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OBSERVATIONAL LEARNING AS A FUNCTION OF MOTORIC REHEARSAL, LENGTH OF TASK, AND AGE

A Thesis

by

Melanie L. Williams

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OBSERVATIONAL LEARNING AS A FUNCTION OF MOTORIC REHEARSAL, LENGTH OF TASK, AND AGE

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INTRODUCTION

It has long been known that man has the capacity to acquire new behaviors through observation of the behavior of others. Indeed, much of the socialization process, that period in which a society's culture is transmitted to its young, depends not on trial and error learning which is slow and could result in dangerous mistakes, nor upon direct tuition, but on the child's ability to learn by watching others.

There is evidence that observation may result in superior learning as compared to trial and error techniques and that even such complex behavior as concept learning can be acquired through observation. Rosenblith (1959), for example, reported that for kindergarten children, observing a model led to better performance on a maze than having additional trials on the maze. Similarly, Craig (1967) and Rosenbaum (1967) found that subjects observing a performer learning a maze learned the maze more quickly than the performer. Evidence of conceptual response learning through observation comes from a study by Chalmers (1964) in which observers watched performers being trained on a discrimination task. When both groups were then required to perform a reversal, nonreversal, or irrelevant shift, no difference between observers and performers was found on any of the shifts.

Although the importance of observation as an instructional technique has inspired many attempts to explain its operating mechanisms, there is controversy and confusion in the literature even as to terminology. The terms observational learning and imitation have often been used loosely to refer to any behavioral similarity resulting from the observer's exposure to a performer, yet the differences in the nature of the behavior subsumed under these terms suggests that they should not be treated collectively. For example, not all behavioral correspondence can be said to involve real learning, as in the case of social facilitation and conformity, where exposure to another person's behavior enhances or "releases" previously acquired responses on the part of the observer. In other instances, the correspondence between the behavior of observer and performer actually involves only choice-matching in which the critical cues are socially transmitted.

The distinction between observational learning and the previously mentioned social influence phenomena, as made by Bandura (1968) and Aronfreed (1969) and as adopted in the present paper, lies in the requirement that learning occurs through cognitive representation of the modeled behavior, a qualification which will be discussed shortly. Although Aronfreed (1969) views imitation as a special form of observational learning, characterized by its fidelity of form, independence of external outcomes, and "intrinsic value" for the individual, both classes of behavior involve representational use of the modeling stimuli and thus no differentiation is assumed here.

Bandura (1965;1968) has argued that a distinction be made between the acquisition and the performance of observed behavior since the variables which govern these events differ. The bulk of the literature on observational learning has been devoted to performance variables such as consequences to the model, consequences to the observer, and characteristics of the model (reviews of this literature can be found in Aronfreed, 1969; Bandura, 1965; Berger, 1968; Flanders, 1968; Gilmore, 1968), with relatively little attention given to the acquisition phase. The following discussion is an attempt to examine the acquisition process and to determine the possible mediating mechanism which might facilitate retention and reproduction of the modeled behavior.

Early explanations of observational learning, the classic of which is Miller and Dollard's theory (1941), attempted to apply the principles of traditional S-R reinforcement theory. Initial matching of responses between observer and model was left to chance, but subsequent matching responses were rewarded while non-matching responses were unrewarded or punished. Such explanations proved to be inadequate, however, since they could not account for the initial occurrence of the matching response, nor for the fact that much of observational learning occurs seemingly without reinforcement to the observer.

The special characteristics of observational learning, i.e., the complexity of the behaviors which can be acquired through observation, often without opportunity for overt practice, the speed and accuracy with which learning takes place, and the apparent defiance of the Law of Effect, led to theories such as those of Sheffield (1961) and Bandura (1965;1968) which state that learning *per se* is acquired through an essentially passive exposure to the demonstration during which sensory responses become associated through classical conditioning to form images. Since all the sensory responses are linked to each other, a complete perception can be elicited by any fragment of the total stimulus pattern. Also, a previously neutral stimulus such as a verbal label, which has become conditioned to the perceptual event, can be used to strengthen the perception and "summon" it in the absence of the original stimuli. Reinforcement, either to the observer or to the model, becomes important after the acquisition process and determines the conditions under which the learned behavior will be performed (Bandura, 1965;1968).

