectedly, no significant difference was found between the second noun recall of Verb plus Interacting Preposition and Verb plus Non - Interacting Preposition linked pairs.

From the point of view of a comparison among training procedures for each connective no significant differences were found among the three types of training for noun pairs linked by Conjunctions or Verbs. However for Preposition and Verb plus Preposition linked pairs significant differences among types of training were obtained. Specifically for noun pairs linked by Interacting Prepositions, Ss given Imagery Prompting recalled significantly more second nouns than either the Imagery Training or No Training Ss who did not differ. For noun pairs linked by Non - Interacting Prepositions no significant differences in second noun recall were obtained across the three types of training. For Verb plus Interacting Preposition linked pairs both Imagery Prompting and Imagery Training Ss performed

equally well and superior to No Training Ss. Finally for noun pairs linked by Verbs plus Non-Interacting Prepositions Imagery Prompting gave superior recall to Imagery Training and No Training which did not differ significantly.

DISCUSSION

The lack of any sentence facilitation effect among those Ss in the No Training condition was one of the more unexpected outcomes of the current research. The Design 1 analysis of second noun recall scores showed the untrained Ss to demonstrate equal performance regardless of whether noun pairs were linked by prepositions, verbs, conjunctions, or verbs plus prepositions. Similarly, as shown in the Design 2 second noun recall analysis, Ss in the No Training condition recalled roughly equal numbers of pairs linked by interacting prepositions, non-interacting prepositions, verbs plus interacting prepositions, and verbs plus non-interacting prepositions. The current failure to replicate the sentence facilitation effect is inconsistent with the majority of past research on children's linked noun pair learning (c.f., Davidson and Adams, 1970; Rohwer, 1966; Rohwer, 1967; Rohwer et. al., 1967; and Suzuki and Rohwer, 1968). The aforementioned researchers all found verb linked noun pairs to be better recalled than noun pairs linked by conjunctions. Furthermore, Rohwer et. al. (1967) found preposition linked noun pairs to be better recalled than conjunction linked pairs, although prepositions did not facilitate second noun recall as much as verbs. Nonetheless, despite the frequency with which the sentence facilitation effect has been reported, the current research is not alone in failing to obtain it. Davidson, Schwenn and Adams (1970), Yuille and Pritchard (1969), Levin (1970a),

and Levin, Kaplan, and Horvitz (1971) also failed to find children's recall of verb linked pairs to be any greater than their recall of noun pairs linked by conjunctions.

Based on the two current theoretical explanations of the sentence facilitation effect (i.e., Rohwer's 1970 semantic elaboration hypothesis and Yuille's 1973 interacting imagery hypothesis) it is possible to generate four alternative explanations for the failure of this and other experiments to replicate the sentence facilitation phenomenon. First, from a semantic elaboration point of view two alternatives are possible: either (a) Ss failed to generate semantic elaborations for the pairs despite the presence of links which are supposed to foster this process (i.e., verbs, prepositions, and verbs plus prepositions) or (b) Ss spontaneously generated semantic elaborations for pairs regardless of the nature of the connective. Second, from an interacting imagery framework two similar possibilities are suggested: either (a) Ss failed to generate interacting images for the pairs despite the presence of interaction suggesting links (i.e., verbs, interacting prepositions, and verbs plus interacting prepositions) or (b) Ss spontaneously generated interacting images for pairs regardless of the nature of the connective. In other words the equal second noun recall obtained (by some researchers) with various types of connectives reflects either spontaneous mediation of pairs regardless of the type of connective or no mediation despite the presence of links which usually prompt successful mediation.

Although, at first glance, these four alternatives may appear equally plausible one of them is more parsimonious than the others both on the basis of theoretical consistency and previous research. First, the proposal that the untrained Ss were spontaneously generating mediators (either imaginal or semantic) is highly unlikely simply because of their very low second noun recall scores. Previous studies of children's associate learning (e.g., Catchpole and Yuille, 1974) have found no evidence to suggest that children consistently generate spontaneous effective mediators for unlinked noun pairs. Therefore it seems unlikely that the conjunction linked pairs in the present experiment were mediated (either imaginally or verbally). In support of this argument, in no case has linking noun pairs with conjunctions resulted in higher second noun recall than a simple noun-noun type of presentation (c.f., Rohwer, 1966; Rohwer, Schwenn and Levin, 1967; and Suzuki and Rohwer, 1968). Given that little or no mediation occurred for conjunction linked pairs, and since performance of the untrained Ss for the other pair types was equally poor, mediation must have been absent (or minimal) in these cases as well. Thus, it seems clear that spontaneous mediation cannot account for the lack of a sentence facilitation effect in the untrained Ss.

The main argument against the third alternative, that the lack of a sentence facilitation among the No Training Ss reflects a failure (for some reason) to generate semantic elaborations, is that the elaboration hypothesis makes no allowance for failures to obtain the

sentence facilitation effect. In other words, the semantic elaboration hypothesis hinges on Ss performing better with verb (and to a lesser extent preposition) linked pairs as opposed to conjunction linked pairs, and the failure to obtain this result creates theoretical difficulty for the hypothesis. While it might be possible to modify the notion of semantic elaboration such that certain experimental conditions prevent it from occurring, no such modification suggests itself at this time. However, the fourth alternative, that the No Training Ss did not show a sentence facilitation effect due to a failure to generate interacting images even for those pairs linked by interaction suggesting connectives, can be shown to be consistent with the findings, as well as with other experimental evidence.

Perusal of past research on sentence embedded noun pair learning by children shows the sentence facilitation effect to occur in a more pronounced and consistent manner if the object referents are presented along with the printed linked noun pairs (e.g., Jensen and Rohwer, 1963, 1965) or if the pairs are presented in an aural rather than printed fashion (e.g., Levin, Kaplan, and Horvitz, 1971). If, however a purely printed presentation of the to-be-learned material is provided (e.g., Yuille and Pritchard, 1969) or if a printed plus aural presentation is provided (e.g., Levin et. al., 1971) then in several studies (including the present one) no sentence facilitation effect was obtained. While difficult to interpret from the point of view of semantic elaboration theory (why should these various manipulations affect genera-

tion of semantic overlaps) these results are consistent with the notion that the untrained Ss failed to generate interacting images. Combining the results of past and current research on children's linked noun pair learning it appears that the failure of printed types of presentation to result in a sentence facilitation effect may be due to the interference of this mode of presentation with the generation of imagery codes. In other words, reading linked noun pairs may occupy the visual system to a degree which interferes with (or even precludes) image formation. The notion that visual activity interferes with imagery processes has found empirical support in a number of studies. For example, both Atwood (1969) and Brooks (1968) reported poorer performance on imagery tasks when the visual system was otherwise occupied (e.g., reading, writing, or monitoring). This proposal is somewhat qualified since some researchers (e.g., Yuille, 1973) have found a sentence facilitation effect in a purely printed linked noun pair learning situation. Presumably the failure to obtain a sentence facilitation effect with printed presentation is a fairly consistent phenomenon which may be assuaged on occasion by various factors such as highly developed reading skills or, perhaps, a strong propensity to image presented nouns. The clarification of the conditions under which the sentence facilitation will occur given a printed presentation awaits further research. Three conditions which do consistently provide a sentence facilitation effect (though these do not involve a purely printed presentation) are simultaneous object referent presenta-

tion (e.g., Jensen and Rohwer, 1963), specific instructions to image presented noun pairs (i.e., the Imagery Prompting condition in this study), and an aural rather than printed presentation (e.g., Levin et. al., 1971). The reason for the consistent occurance of a sentence facilitation effect given any of the above manipulations, may be that each serves to circumvent the aforementioned image inhibitory effect of a printed presentation. That is, by avoiding presenting the linked noun pairs to the visual system an aural type of presentation may free the visual system for imagery coding. Similarly simultaneous object referent presentation or specific image generation instructions may function to ensure that Ss do form images of presented noun pairs. As stated by Paivio (1971) generation of separate images is vital to improved noun pair learning since without such coding, links which suggest an interaction will not result in interacting image generation because there will be no S-generated images to be interacted.