Debate as to the role of reinforcement in observational learning still exists in the literature, however. Aronfreed (1969) has advanced the theory that the phenomena of observational learning require that the observer form a cognitive representation of the modeled behavior. The formation of this cognitive representation, however, and its subsequent translation into overt performance depend on the change of affect which the modeled behavior produces in the observer. Affect, in turn, is dependent upon either direct or vicarious reinforcement. Recently, Berger (1968; 1969) has attempted to reconceptualize the issue of reinforcement in observational learning and to integrate the area by placing it within the framework of arousal theory. Accordingly, each parameter of the observational learning situation (e.g., the model's cue, response, reinforcer, characteristics; the observer's cue, response, etc.) is shown to provide direction and arousal (as indicated by physiological measures) for the observer. Berger's analysis is not in disagreement with the postulation of central mechanisms such as sensory experiences, symbolic processes, or other cognitive constructs. The theory differs, however, in assuming that modeling occurs not because of the involvement of central mechanisms alone, but is due to activation of such mechanisms by the parameters mentioned above.

Since further discussion of reinforcement in observational learning would be beyond the scope of the present paper, we will return to the issue of cognitive structures which might underlie the observational learning process. Although Aronfreed (1969) takes issue with the stimulus contiguity concept because of its failure to include the controlling aspects of affect, the idea that the observer must form a durable representation of the modeled behavior rather than rely upon straight perceptual or proprioceptive feedback of stimulation is not out of line with Bandura's theorizing (1965;1968). The need for some type of cognitive representation is especially apparent when there is a discrepancy in terms of perceptual feedback between the stimulus properties of the observed behavior and the observer's reproduction. The effects of such a discrepancy are demonstrated in a study by Wapner & Cirillo (1968) in which observer and model faced each other and correct reproduction depended on the observer's making left-right translations of the model's behavior. Younger subjects, who presumably had not produced a representation of the modeled behavior or were unable to translate it into overt performance, made many more mirror-like reproductions than older subjects. A related finding is reported by Greenwald & Albert (1968) who demonstrated that learning by observation was retarded when there was a dissimilarity between orientation of observer's and model's apparatus and when translations between left and right hand had to be made.

Given that successful acquisition of behavior through observation depends on the observer's formulation of a representation of that behavior, the question arises as to what form the representation may take. Aronfreed (1969) believes that representation may be conceptualized as a set of cognitive templates which need not be exact copies or photographic replicas of the modeled behavior. The templates could well be stored as symbols or operators which could permit a construction of the behavior. He further speculates that the nature of the cognitive template determines the fidelity of the behavioral reproduction and the mobility of translation which the observer will have. Verbal coding, for example, would probably enable the observer to reproduce the direction and sequencing of the modeled behavior, but might prove inadequate for the precise structuring of the behavior. Bandura (1965;1968), on the other hand, gives primary emphasis to the verbal concomitants of sensory events.

The Bandura *et al.* study leaves some important issues unsettled, however. In the most recent statement of his theory, Bandura (1968) acknowledges that complex interactions of subprocesses are involved in observational learning. One requisite is that the observer attend to the relevant cues. Motivational conditions, incentive, prior experience in discrimination, and more important to the point being made, involvement in the task, are certainly factors which increase attention thereby facilitating performance. In the Bandura, Grusec, and Menlove study (1966) the superior performance of verbalizers might have been due to increased attention to the modeling stimuli brought about by involvement in the task and therefore may not have been a direct function of verbal coding. Since a non-verbal participation group was not used, it cannot be determined that verbalization was the critical factor.