In summary it is proposed that the current failure to obtain a sentence facilitation effect among the untrained Ss reflects an inhibitory effect of printed presentation upon imaginal coding, and because this reading problem reduces image generation to such a large extent (in most cases), whether or not the E-supplied connective is suggestive of an interaction is unimportant since interacting images will not be formed. The trend among the No Training Ss to recall conjunction linked pairs slightly less readily than those linked by other types of connectives suggests that the image reduction effect of a

printed presentation may not have prevented imaginal coding entirely and, as indicated in some experiemnts, on occasion a significant sentence facilitation among printed linked noun pairs can be expected to occur. No explanation for the results of these experiemnts is provided though, presumably children with better reading skills would read more quickly and therefore the visual system might not be so likely to be fully occupied. In terms of implications for further research it is clear that successful imagery mediation is highly dependent on the nature of the presentation materials as well as Ss learning strategy and, therefore, future experimenters would be wise to carefully control these conditions.

The discussion of the results now turns to the performance of those Ss in the Imagery Training condition. In Design 1 it was found that Ss instructed to form interacting images of every noun pair correctly recalled equal numbers of pairs linked by verbs, conjunctions, prepositions, and verbs plus prepositions. Similarly results from Design 2 showed the Imagery Training Ss to perform equally well with pairs linked by interacting and non-interacting prepositions (alone or with verbs). Although these results appear consistent with the prediction that the Imagery Training Ss would show no differential facilitation across connectives (because they were forming their own interacting images), the results from the comparisons among training procedures for each type of connective dispute the notion that the Imagery Training Ss were, in fact, forming effective interacting images.

Unexpectedly and despite the frequent finding that Imagery Training is a powerful E-induced learning strategy (e.g., Yuille and Catchpole, 1973, 1974; Levin et. al., 1973; and Catchpole and Yuille, 1974), the performance of the Imagery Training Ss was not significantly superior to that of the No Training Ss in combination with any type of connective except verbs plus prepositions. Apparently, though a highly effective mnemonic for unlinked noun and object pair learning Imagery Training is ineffective in significantly improving children's learning of linked noun pairs. However, despite a failure to reach significant levels the Imagery Training Ss showed a strong and consistent trend towards higher recall relative to the No Training Ss in combination with every type of connective. In view of this strong, but not quite significant, superior performance of Imagery Training relative to No Training a definitive interpretation of these results is most difficult to generate. That is, on the one hand, since the Imagery Training Ss did not have significantly higher second noun recall than the No Training Ss it is difficult to support the idea that they were forming their own interacting imagery codes. While, on the other hand, because of the strong and consistent trend showing Imagery Training to be superior to No Training, it can not be argued that the Imagery Training Ss showed a lack of imagery coding equivalent to that of the untrained Ss. Therefore two alternative explanations will be provided which may help subsequent researchers clarify the utility of Imagery Training with linked noun pairs.

One interpretation of this finding may be that the Imagery

Training Ss failed to show significantly higher recall than the No Training Ss due to an interference between E-supplied and S-generated links. That is, because the Imagery Training Ss were instructed to form images of the two nouns and then interact these images it seems that their poor performance would not be due to a reading problem as was the case with the No Training Ss (because the Imagery Training Ss were instructed to picture the two nouns) but rather to an interference between instructions to generate their own interactions and E-supplied interacting links. In other words the generally superior performance of Imagery Training relative to No Training may have resulted from a reduction in the imagery inhibiting effect of printed presentation, however, because Ss instructions to form their own interactions were incompatible with the E-supplied links the overall recall performance of the Imagery Training Ss was not as great as might otherwise be expected. There is, however, a basic problem with this interpretation. If E and S supplied interactions were incompatible then the Imagery Training Ss should have experienced the most interference in combination with interaction suggesting links and the least interference with pairs linked by connectives which do not suggest an interaction. However, the pattern of second noun recall across connectives revealed a trend exactly opposite to the above requirements. That is, there was a non-significant trend among the Imagery Training Ss to recall pairs linked by interaction suggesting connectives more readily than pairs linked by non-interaction connectives. This result

considerably weakens the idea that the failure of the Imagery Training Ss to perform better than the No Training Ss reflects an interference between E and S supplied interactions.

A second, somewhat more parsimonious interpretation of the comparison between Imagery Training and No Training is based on the possibility that the Imagery Training Ss were confused as to how to follow their instructions given that some pairs already had an E-supplied interaction. That is, Ss may have been prepared to form interacting images of present noun pairs and may have done so for the first few items, however, given the large numbers of pairs already having an interaction suggested by the link, the Imagery Training Ss may have then abandoned their instructional set and merely read (and perhaps imaged) the remaining linked pairs. Thus the first few conjunction linked pairs may have been transformed into interacting images, however, the subsequent dropping of the interacting imagery strategy prevented all conjunction linked pairs from being coded as interacting images. Similarly, Ss may have formed their own interacting images for the other types of linked pairs in the first few cases and then stored the E-supplied interactions for the remaining items. This explanation cannot be directly tested from present data but further study with between Ss designs can examine its validity.

In general, the results of the Imagery Training Ss were confusing and, in light of their consistently, but not significantly higher second noun recall relative to the No Training Ss it may be the case

that the Imagery Training Ss were forming some interacting images. The lack of a consistent interpretation for the performance of Imagery Trained Ss in combination with linked noun pairs clearly points to a need for further research. Two suggestions which may help circumvent certain problems encountered in the current study would be to modify the Imagery Training procedure such that Ss are instructed to form interacting images for only those pairs which do not already have an interaction implied by the connective or to employ only non-interacting links in combination with Imagery Training.

In spite of the unexpected failure to obtain a significant sentence facilitation effect among the No Training Ss, a strong effect was found in the Imagery Prompting condition. As shown in the Design 1 second noun recall analysis, Ss in the Imagery Prompting condition recalled significantly less conjunction linked pairs relative to noun pairs linked by verbs plus prepositions, verbs, and prepositions. Furthermore, those pairs linked by verbs plus prepositions were significantly better recalled than pairs linked by the other three types of connectives. No significant difference in second noun recall performance was found between verb and preposition linked pairs. From the point of view of a comparison among training procedures, Imagery Prompting Ss had significantly higher recall scores than the Imagery Training Ss in the case of verb plus preposition linked pairs only, although a large but not quite significant difference in favour of Imagery Prompting was also found for preposition linked pairs. Relative

to the No Training Ss the performance of the Imagery Prompting Ss was significantly higher for both preposition and verb plus preposition linked pairs and, in addition, a strong but not quite significant superiority of Imagery Prompting was also found in the case of verb links. Inspection of Figure 1 suggests that the failure of this latter difference to reach significance reflected, in part, a non-significant trend among the No Training Ss to perform better with verb links.

Considering both the interacting imagery and semantic elaboration explanation of the sentence facilitation effect, several outcomes of the Design 1 analysis favour the former hypothesis over the latter. First, from the point of view of semantic elaborations it is unclear why verbs and prepositions gave roughly equal second noun recall facilitation (in fact, the trend showed prepositions to result in higher performance). It seems that verbs like "eats" and "wears", for example, should be more likely to prompt the generation of semantic overlaps than prepositions like "in" or "on". However, from an interacting imagery perspective the roughly equal facilitation of verb and preposition links is entirely expected because (according to the hypothesis) verbs facilitate recall due to the fact that they suggest interacting images. Thus a verb like "wears", for example, gives an equal facilitation effect relative to the preposition "on" because both suggest a physical interaction of the two items. Since further discussion of the effect of preposition and verb plus preposition

links requires consideration of the Nature of Implied Interaction variable, a discussion of the effects of these connectives will follow the discussion of the Design 2 results. A second outcome of the Design 1 analysis which favours the interacting imagery hypothesis was the fact that a sentence facilitation effect was obtained in the Imagery Prompting but not the No Training condition. While it is unclear how formation of separate images could benefit the generation of semantic elaborations such a process is vital to successful interacting image formation. If the proposal that merely reading printed material will not evoke (and may inhibit) image generation is correct, then the appearance of a sentence facilitation effect among the Imagery Prompting Ss suggests that such an instructional procedure can overcome this problem. That is, by increasing the likelihood of Ss generating separate images of the two nouns in each pair (either by instruction to do so or also, perhaps, by simultaneous object referent presentation e.g., Jensen and Rohwer, 1963, 1965), image generation prompts would be expected to improve Ss recall of pairs linked by interaction suggesting connectives because these connectives would prompt Ss to interact their self-generated images. Whereas, for pairs linked by connectives which do not imply an interaction, Ss would not be prompted to interact the two images formed for each noun pair and therefore would not show improved recall.

The Design 2 analysis of the Imagery Prompting Ss second noun recall scores adds strong support to the interacting imagery hypothesis

of children's linked noun pair learning. Consistent with the notion that given separate image generation, links which suggest an interaction will result in higher second noun recall than non-interaction suggesting links, the results from the Design 2 analysis showed the Imagery Prompting Ss to recall significantly ($p < .06$) more pairs linked by interacting prepositions (e.g., "in", "on", and "around") than non-interacting prepositions (e.g., "beside", "over" and "below"). By first ensuring separate image generation, Imagery Prompting resulted in a recall pattern highly in favour of interaction suggesting connectives. The finding that interacting prepositions produce higher second noun recall than non-interacting prepositions is the strongest evidence to date in favour of an interacting imagery hypothesis of children's linked noun pair learning. Apparently, by increasing the likelihood that Ss would generate images of the two nouns in each pair, the Imagery Prompting procedure was able to avoid the usual image inhibitory effect of having Ss read printed linked noun pairs and thus a recall pattern strongly in favour of interaction suggesting links was obtained.

Further support for the imagery hypothesis as elaborated in the above discussion is found in the results of the connective recall analysis. First, the finding that interacting prepositions and verbs plus interacting prepositions were significantly better recalled than their non-interacting counterparts lends credence to the notion that Ss were tending to store E-supplied interactions. That is, because

interacting links resulted in interacting image storage while non-interacting links did not, Ss greater ability to recall specific types of interactions as opposed to their ability to recall specific distanced relationships, supports the hypothesis that Ss were tending to form interacting images of the E-suggested interactions. Furthermore the comparison among the three training procedures on the connective recall task showing Imagery Prompting to give maximum connective recall, Imagery Training to result in intermediate connective recall, and No Training to give the poorest connective recall, supports the proposal that the Imagery Prompting Ss were making the most use of E-supplied connectives while the Imagery Training Ss were also using the E-supplied links but to a lesser degree, and the No Training Ss received the least benefit from the provided connectives.

Turning now to a discussion of the performance of the Imagery Prompting Ss in combination with verbs plus preposition links, the results of the Design 2 analysis were in disagreement with the experimental predictions. Unexpectedly, verbs plus interacting prepositions did not result in higher second noun recall than verbs plus non-interacting prepositions. Apparently, addition of a verb to a non-interacting preposition improved the normally poor recall facilitation of such a link to the same level as that obtained with an interacting preposition or verb plus interacting preposition. In other words, for example, a phrase like "the CAT runs under the HOUSE" would be as well recalled as "the CAT runs in the HOUSE" even though "the CAT under the

HOUSE" would not be as well recalled as "the CAT in the HOUSE". This potential of verbs for supplementing the otherwise non-facilitory effect of non-interacting prepositions is puzzling and must await further research into the capacity of various verbs to prompt interacting image generation.

The appearance of several interactions involving the list variable may indicate a lack of control over the capacity of certain linked pairs to elicit interacting imagery coding. For example, "the BIRD over the FIELD" does not suggest an interacting image whereas "the ELASTIC over the BOOK" does suggest an interaction. This capacity of connectives to either suggest or not suggest interactions depending on the nouns they link may be responsible in part for some of the list interactions. Another factor that may be responsible is whether the nouns refer to animate or inanimate things. Nonetheless the occurence of interactions between certain independent variables and certain lists does not seriously qualify the interpretation of the results because in most cases the list interaction did not indicate a reversal of an effect among lists but rather a significant effect in some lists and a similar but non-significant trend in others.

GENERAL CONCLUSIONS

It is proposed that a purely printed mode of presentation is relatively ineffective for maximizing children's recall of sentence embedded noun pairs. Because this type of presentation must be encoded by reading, children's visual system is occupied and thus they are unable to effectively employ imagery mnemonics which therefore causes a reduction in their recall performance. In the case of pairs linked by interaction suggesting connectives this problem can be overcome in at least three ways. First, by employing an aural rather than printed presentation, Ss visual system can be freed and thus directed towards imagery coding. Second, results from this research indicate that by specific instruction to generate visual images of presented noun pairs, children are able to overcome the reading problem. Third, other researchers have found that simultaneous object referent presentation will also ensure effective imagery coding. A few researchers have obtained a sentence facilitation effect even in the case of a purely printed presentation indicating that other factors may also allow or encourage imagery coding. For noun pairs linked by connectives which do not suggest an interaction results from the current research suggest that Imagery Training may be effective though perhaps only if interaction suggesting links are not included among the pairs linked by connectives which do not imply an interaction.

In terms of theoretical importance the results of this study

create great difficulty for the semantic elaboration theory of linked noun pair learning. Findings showing superior recall for pairs linked by interacting prepositions rather non-interacting prepositions combined with the strong sentence facilitation effect obtained only in the Imagery Prompting condition, are clearly far more consistent with the hypothesis that interacting imagery processes are the major contribution to the sentence facilitation phenomenon.

REFERENCES

Ammon, P.R. and Ammon, M.S. Effects of training in vocabulary versus sentence construction. Presented by Ammon and Ammon (1970) at the annual meeting of the American Educational Research Association.

Atwood, G.E. Experimental studies of mnemonic visualization. Unpublished doctoral dissertation, University of Oregon, 1969.

Bower, G.H. Mental imagery in associative learning. In Lee Gregg (Ed.) Cognition in learning and memory, New York: Wiley, 1972.

Brooks, L.R. Spatial and verbal components of the act of recall. Canadian Journal of Psychology, 1968, 22, 349-368.

Catchpole, M.J. and Yuille, J.C. Verbal versus imagery training in children's associative learning. 1974, In preparation.

Cooper, C.S. The relationship among reading ability, grade level, and syntactical mediation in paired associate learning. Unpublished Master's Thesis, University of Wisconsin, 1968.

Danner, F.W. and Taylor, A.M. Integrated pictures and relational imagery training in children's learning. Journal of Experimental Child Psychology, 1973, 16, 47-54.

Davidson, R.E. and Adams, J.F. Verbal versus pictorial facilitation of paired associate learning. Journal of Experimental Child Psychology, 1970, 9, 429-435.

Davidson, R.E., Schwenn, E.A., and Adams, J.F. Semantic effects in

transfer. Journal of Verbal Learning and Verbal Behavior, 1970, 9, 212-217.

Holyoak, K., Hogeterp, H., and Yuille, J.C.A. A developmental comparison of verbal and pictorial mnemonics in paired associate learning. Journal of Experimental Child Psychology, 1972, 14, 53-65.

Jensen, A.R. and Rohwer, W.D., Jr. The effect of verbal mediation on the learning and retention of paired associates by retarded adults. American Journal of Mental Deficiency, 1963, 68, 80-84.

Jensen, A.R. and Rohwer, W.D., Jr. Syntactical mediation of serial and paired associate learning as a function of age. Child Development, 1965, 36, 601-608.

Levin, J.R. Factors related to the sentence facilitation of paired associate learning: some characteristics of verbs. Journal of Educational Psychology, 1970, 61, 431-439(a).