The heavy dependence on verbal mediation by adults and older children as a solution strategy to a variety of learning problems should not tempt us to discount the possibility that some form of non-verbal representation may be an important factor in the observational learning process. Ranken (1963) has conducted a study which, though not involving observational learning, suggests that the mode through which information is most effectively coded depends largely upon the nature of the information. He attempted to induce different forms of representation of a set of novel shapes by providing one group with animal names for the stimuli, while the other group was told only to pay close attention to the shapes. Half of the Ss in each group were to solve a "mental jigsaw puzzle" composed of the shapes. The other half of each group had to recall a novel ordering of the shapes which had been presented only once. The group that learned names for the stimuli made fewer errors in the serial ordering task than the group without names, but performed less well on the mental jigsaw puzzle, a task which could be solved only if the mode of representation had encoded the figural properties of the stimuli.

Ranken's study suggests that verbal coding may not be an efficient mediating device when problem solution depends on the discrimination of specific attributes of the stimuli. A study by Carmichael, Hogan and Walter (1932) supports this notion. Ss were presented a series of simple drawings and were required to reproduce them from memory. Those Ss who provided names for the pictures reproduced the stimuli less realistically and with more distortion than did Ss who did not name the stimuli. Furthermore, in a replication of the study in which a recognition test was substituted for the reproduction task (Prentice, 1954), the results indicated that labeling did not interfere with the recognition of the pictures, but only with reproduction. Thus, verbal coding is not sufficient to produce the complex imagery necessary for precise stimulus reproduction.

Although these studies point to imaginal or ikonic modes of representation as being more effective than verbalization under certain conditions, there are times when the type of information to be stored lends itself to motoric or enactive coding. An example would be the common experience of tracing a "map" in the air or using body orientation to aid in remembering a route, often a more helpful mnemonic than verbalizing the directions.

The nature of enactive representation might be better understood if it were examined developmentally. Piaget (Flavell, 1963) views motoric symbolism as playing its most important role in the sensorimotor stage of development where action and perception are closely intertwined. Action "represents" the object in the sense that the object exists for the infant only when he is engaged in action toward it.

Piaget's ideas on motoric representation are smiliar in many respects to the "motor-copy" theory espoused by Soviet psychologists (Zaporozhets, 1961;1965;1969). According to this theory, the development of perception in the young child depends upon motoric manipulation of the environment. Through his "orienting-exploratory" movements the child investigates the object and forms a copy or image of it. The child can then compare his image with the object and use this feedback to make the necessary corrections in his image by additional motor actions. The correction procedure continues until the child's image is an accurate representation of the object. As the child becomes older, tactual manipulation becomes more refined and finally is reduced to efficient visual orientation.

Bruner (1966), agreeing with Piaget as to the origins of enactive representation, believes that it persists in adult intellectual life and interacts with ikonic and symbolic modes of representation. For Bruner, enactive representation is action which has become "habitual" and serves as a pattern to guide behavior. Habitualized action is representational in that it frees behavior from mere serial linking and dependence upon external cues. Bruner's notions of enactive representation are derived largely from an experiment by Mandler (1962). Ss were required to learn a complex maze of toggle switches without vision of the maze. After they had achieved errorless performance they were asked to continue going through the maze for many trials. Several Ss reported that their actions were now "guided" by an image of the path rather than by successive linking of actions. Mandler suggests that after practice, when motor activity has become stabilized, components or sequences of behavior become integrated to form a functional unit which is abstracted from and independent of the environment. Such "simultaneous" action permits covert trial and error and allows for flexible behavior.

It appears, then, that what has been broadly classified as enactive representation actually assumes different forms at various ages. In infancy action is the object and is thus one type of motoric symbolism. In early childhood when percept and action are gradually becoming separated and the child is capable of some imagery which is action-free, he is still dependent upon a type of enactive representation. For example, he has difficulty imagining the environment from perspectives other than his own and must depend upon bodily reorientation to make such judgements (Piaget & Inhelder, 1956). For older children and adults enactive representation would seem to be largely task specific, i.e., relied upon mainly for motor or mechanical tasks. This last form of motoric representation appears to be most amenable to the analyses of Mandler (1962), Sheffield (1961), and Bruner (1966).