Levin, J.R., Davidson, R.E., Wolff, P., and Citron, M. A comparison of induced imagery and sentence strategies in children's paired associate learning. Journal of Educational Psychology, 1973, 6, 306-309.

Levin, J.R., Horvitz, J.M., and Kaplan, S.A. Verbal facilitation of paired associate learning: A limited generalization? Wisconsin Research and Development Centre for Cognitive Learning. Centre No. C-03/Contract OE 5-10-154, 1971.

Levin, J.R. and Kaplan, S.A. Imaginal facilitation of paired associate learning: a limited generalization? Journal of Educational Psychology, 1972, 63, 429-432.

Levin, J.R., Kaplan, S.A. and Horvitz, J.M. Verbal facilitation of paired associate learning: A limited generalization? Working paper No.72, Wisconsin Research and Development Centre for Cognitive Learning, 1971.

Milgram, N.A. Verbal context versus visual compound in paired associate learning by children. Journal of Experimental Child Psychology, 1967, 5, 597-603(b).

Paivio, A. On the functional significance of imagery. In H.W. Reese (Chm) Imagery in children's learning. A symposium. Psychological Bulletin, 1970, 73, 385-392.

Paivio, A. Imagery and verbal processes. New York: Holt, Rinehart and Winston, 1971.

Reese, H.W. Imagery in paired-associate learning. Journal of Experimental Child Psychology, 1965, 2, 290-296.

Reese, H.W. Imagery and contextual meaning, Symposium presented at the meeting of the Society for Research in Child Development, Santa Monica, California, 1969.

Rohwer, W.D., Jr. Constraint, syntax and meaning in paired associate learning. Journal of Verbal Learning and Verbal Behavior, 1966, 5, 541-547.

Rohwer, W.D., Jr. Social class differences in the role of linguistic

structures in paired associate learning: elaboration and learning proficiency. Final report on US Office of Education basic research project number: 5 - 0605, contract number: OE 6-10-273, November, 1967.

Rohwer, W.D., Jr. Images and pictures on children's learning: Research results and educational implications. In H.W. Reese (Chm), Imagery in children's learning: A symposium, Psychological Bulletin, 1970, 73, 393-402.

Rohwer, W.D., Jr., Lynch, S., Levin, J.R., and Suzuki, N. Pictorial and verbal factors in the efficient learning of paired associates. Journal of Educational Psychology, 1967, 58, 278-284.

Rohwer, W.D., Jr. and Levin, J.R. Action, meaning and stimulus selection in paired associate learning. Journal of Verbal Learning and Verbal Behaviour, 1968, 7, 137-141.

Rohwer, W.D., Jr., Shuell, T.J., and Levin, J.R. Context effects in the initial storage and retrieval of noun pairs. Journal of Verbal Learning and Verbal Behaviour, 1967, 6, 796-801.

Rohwer, W.D., Jr., Ammon, M.S., and Levin, J.R. Learning efficiency and elaboration training among four and five year old children. Final Report, Office of Economic Opportunity, Contract No. B99-4776, June 1971.

Rohwer, W.D., Jr. and Ammon, M.S. Elaboration training and paired associate learning efficiency in children. Journal of

Educational Psychology, 1971, 62, 376-383.

Rohwer, W.D., Jr. and Gerdes, B.J. The assessment of improvement of learning and language skills in four and five year old culturally disadvantaged children. Final Report. Office of Economic Opportunity, Contract No. B99-4776, 1971, 20-28.

Rohwer, W.D., Jr. Elaboration and learning in childhood and adolescence. In H.W. Reese (Ed.) Advances in child development and behaviour. New York: Academic Press, in press, 1973.

Rohwer, W.D., Jr., and Matz, R.D. Improving aural comprehension in white and black children. Pictures versus print. Preprint 1974.

Suzuki, N. and Rohwer, W.D., Jr. Verbal facilitation of paired associate learning: type of grammatical unit versus connective form class. Journal of Verbal Learning and Verbal Behaviour, 1968, 7, 584-588.

Taylor, A.M. and Black, H.B. Variables affecting imagery instruction in children. Paper presented at the annual meeting of the Midwest Psychological Association, Chicago, Illinois, 1969.

Yuille, J.C. Changes in verb meaning and the sentence context effect in children's paired associate learning. Journal of Experimental Child Psychology, 1973, 15, 247-253.

Yuille, J.C. Syntactic facilitation of children's associative learning: An instructional effect. Paper submitted to Journal of Experimental Child Psychology, July 1973.

Yuille, J.C. and Catchpole, M.J. Associative learning and imagery training in children. Journal of Experimental Child Psychology, 1973, 16, 403-412.

Yuille, J.C. and Catchpole, M.J. The effects of delay and imagery training on the recall and recognition of object pairs. Journal of Experimental Child Psychology, 1974, in press.

Yuille, J.C. and Pritchard, S. Noun concreteness and verbal facilitation as factors in imaginal mediation and PA learning in children. Journal of Experimental Child Psychology, 1969, 7, 459-466.

APPENDIX

TABLE 1

Practice Items Employed During Imagery Training, Imagery Prompting, and No Training Instructions

AIRPLANE	THIMBLE
BUTTON	ROCK
AIRPLANE	_____
BUTTON	_____
RULER	STRING
ARROW	GUITAR
TIE	BRUSH
LEAF	HAMMER
MASK	FROG

The HOCKEY PLAYER dances between the HELICOPTERS

The FLY above the ASHTRAY

The HOOK catches the SHELL

The NECKLACE and the CLOTHESPEG

The HAIRCLIP rusts within the JUG

The ALLIGATOR splashes the FLOWER

The LIGHTBULB inside the BUGGY

TABLE 2

List 1 Learning Set Items (Presentation Order)

1. the KLEENEX in the PIPE
2. the DIME and the BELL
3. the LION eats the ORANGE
4. the YO-YO on the ENVELOPE
5. the MATCH and the SHOE
6. the HORSE falls beside the GUN
7. the ERASER and the HIGHCHAIR
8. the DOG sits outside the TRUCK
9. the CUP holds the KEY
10. the ELASTIC over the BOOK
11. the BOY wears the WATCH
12. the BULL runs around the FLAG
13. the PENCIL below the FUNNEL
14. the BRACELET and the CAR
15. the HAT floats inside the BOTTLE
16. the BIRD smashes the WHISTLE

TABLE 3

List 2 Learning Set Items (Presentation Order)

1. the CHAIR and the ROLLING PIN
2. the RAT chews the GUM
3. the BALL and the MIRROR
4. the GLOVE wipes the DOOR
5. the FISH hides in the BOX
6. the POSTCARD around the MARBLE
7. the STAMP sticks below the SWEATER
8. the CAT scratches the PENNY
9. the WHEEL and the BANANA
10. the ELEPHANT steps on the TREE
11. the KITE beside the NAIL
12. the TOOTHBRUSH and the JAR
13. the LAMP inside the RAG
14. the FORK pokes the CAMERA
15. the SOAP outside the SHOVEL
16. the SNAKE curls over the RING

TABLE 4

List 3 Learning Set Items (Presentation Order)

1. The ELASTIC and the BOOK
2. The HAT outside the BOTTLE
3. The BOY steps on the WATCH
4. The PENCIL pokes the FUNNEL
5. The BIRD hides in the WHISTLE
6. The BULL chews the FLAG
7. the CUP around the KEY
8. The HORSE and the GUN
9. The LION wipes the ORANGE
10. The YO-YO sticks below the ENVELOPE
11. The DIME beside the BELL
12. The ERASER scratches the HIGHCHAIR
13. The DOG and the TRUCK
14. The BRACELET inside the CAR
15. The KLEENEX and the PIPE
16. The MATCH curls over the SHOE

TABLE 5

List 4 Learning Set Items (Presentation Order)

1. The CAT and the PENNY
2. The SNAKE wears the RING
3. The SOAP floats inside the SHOVEL
4. The RAT and the GUM
5. The FISH eats the BOX
6. The GLOVE in the DOOR
7. The STAMP and the SWEATER
8. The CHAIR on the ROLLINGPIN
9. The LAMP sits outside the RAG
10. The TOOTHBRUSH over the JAR
11. The ELEPHANT falls beside the TREE
12. The KITE holds the NAIL
13. The WHEEL below the BANANA
14. The FORK smashes the CAMERA
15. The POSTCARD and the MARBLE
16. The BALL runs around the MIRROR

TABLE 6

Format of Each Experimental Booklet

Booklet Number	Presentation Time	Page Number	
1	10 sec.	1	unlinked pairs for demonstration
1	10 sec.	2	of paired associate procedure
1	10 sec.	3	first word of each demonstration
1	10 sec.	4	pair plus blank space for partner
1		5	five unlinked practice pairs for
1	10 sec. each	⋮	employment during training, promp-
1		9	ting, or practice session
1			
1		10	eight linked pairs for employment
1	10 sec. each	⋮	during phase 2 of Imagery Training,
1		⋮	Imagery Prompting, or No Training
1		17	conditions
2		1	sixteen to-be-learned linked
		⋮	pairs
2		16	
2		17	first word of each preceding
		⋮	pair presented in a random order.
		⋮	Space provided for S to supply
2		32	second noun
3		1	original to-be-learned pairs
		⋮	with a space instead of the
		⋮	original connective. Ss task
3		16	is to supply the connective.

TABLE 7

Introduction and General Paired Associate Instructions

"Hello, my name is Mike Catchpole. I'm a university student and am doing some work to try to find out how children like you remember things.

"What I am going to do is give you a booklet with some pairs of words in it. I will ask you to read these pairs very carefully and try to remember them. After you have read the pairs I will show you the first word of each pair, one at a time, and your job will be to try to write down the partner of the first word.

"For example if you would turn over your booklet you will see that the first pair of words is 'AIRPLANE THIMBLE'. Your job is to remember that 'AIRPLANE' goes with 'THIMBLE'. Now please turn to page 2. This pair of words is 'BUTTON ROCK'. Your job is to remember that 'BUTTON' goes with 'ROCK'. Alright now turn to page 3. What I want you to do is write down the word that went with the word 'AIRPLANE' in the blank. The answer is 'THIMBLE'. Did everyone get that? Good now turn to page 4 and write down the partner for the word 'BUTTON'. The answer os 'ROCK'. Did everyone get that? Okay, this is just how we will play the real game except that there will be more pairs to remember. Are there any questions?"

TABLE 8

Imagery Training Instructions

"There is a special way I want you to learn the real pairs so we will practice this method for a while. What I want you to do is for each pair you read try to think of a mental picture of the two things playing together. For example if you turn to page 5 you see the pair 'RULER STRING'. What I want you to do is to try and think of a picture of these two things playing together. For example the RULER measures the STRING. Now turn to page 6. This pair is 'ARROW GUITAR'. Try to imagine how these two things might play together. For example the ARROW shoots the GUITAR. Now turn to page 7. The pair is'TIE BRUSH'. I want you to think of a mental picture of how these two things could go together. For example the TIE wraps around the BRUSH. Now turn to page 8. This pair is 'LEAF HAMMER'. Try to imagine how these two things could play together. For example the LEAF falls on the HAMMER. Next turn to page 9. This pair os 'MASK FROG'. Try to think of a picture of how these two things could play together. For example the MASK could be on the FROG.

"Now, when you see the real pairs which you are to try to remember they will be printed in capitals in a short sentence. What I will want you to do is to read this sentence and try to think of a picture in your mind of the two things printed in capitals playing together. So first we will look at some more practice pairs but now they will be in short sentences. Okay, turn to page 10. 'The LIGHTBULB inside the BUGGY'. Try to think of a picture of these two things going together. Now turn to page 11. 'The ALLIGATOR splashes the FLOWER'. Once again try to imagine these two things playing together. Now turn to page 13. 'The NECKLACE and the CLOTHESPEG'. Try to think of a picture of these two things going together. Now turn to page 14. 'The HOOK catches the SHELL'. Now think of a picture of these two things going together. Now turn to page 15. 'The PLATE and the COMB'. Imagine how these two things could play together. Now turn to page 16. 'The FLY above the ASHTRAY'. Imagine how the two things could go together. Now turn to page 17. 'The HOCKEY PLAYER dances between the HELICOPTERS'. Think of a picture of these two things playing together.

"Now I am going to have you read the real pairs that I want you to remember. Each pair will be in capitals in a short sentence. For each pair read the sentence carefully and try to imagine how the two things could play together.

TABLE 9

Imagery Prompting Instructions

"There is a special way I want you to learn the real pairs so we will practice this method for a while. What I want you to do is for each pair you read try to think of a picture of the two things. For example if you turn to page 5 you see the pair'RULER STRING'. What I want you to do is to try and think of a picture of these two things. For example think of a picture of a RULER and a STRING. Now turn to page 6. This pair is 'ARROW GUITAR'. Try to think of a picture of an ARROW and a GUITAR. Now turn to page 7. The pair is 'TIE BRUSH'. I want you to try to think of a picture of a TIE and a BRUSH. Now turn to page 8. This pair is 'LEAF HAMMER'. Try to imagine a picture of these things. That is think of a picture of a LEAF and a HAMMER. Next turn to page 9. This pair is 'MASK FROG'. Try to think of a picture of these two things. Think of a picture of a MASK and FROG.

"Now, when you see the real pairs which you are to try to remember they will be printed in capitals in a short sentence. What I want you to do is to read the sentence and try to think of a picture in your mind of the two things printed in capitals. So first we will look at some more practice pairs but now they will be in a short sentence. Okay turn to page 10. 'The LIGHTBULB inside the BUGGY'. Try to think of a picture of these two things. Now turn to page 11. 'The ALLIGATOR splashes the FLOWER'. Once again think of a picture of these two things. Now turn to page 12. 'The HAIRCLIP rusts within the JUG'. Think of a picture of these two things. Now turn to page 13. 'The NECKLACE and the CLOTHESPEG'. Try to think of a picture of these two things. Now turn to page 14. 'The HOOK catches the SHELL'. Think of a picture in your mind of these two things. Now turn to page 15. 'The PLATE and the COMB'. Imagine a picture of these two things. Now turn to page 16. 'The FLY above the ASHTRAY'. Think of a picture of these two things. Now turn to page 17. 'The HOCKEY PLAYER dances between the HELICOPTERS'. Think of a picture of these two things.

"Now I am going to have you read the real pairs that I want you to remember. Each pair will be printed in capitals in a short sentence. For each pair read the sentence carefully and try to think of a picture of the two things."

TABLE 10

No Training Instructions

"Before we start the real game we will practice a bit more to make sure everybody understands. For example if you turn to page 5 you see the pair 'RULER STRING'. Now turn to page 6. This practice pair is 'ARROW GUITAR'. Now turn to page 7. This pair is 'TIE BRUSH'. Now turn to page 8. This pair is 'LEAF HAMMER'. Now turn to page 9. The pair is 'MASK FROG'.

"Now, when you see the real pairs which you are to try to remember they will be printed in capitals in a short sentence. What I will want you to do is to read this sentence and try to remember the pair. So first we will look at some more practice pairs but now they will be in short sentences. Okay turn to page 10. 'The LIGHTBULB inside the BUGGY'. Now turn to page 11. 'The ALLIGATOR splashes the FLOWER'. Now turn to page 12. 'The HAIRCLIP rusts within the JUG'. Now turn to page 13. 'The NECKLACE and the CLOTHESPEG'. Now turn to page 14. 'The HOOK catches the SHELL'. Now turn to page 15. 'The PLATE and the COMB'. Now turn to page 16. 'The FLY above the ASHTRAY'. Now turn to page 17. 'The HOCKEY PLAYER dances between the HELICOPTERS'.

"Now I am going to have you read the real pairs that I want you to remember. Each pair will be in capitals in a short sentence. For each pair read the sentence carefully and try to remember the pair."