The discussion thus far has been an attempt to specify the nature of representation in observational learning by examining forms of mediation in other kinds of learning situations. The findings, when applied to observational learning, indicate that although verbal coding is probably useful in a task which does not demand high fidelity in the reproduction of the topography of the modeled behavior, the inadequacy of verbalization is apparent when a task requires that find discriminations be made. When the observer must reproduce specific behaviors which he has seen demonstrated and especially when these behaviors have a high motoric content, an enactive or motoric representation of the behavior might be more appropriate. Since motoric representation has been identified as a type of imagery which is achieved through action, rehearsal of the modeled behavior during the process of observation would seem a natural and, in fact, necessary occurrence. That observers do engage in rehearsal of a motor task is demonstrated in a study by Berger (1966). When observers were exposed to a confederate performing items from the manual alphabet for the deaf, it was found that they spontaneously practiced the hand movements regardless of whether or not they expected to be tested. Margolius and Sheffield (1961) found that unless observers were permitted to practice a mechanical assembly task which they were observing, slower learning resulted. The authors argue that passive observation of a demonstration limits learning to the acquisition of perceptual and symbolic responses. Without the rehearsal of modeled responses, imagery is not likely to become stabilized and "consolidated" (i.e., resistant to interference). When this imagery must then be translated into overt performance after a period of delay it is less effective in guiding behavior.

The purpose of the present research was to investigate further the role of motoric activity in observational learning, the guiding hypothesis being that to the extent that the modeling stimuli involve motoric responses, enactive representation should be an effective mediating device. A pilot study was carried out with fourth-grade children, using a list of paired associates as the modeling stimuli. The stimulus items of the list were letters of the alphabet and the response items were connected-dot patterns. These response patterns could not easily be verbalized. Subjects either practiced connecting the dots with the model (Active group), observed passively (Passive group), or engaged in an interfering motor task (Interference group). It was hypothesized that rehearsal of response patterns would facilitate internalization of action, thus mediating recall and resulting in superior performance for the Active group.

Furthermore, it was expected that the performance of the observational conditions would be affected differentially by the kind of test employed. Since the reproduction of behavior involves a more complex perceptual process than merely recognizing it when it occurs (Piaget & Inhelder, 1956; Macoby, 1968; Macoby & Bee, 1965; Olson, 1968), it was predicted that if both a recognition and a reproduction test were used, the superiority of the Active group would be most marked in a test of reproduction due to the increased likelihood in this group of more refined stimulus discrimination and stronger imagery.

Contrary to prediction, rehearsal of the response resulted in inferior recall as compared to passive observation, although the effect did not reach significance. All groups performed better on the recognition test than on the reproduction test, but the hypothesized interaction between type of test and observational condition was not confirmed. Although the difference between Active and Passive groups was not significant, the direction of the difference is in keeping with other findings of detrimental effects of active involvement in learing (Hillix & Marx, 1960; Rosenbaum, 1967; Rosenbaum & Schutz, 1967). It might be argued, however, that since the best group could recall only 55% of the material, Ss' performance was not stable enough to achieve the "habitual", "consolidated" or "autonomous" state which characterizes motoric representation according to theorists (Bruner, 1966; Mandler, 1962; Sheffield, 1961).

In view of the possible methodological difficulties in the pilot study and the promise of interesting implications for the role of motoric participation in observational learning, the present study was a partial replication and extention of the earlier work. The low terminal level of performance of the Ss in the pilot study indicates that the task was a difficult one. In the present study, therefore, children of different chronological ages were compared on the task and the number of practice trials was extended. In addition, the length of the paired-associate list was varied to determine whether motoric rehearsal would interact with the amount of information to be stored. It was predicted that performance would improve with age and that retention would be better on a short list than on a long one. It was further hypothesized, despite contraindications from the pilot study, that the Active group would be superior to the Passive group and that the effects of rehearsal would be more marked when the list was long than when it was short.

METHOD

Subjects. A total of 88 children served as Ss, 44 from each of grades four and six of Crocker Farm School in Amherst, Massachusetts.

Design. A 2 x 2 x 2 x 10 factorial design was employed, with groups differing as to observational condition (Active and Passive), length of paired-associate list (Short and Long), and grade level (Fourth and Sixth). All groups received ten test trials.