TABLE 11

Second Noun Recall Instructions

"Now that you have read all the pairs I am going to have you read the first word of each pair, one at a time, and try to write down its partner, the second word. The only word I want you to write in the blank beside the first word is its partner, the second word. Please guess if you have any idea. Don't worry about spelling and keep your answers to yourself.

"Now turn to page 34 and try to write down the partner for this word..."

TABLE 12

Connective Recall Instructions

"This is the last part of the game. As you remember the two words of each pair had the word "the" in front of them. Also they had one or two words between them. What I am going to do now is show you the pairs you just tried to remember. There will be a blank between them. Your job will be to try to remember the word or words that joined a pair and write it in the blank. You will have 10 seconds for each pair. Are there any questions? Okay, turn to page 50 and try to fill in the missing word or words. Now turn to page 51..."

TABLE 13

Source Table for the Analysis of Variance of Design 1
Second Noun Recall - Grade (2) x Type of Training (3)
x List (4) x Type of Connective (4)

Source	SS	df	MS	F	p
Between Subjects	138.163	71			
Grade	6.420	1	6.420	4.091	$p < .05$
Type of Training	21.299	2	10.649	6.785	$p < .01$
List	4.177	3	1.392	0.887	-
Grade x Training	1.549	2	0.774	0.493	-
Grade x List	0.955	3	0.318	0.203	-
Training x List	11.563	6	1.927	1.228	-
Grade x Training x List	16.868	6	2.811	1.791	-
Subjects within Groups (Error)	75.333	48	1.569		
Within Subjects	158.750	216			
Type of Connective	10.705	3	3.568	5.104	$p < .01$
Grade x Connective	0.423	3	0.161	0.230	-
Training x Connective	8.035	6	1.339	1.916	$p < .075$
List x Connective	13.198	9	1.466	2.098	$p < .05$
Grade x Training x Connective	1.340	6	0.223	0.320	-
Grade x List x Connective	6.976	9	0.775	1.109	-
Training x List x Connective	6.437	18	0.358	0.512	-
Grade x Training x List x Connective	10.910	18	0.606	0.867	-
Connective x Subjects within Groups (Error)	100.667	144	0.699		
Total	296.913	287			

TABLE 14

Newman-Keuls Test of Type of Connective
Main Effect - Design 1 (Second Noun Recall)

Source	SS	df	MS	F	p
Connective	10.71	3	3.57	5.10	$p < .01$

Order	1	2	3	4
Treatment in Order of Positions	C	P	V	V+P
Tj	53	72	76	92

Truncated Range		2	3	4
$S\bar{x}q$	.95	19.86	23.84	26.18
$S\bar{x}q$	.99	26.25	29.80	31.94

	C	P	V	V+P
C	-	19 $p < .055$	23 $p < .055$	39 $p < .01$
P		-	4	20
V			-	16
V+P				-

TABLE 15

Simple Main Effects Test and Subsequent Newman-Keuls Tests of the List x Connective Interaction in Design 1 (Second Noun Recall)

	P	C	V	V+P
List 1	20	10	16	17
List 2	15	16	21	35
List 3	17	18	16	20
List 4	20	9	23	20

Analysis of Simple Main Effects - Connective at List

Source	SS	df	MS	F	p
Connective at List 1	2.93	3	0.98	1.40	-
Connective at List 2	14.15	3	4.72	6.75	$p < .01$
Connective at List 3	0.49	3	0.16	-	-
Connective at List 4	6.33	3	2.11	3.02	$p < .05$
Error	100.67	144	0.70		

a) Newman-Keuls Test for Connective at List 2

Order	1	2	3	4
Treatments in Order of Position	P	C	V	V+P
Tj	15	16	21	35

Truncated Range		2	3	4
$S\bar{x}q$	.95	8.08	9.70	10.66
$S\bar{x}q$	.99	10.69	12.13	13.00

	P	C	V	V+P
P	-	1	6	20 $p < .01$
C		-	5	19 $p < .01$
V			-	14 $p < .01$
V+P				-

b) Newman-Keuls for Connective at List 4

Order	1	2	3	4
Treatments in Order of Position	C	P	P+V	V
Tj	9	20	20	23

TABLE 15 (cont.)

Truncated Range		2	3	4
$S_{\bar{x}q}$	.95	8.08	9.70	10.66
$S_{\bar{x}q}$	.99	10.69	12.13	13.00

	C	P	V+P	V
C	–	11 $p<.01$	11 $p<.01$	14 $p<.01$
P		–	0	3
V+P			–	3
V				–

TABLE 16

Newman-Keuls Test of the Type of Training Effect in Design 1 (Second Noun Recall)

Source	SS	df	MS	F	p
Training	21.30	2	10.65	6.79	$p < .01$

Order	1	2	3
Treatments in Order of Positions	NT	IT	IP
Tj	63	104	126

Truncated Range		2	3
$S_{\bar{x}q}$	.95	34.88	41.98
$S_{\bar{x}q}$	.99	46.38	52.99

	NT	IT	IP
NT	-	41 $p < .05$	63 $p < .01$
IT		-	22
IP			-

TABLE 17

Simple Main Effects Test and Subsequent Newman-Keuls Test of the Training x Connective Interaction in Design 1 (Second Noun Recall) from the Point of View of Connective at Training

	P	C	V	V+P
IT	23	22	28	31
IP	34	18	29	45
NT	15	13	19	16

Source	SS	df	MS	F	p
Connective at IT	2.25	3	0.75	1.07	-
Connective at IP	15.71	3	5.24	7.49	$p<.01$
Connective at NT	0.78	3	0.26	-	-
Error	100.67	144	0.70		

Newman-Keuls Test for Connective at IP

Order	1	2	3	4
Treatments in Order of Positions	C	V	P	V+P
Tj	18	29	34	45

Truncated Range	2	3	4
$S\bar{x}q$ .95	11.47	13.76	15.11
$S\bar{x}q$ .99	15.16	17.20	18.43

	C	V	P	V+P
C	-	11 $p<.055$	16 $p<.05$	27 $p<.01$
V		-	5	16 $p<.05$
P			-	11 $p<.055$
V+P				-

TABLE 18

Simple Main Effects Test and Subsequent Newman-Keuls Tests of the Training x Connective Interaction in Design 1 (Second Noun Recall) from the Point of View of Training at Connective

	P	C	V	V+P
IT	23	22	28	31
IP	34	18	29	45
NT	15	13	19	16

Source	SS	df	MS	F	p
Training at P	7.58	2	3.79	4.14	$p<.05$
Training at C	1.69	2	0.85	0.92	
Training at V	2.53	2	1.26	1.38	
Training at V+P	17.53	2	8.76	9.56	$p<.01$
Pooled Error		144	0.92		

a) Newman-Keuls Test for Training at P

Order	1	2	3
Treatments in Order of Positions	NT	IT	IP
T_j	15	23	34

Truncated Range		2	3
$S_{\bar{x}q}$	.95	13.09	15.71
$S_{\bar{x}q}$	.99	17.31	19.65

	NT	IT	IP
NT	-	8	19 $p<.05$
IT		-	11
IP			-

b) Newman-Keuls Test for Training at V+P

Order	1	2	3
Treatments in Order of Positions	NT	IT	IP
T_j	16	31	45

TABLE 18 (cont.)