Procedure. Two lists of paired-associates differing in length (adapted from Cook, 1961) were used. One list (Short) contained four pairs, the stimulus items being letters A through D, response items being four connected-dot patterns. The other list (Long) was composed of letters A through H as stimulus items and eight dot patterns as response items. Each dot pattern consisted of two lines connecting four dots of a standard seven-dot setting (see Appendix A). The connected-dot patterns did not resemble any of the stimulus letters.

An overhead projector was used to display the stimuli. In all conditions the model presented the stimulus letter, which was printed on an acetate sheet, and then, on another sheet containing the standard seven-dot setting, drew an imaginary line with a stylus connecting the appropriate dots. Each letter-pattern pair was demonstrated twice. The procedure for the various experimental groups was as follows:

Group Active-Short. *Ss* in this condition received the Short list. Each *S* had a chart containing the standard seven-dot setting at his seat and traced the appropriate dot pattern with a stylus after the model's demonstration.

Group Active-Long. The same procedure was employed as in the previous condition except that the Long list was administered.

Group Passive-Short. *Ss* in this condition received the Short list and were instructed only to pay close attention during the model's performance. No motoric movement was permitted in this group.

Group Passive-Long. In this condition the Long list was given and again *Ss* were instructed to watch the model closely without attempting to rehearse.

A training trial consisted of the model's demonstration followed by *Ss*' participation (Active groups) and continued until all the letter-pattern pairs were presented. The pairs were presented in a different order on each trial. *Ss* in the Active condition were given a practice trial followed by a test trial and so on until ten training and test trials were completed.

Test. A paper and pencil test was administered to each *S* at his seat. The test sheet contained four squares for *Ss* who received the Short list and eight squares for *Ss* who received the Long list, each square containing the standard seven-dot setting. Beside each square was a stimulus letter. The subject was required to connect the dots to form the pattern corresponding to each letter. The order of presentation of the stimulus letters was the same on each test trial. There was no strict time limitation on the test trials, but Ss were encouraged to work quickly and to guess if they were uncertain of their answers.

The procedure was administered to an entire classroom at once. Classrooms were randomly selected as to which would receive the Short and Long lists (teachers reported no differences in composition of the classrooms) and within each classroom Ss were randomly assigned to Active and Passive conditions. Active and Passive groups were separated enough so that there would be no interference between the two. Ss were told that they were going to learn a secret code and instructions stressed that although they would be asked to reproduce the code it was not a test of any kind.

RESULTS

Correct response data. Each of the two component lines of a response pattern was considered separately in order to allow for partially correct responses and each line received 1 point if it was correct. Thus, the highest possible score on the Short list was 8, and on the Long list 16. All scores were converted into percentages.

Since the Hartley F_{max} test did not indicate violation of the homogeneity of variance assumption, the analysis of variance was carried out on the original data. Table 1 shows the mean percentage of correct responses for experimental groups averaged over trials. Significant main effects were obtained for List Length ($F = 37.77$, $df = 1/80$, $p < .001$), Grade ($F = 65.12$, $df = 1/80$, $p < .001$), and Trials ($F = 180.75$, $df = 9/720$, $p < .001$). Reproduction was better on the Short than on the Long list, Sixth-grade Ss were superior to Fourth-grade Ss, and performance improved over trials.

An Observational Condition x Trials interaction was obtained ($F = 3.69$, $df = 9/720$, $p < .001$), as well as an Observational Condition x List Length x Trials interaction ($F = 3.95$, $df = 9/720$, $p < .001$). Both the first- and the second-order interactions can be seen in Figure 1 which presents correction response percentages for observational condition and list length combinations averaged over grade level as a function of trials. Further analyses of the interactions were conducted using the

TABLE 1

Mean Percentage of Correct Responses for Observational Condition, List Length, and Grade

		Observational Condition	
Grade	List Length	Active	Passive
Fourth	Short	80.25	87.26
	Long	60.81	68.78
Sixth	Short	84.61	92.45
	Long	75.49	72.25

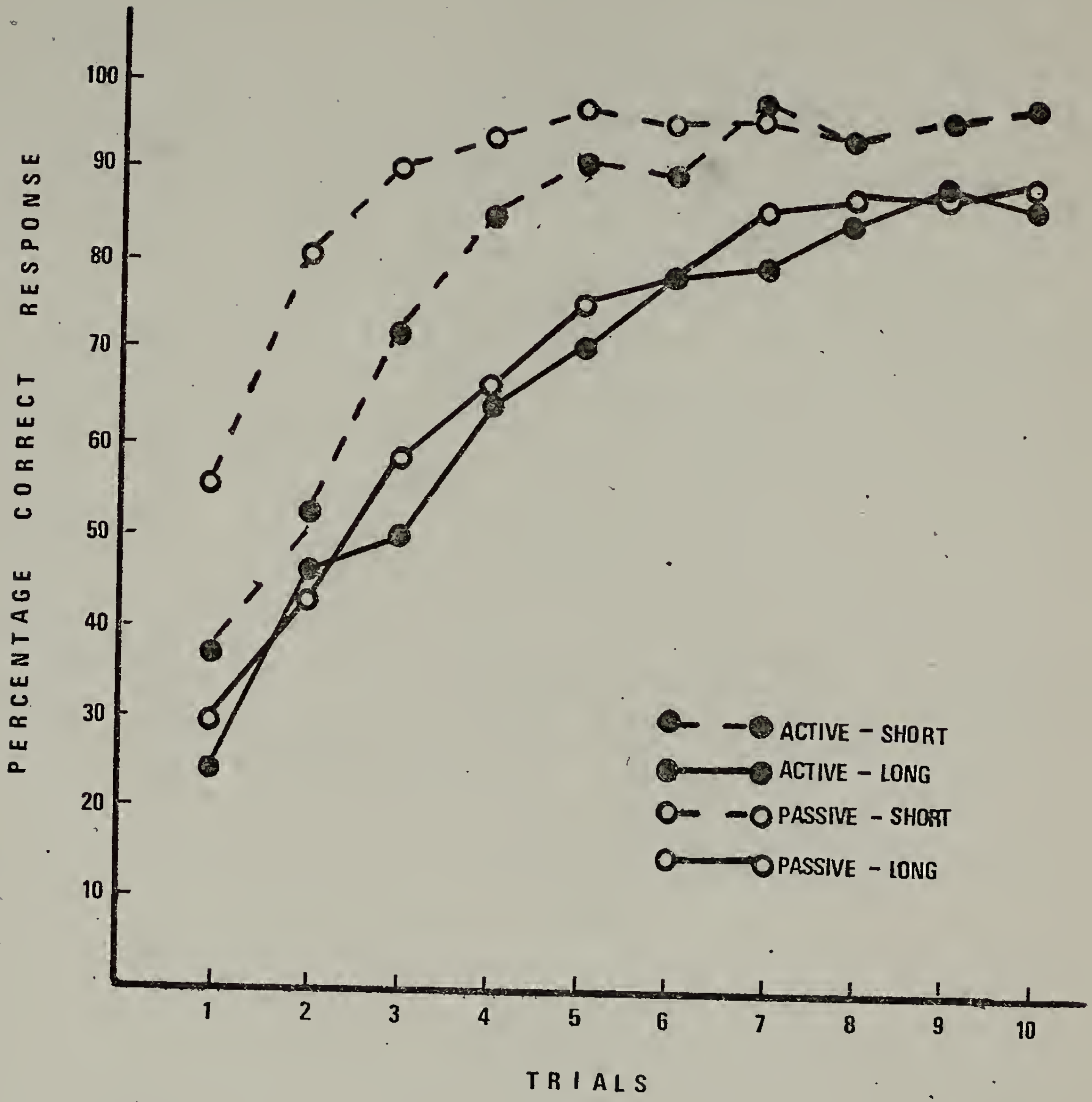

Fig. 1. Mean percentage correct response for groups averaged over grade level as a function of trials.

Newman-Keuls procedure. For the Observational Condition x Trials interaction, pairwise comparisons of means on individual trials revealed no differences between Active and Passive conditions on any trial. However, a trend analysis of the linear component of the interaction indicated differences in the slopes of the two groups ($F = 10.94$, $df = 1/20$, $p < .01$), suggesting that the Passive group learned at a faster rate than the Active group.