Truncated Range		2	3
$S_{\bar{x}q}$	.95	13.09	15.71
$S_{\bar{x}q}$	.99	17.31	19.65

	NT	IT	V+P
NT	-	15 $p<.05$	29 $p<.01$
IT		-	14 $p<.05$
IP			-

TABLE 19

Source Table for the Analysis of Variance of Design 2
Second Noun Recall - Grade (2) x Type of Training (3)
x List (4) x Type of Connective (2) x Nature of
Implied Interaction (2)

Source	SS	df	MS	F	p
Grade	1.39	1	1.39	2.96	-
Type of Training	12.01	2	6.00	12.81	$p<.01$
List	1.58	3	0.53	1.13	-
Type of Connective	1.39	1	1.39	4.04	$p<.05$
Nature of Implied Interaction	0.56	1	0.56	0.17	-
Grade x Training	0.76	2	0.38	0.81	-
Grade x List	0.75	3	0.25	0.53	-
Training x List	2.94	6	0.49	1.04	-
Grade x Connective	0.22	1	0.22	0.65	-
Training x Connective	0.55	2	0.27	0.80	-
List x Connective	4.12	3	1.47	4.28	$p<.01$
Grade x Interaction	0.56	1	0.56	0.17	-
Training x Interaction	0.34	2	0.17	0.53	-
List x Interaction	0.83	3	0.28	0.09	-
Connective x Interaction	0.56	1	0.56	0.16	-
Grade x Training x List	6.19	6	1.03	2.20	-
Grade x Training x Connective	0.13	2	0.66	0.19	-
Grade x List x Connective	2.42	3	0.81	2.34	-
Training x List x Connective	1.73	6	0.29	0.84	-
Grade x Training x Interaction	1.17	2	0.59	1.82	-
Grade x List x Interaction	0.92	3	0.31	0.95	-
Training x List x Interaction	3.27	6	0.55	1.69	-
Grade x Connective x Interaction	0.22	1	0.22	0.63	-
Training x Connective x Interaction	1.88	2	0.94	2.68	$p<.075$
List x Connective x Interaction	1.81	3	0.60	1.72	-
Subj. w. Groups	22.50	48	0.47	-	-
Grade x Training x List x Connective	2.15	6	0.36	1.04	-
Grade x Training x List x Interaction	1.10	6	0.18	0.57	-
Grade x Training x Connective x Interaction	0.88	2	0.44	1.26	-
Grade x List x Connective x Interaction	0.36	3	0.12	0.34	-
Training x List x Connective x Interaction	1.51	6	0.25	0.72	-
Connective x Subj. w. groups	16.50	48	0.34		
Interaction x Subj. w. groups	15.50	48	0.32		

TABLE 19 (cont.)

Source	SS	df	MS	F	p
Grade x Training x List x Connective x Interaction	0.95	6	0.16	0.45	-
Connective x Interaction x Subj. w. groups	16.83	48	0.35		

TABLE 20

Newman-Keuls Test of the Type of Training Main Effect - Design 2 - Second Noun Recall

Source	SS	df	MS	F	p
Training	12.01	2	6.00	12.81	$p < .01$

Order	1	2	3
Treatment in Order of Positions	IP	IT	NT
Tj	31	54	79

Truncated Range		2	3
$S\bar{x}q$	.95	19.12	22.94
$S\bar{x}q$	.99	25.49	29.12

	IP	IT	NT
IP	-	23 $p < .05$	48 $p < .01$
IT		-	25 $p < .05$
NT			-

TABLE 21

Simple Main Effects Test of the List x Connective Interaction in Design 2 (Second Noun Recall) from the Point of View of Connective at List

	Prepositions	Verbs plus Prepositions
List 1	20	17
List 2	15	35
List 3	17	20
List 4	20	20

Source	SS	df	MS	F	p
Connective at List 1	0.13	1	0.13	0.36	-
Connective at List 2	5.56	1	5.56	16.16	$p < .01$
Connective at List 3	0.13	1	0.13	0.36	-
Connective at List 4	0.0	1	0.0	0.0	-
Error		48	0.34		

For List 2 V+P > P $p < .01$

TABLE 22

Simple Main Effects Test and Subsequent Newman-Keuls Test of the List x Connective Interaction in Design 2 (Second Noun Recall) from the Point of View of List at Connective

	Prepositions	Verbs plus Prepositions
List 1	20	17
List 2	15	35
List 3	17	20
List 4	20	20

List at Connective - Pooled Error Term = .4063

Source	SS	df	MS	F	p
List at P	.50	3	0.17	0.41	-
List at V+P	6.00	3	2.00	4.92	$p < .01$
Pooled Errod		48	o.41		

Newman-Keuls Test of List at V+P

Order	1	2	3	4
Treatments in Order Of Positions	List 1	List 3	List 4	List 4
Tj	17	20	20	35

Truncated Range		2	3	4
$S\bar{x}q$	.95	10.90	13.12	14.42
$S\bar{x}q$	.99	14.53	16.60	17.82

	L_1	L_3	L_4	L_2
L_1	-	3	3	18 $p < .01$
L_3		-	0	15 $p < .01$
L_4			-	15 $p < .01$
L_2				-

TABLE 23

Simple Main Effects Analysis of the Interaction of Type of Training x Nature of Implied Interaction at Prepositions - Design 2 (Second Noun Recall) from the Point of View of Nature of Implied Interaction at Training

	Int. P	Non-int. P
IT	10	13
IP	21	13
NT	7	8

Source	SS	df	MS	F	p
Implied interaction at IT (preps)	0.19	1	0.19	-	
Implied interaction at IP (preps)	1.33	1	1.33	3.80	$p < .06$
Implied interaction at NT	0.02	1	0.02	-	
Error		48	0.35		

For IP - interacting preps > non-interacting preps

TABLE 24

Simple Main Effects Analysis of the Interaction of Type of Training x Nature of Implied Interaction at Verbs plus Prepositions - Design 2 (Second Noun Recall) from the Point of View of Nature of Implied Interactions at Training

	V+Int.P	V+Non-int.P
IT	18	13
IP	21	24
NT	7	9

Source	SS	df	MS	F	p
Implied interaction at IT (V+P)	0.52	1	0.52	1.49	-
Implied interaction at IP (V+P)	0.19	1	0.19	0.53	-
Implied interaction at NT (V+P)	0.08	1	0.08	0.24	-
Error		48	0.35		

TABLE 25

Simple Main Effects Analysis and Subsequent Newman-Keuls Tests of the Training x Connective x Nature of Implied Interaction in Design 2 (Second Noun Recall) from the Point of View of Training at Connective x Nature of Implied Interaction

	P		V+P	
	Int.	Non-int.	Int.	Non-int.
IT	10	13	18	13
IP	21	13	21	24
NT	7	8	7	9

Source	SS	df	MS	F	p
Training for int. at P	4.53	2	2.26	6.45	$p < .01$
Training for non-int. at P	0.69	2	0.35	0.99	-
Training for int. at V+P	4.53	2	2.26	6.46	$p < .01$
Training for non-int. at V+P	5.03	2	2.51	7.17	$p < .01$
Error		48	0.35		

Newman-Keuls Tests for Training at Interacting Prepositions, Training at Verbs plus Interacting Prepositions, and Training at Verbs plus Non-interacting Prepositions

Truncated Range		2	3
$S_{\bar{x}q}$	.95	8.27	9.95
$S_{\bar{x}q}$	.99	11.02	12.59

a) Training at Interacting Prepositions

Order	1	2	3
Treatments in Order of Positions	NT	IT	IP
Tj	7	10	21

TABLE 25 (cont.)

	NT	IT	IP
NT	-	3	14 $p<.01$
IT		-	11 $p<.05$
IP			-

b) Training at Verbs plus Interacting Prepositions

Order	1	2	3
Treatments in Order of Positions	NT	IT	IP
Tj	7	18	21

	NT	IT	IP
NT	-	11 $p<.05$	14 $p<.01$
IT		-	3
IP			-

c) Training at Verbs plus Non-interacting Prepositions

Order	1	2	3
Treatments in Order of Positions	NT	IT	IP
Tj	9	13	24

	NT	IT	IP
NT	-	4	15 $p<.01$
IT		-	11 $p<.05$
IP			-

TABLE 26

Source Table for the Analysis of Variance of Design 1 - Connective Recall

Source	SS	df	MS	F	p
Grade	0.50	1	0.50	0.65	-
Type of Training	5.05	2	2.52	3.27	$p < .05$
List	2.35	3	0.78	1.02	-
Connective	55.68	3	18.56	23.93	-
Grade x Training	1.65	2	0.82	1.07	-
Grade x List	0.64	3	0.21	0.28	-
Training x List	7.67	6	1.28	1.66	-
Grade x Connective	2.25	3	0.75	0.97	-
Training x Connective	2.42	6	0.40	0.52	-
List x Connective	14.07	9	1.56	2.02	$p < .05$
Grade x Training x List	13.30	6	2.22	2.88	$p < .05$
Grade x Training x Connective	2.77	6	0.46	0.60	-
Grade x List x Connective	4.17	9	0.46	0.60	-
Training x List x Connective	21.41	18	1.19	1.53	-
Ss within Groups (Error)	37.00	48	0.77		
Grade x Training x List x Connective	29.06	18	1.61	2.08	$p < .01$
Connective x Ss within Groups (Error)	111.67	144	0.78		

TABLE 27

Newman-Keuls Test of the Training Effect
in Design 1 - (Connective Recall)

Source	SS	df	F	p
Training	5.05	2	2.52	$p < .05$
Error		48	0.77	

Order	1	2	3
Treatments in Order of Positions	NT	IT	IP
Tj	78	91	109

Truncated Range		2	3
$S\bar{x}_q$	.95	24.52	29.17
$S\bar{x}_q$	.99	32.18	36.56

	NT	IT	IP
NT	-	13	31 $p < .05$
IT		-	18
IP			-

TABLE 28

Newman-Keuls Test of the Connective Effect in Design 1 (Connective Recall)

Source	SS	df	MS	F	p
Connective	55.68	3	18.56	23.93	$p < .01$
Error		144	0.78		

Order	1	2	3	4
Treatments in Order of Positions	V+P	P	V	C
Tj	34	42	99	103

Truncated Range r	2	3	4
$S_{\bar{x}q}$ .95	20.92	25.02	27.49
$S_{\bar{x}q}$ .99	27.56	31.30	33.54

	V+P	P	V	C
V+P	–	8	65 $p < .01$	69 $p < .01$
P		–	57 $p < .01$	61 $p < .01$
V			–	–
C				

$\therefore$ V+P = P < V=C

TABLE 29

Simple Main Effects Test and Subsequent Newman-Keuls Analysis of the Connective x List Interaction in Design 1 (Connective Recall) from the Point of View of a Comparison Among Lists at Each Connective

	P	C	V	V+P
List 1	14	27	25	9
List 2	4	28	36	8
List 3	12	21	17	10
List 4	12	27	21	7

Source	SS	df	MS	F	p
List at P	3.28	3	1.09	1.41	-
List at C	1.71	3	0.57	0.74	$p<.01$
List at V	11.17	3	3.72	4.81	-
List at V+P	0.27	3	0.09	0.12	-
Error		144	0.77		

Newman-Keuls Test for List at V

Order	1	2	3	4
Treatments in Order of Positions	L_3	L_4	L_1	L_2
T_j	17	21	25	36

Truncated Range		2	3	4
$S\bar{x}q$	.95	10.41	12.50	13.73
$S\bar{x}q$	.99	13.76	15.63	16.75

TABLE 29 (cont.)

	List 3	List 4	List 1	List 2
List 3	-	4	8	19 $p<.01$
List 4		-	4	15 $p<.025$
List 1			-	11 $p<.05$
List 2				-

TABLE 30

Source Table for the Analysis of Variance of Design 2 - Connective Recall

Source	SS	df	MS	F	p
Grade	0.35	1	0.35	1.69	-
Training	1.72	2	0.86	4.19	$p < .05$
List	1.03	3	0.34	1.67	-
Connective	0.22	1	0.22	1.05	-
Nature of Implied Interaction	3.56	1	3.56	16.25	$p < .01$
Grade x Training	0.55	2	0.27	1.34	-
Grade x List	0.60	3	0.19	0.93	-
Training x List	1.03	6	0.17	0.84	-
Grade x Connective	0.13	1	0.13	0.59	-
Training x Connective	0.90	2	0.45	0.21	-
List x Connective	0.75	3	0.25	1.18	-
Grade x Interaction	0.14	1	0.14	0.06	-
Training x Interaction	0.26	2	0.13	0.59	-
List x Interaction	0.31	3	0.10	0.47	-
Connective x Interaction	0.56	1	0.56	0.26	-
Grade x Training x List	1.37	6	0.23	1.11	-
Grade x Training x Connective	0.40	2	0.20	0.93	-
Grade x List x Connective	0.35	3	0.12	0.55	-
Training x List x Connective	1.10	6	0.18	0.87	-
Grade x Training x Interaction	0.90	2	0.45	0.21	-
Grade x List x Interaction	0.13	3	0.42	0.19	-
Training x List x Interaction	0.72	6	0.12	0.55	-
Grade x Connective x Interaction	0.13	1	0.13	0.59	-
Training x Connective x Interaction	0.30	2	0.15	0.70	-
List x Connective x Interaction	3.81	3	1.27	5.99	$p < .01$
Ss within Groups (Error)	9.83	48	0.20		
Grade x Training x List x Connective	2.30	6	0.38	1.81	-
Grade x Training x List x Interaction	0.94	6	0.16	0.71	-
Grade x Training x Connective x Interaction	0.27	2	0.14	0.14	-
Grade x List x Connective x Interaction	1.46	3	0.49	2.30	-

TABLE 30 (cont.)

Source	SS	df	MS	F	p
Training x List x Connective x Interaction	0.67	6	0.11	0.53	-
Connective x Ss within Groups (Error)	10.17	48	0.21		
Interaction x Ss within Groups (Error)	10.50	48	0.22		
Grade x Training x List x Connective x Interaction	2.65	6	0.44	2.08	-
Connective x Interaction x Ss within Groups (Error)	10.17	48	0.21		

TABLE 31

Newman-Keuls Test of the Type of Training Effect in Design 2 (Connective Recall)

Source	SS	df	MS	F	p
Training	1.72	2	0.86	4.19	$p < .05$
Error		48	0.20		

Order	1	2	3
Treatments in Order of Positions	NT	IT	IP
Tj	15	29	32

Truncated Range	2	3
$S_{\bar{x}q}$ .95	12.64	15.21
$S_{\bar{x}q}$ .99	16.85	19.29

	NT	IT	IP
NT	-	14 $p < .05$	17 $p < .05$
IT		-	3
IP			-

NT < IT = IP

TABLE 32

Analysis of Simple Main Effects of the List x Implied Interaction x Connective Interaction in Design 2 (Connective Recall)

	P		V+P	
	Int.	Non-int.	Int.	Non-int.
List 1	11	3	4	5
List 2	1	3	8	0
List 3	8	4	9	1
List 4	10	2	3	4

Source	SS	df	MS	F	p
List 1: Int. P vs V+int.P	1.36	1		6.48	$p<.01$
List 1: Non-int. P vs V+non-int. P	0.11	1		0.52	-
List 1: Int. P vs Non-int. P	1.78	1		8.48	$p<.01$
List 1: V+int. P vs V+non-int. P	0.03	1		0.14	-
List 2: Int. P vs V+int. P	1.36	1		6.48	$p<.01$
List 2: Non-int. P vs V+non-int. P	0.25	1		1.19	-
List 2: Int. P vs Non-int. P	0.12	1		0.57	-
List 2: V+int. P vs V+non-int. P	1.78	1		8.48	$p<.01$
List 3: Int. P vs V+int. P	0.03	1		0.14	-
List 3: Non-int. P vs V+non-int. P	0.25	1		1.19	-
List 3: Int. P vs Non-int. P	0.44	1		2.10	-
List 3: V+int. P vs V+non-int. P	1.78	1		8.48	$p<.01$
List 4: Int. P vs V+int. P	1.37	1		6.52	$p<.01$
List 4: Non-int. P vs V+non-int. P	0.11	1		0.52	-
List 4: Int. P vs Non-int. P	1.78	1		8.48	$p<.01$
List 4: V+int. P vs V+non-int. P	0.03	1		0.14	-
Error		48	0.21		