Trial by trial comparisons of means for the Observational Condition x List Length x Trials interaction revealed that for the Active group, there was no difference in performance on the Short and Long lists on any trial whereas for the Passive group, performance on the Short list was significantly better than on the Long list for the first four trials.

Significant interactions were also obtained for List Length x Trials ($F = 6.33$, $df = 9/720$, $p < .01$). These interactions can be seen in Figure 2 which presents the correct response percentages for list length and grade combinations averaged over observational condition as a function of trials. Comparisons of the two lists trial by trial for the List Length x Trials interaction revealed that performance was significantly superior on the Short list for the first four trials. When means were compared on individual trials for the List Length x Grade x Trials interaction, it was found that after Trial 1 and until Trial 6, performance was better on the Short list than on the Long list for the Fourth-grade Ss, but there were no differences on the lists for the Sixth-grade Ss.

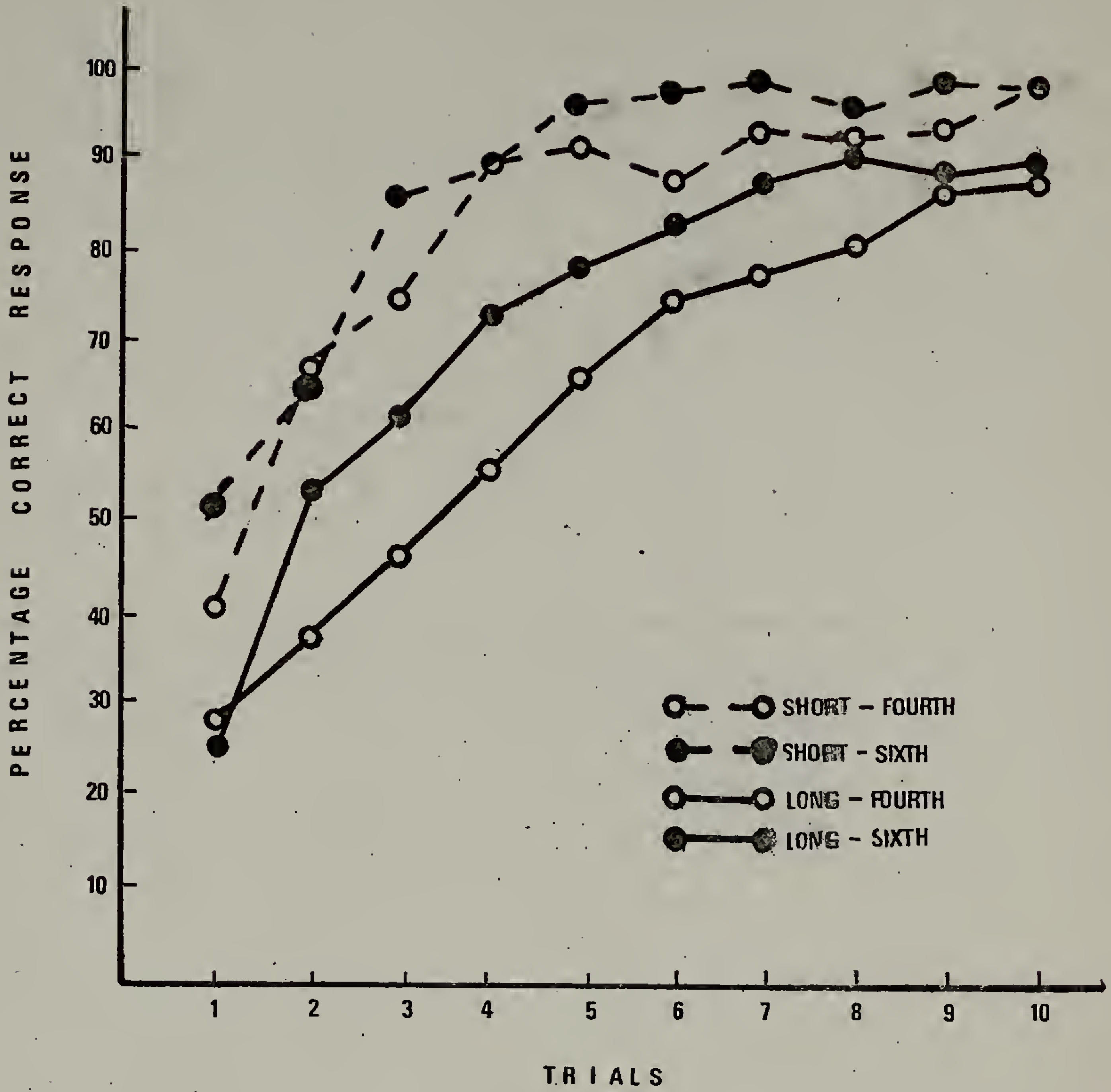

Fig. 2. Mean percentage correct response for groups averaged over observational condition as a function of trials.

Error data. Three major kinds of errors were found in the data and will be referred to as Extralist, Intrusive and Associative types. With the exception of the Associative error which will be described shortly, each of the two component lines of a response pattern was considered separately for error type. A line was scored as an Extralist error if it was not a component of any response pattern within the list. If the line was a component of some other pattern within the list, it was scored as an Intrusive error. An Associative error was one in which the entire pattern was accurately reproduced but was matched with an inappropriate stimulus.

Since Extralist and Intrusive errors seem to indicate different degrees of incomplete response integration, while an associative error indicates incomplete S-R association, comparisons of experimental groups on each of the error types might help to pinpoint the effect of the various treatments on performance.

Separate analyses of variance were performed for each error type. Error data was converted into percentage scores formed by taking the product of the two ratios: the ratio of total errors made (of all types) to total possible errors (depending on list length) multiplied by the ratio of a particular type of error to total errors made. Since the group variances were found to be heterogeneous for each error type, the arc sine transformation was applied to all percentage scores. Table 2 presents the mean percentage error scores averaged over trials for each error type.

TABLE 2

Mean Percentage of Three Error Types for Observational Condition, List Length, and Grade

Grade	List Length	Observational Condition Active	 Passive
		Extralist Error Type	
Fourth	Short	13.21	8.52
	Long	14.26	15.56
Sixth	Short	8.95	5.76
	Long	10.98	13.27
		Intrusive Error Type	
Fourth	Short	4.43	3.64
	Long	20.91	19.06
Sixth	Short	2.22	2.24
	Long	13.59	14.18
		Associative Error Type	
Fourth	Short	5.11	2.54
	Long	15.98	6.65
Sixth	Short	4.90	1.85
	Long	7.32	9.69

For all error types there was a reduction in percentage of errors over trials (Extralist: $\underline{F} = 107.71$, $\underline{df} = 9/720$, $\underline{p} < .001$; Intrusive: $\underline{F} = 7.65$, $\underline{df} = 9/720$, $\underline{p} < .001$; Associative: $\underline{F} = 19.89$, $\underline{df} = 9/720$, $\underline{p} < .001$). There were no differences between Active and Passive groups on any error type except Associative ($\underline{F} = 8.63$, $\underline{df} = 1/80$, $\underline{p} < .005$): the Active group made more of this type error than did the Passive group. Each error type was higher on the Long list than on the Short (Extralist: $\underline{F} = 8.94$, $\underline{df} = 1/80$, $\underline{p} < .005$; Intrusive: $\underline{F} = 93.48$, $\underline{df} = 1/80$, $\underline{p} < .001$; Associative: $\underline{F} = 34.75$, $\underline{df} = 1/80$, $\underline{p} < .001$). Grade level differences were obtained in the frequency of Intrusive errors ($\underline{F} = 7.65$, $\underline{df} = 1/80$, $\underline{p} < .01$) and Extralist errors ($\underline{F} = 4.56$, $\underline{df} = 1/80$, $p < .05$). Fourth-grade Ss making more of both, but no differences were found between grades on Associative errors.

The three error types differed in their pattern of interactions which will be mentioned only briefly here. A more complete picture of the data may be obtained by referring to Table 2 and Appendix B. The interactions which were significant in the correct resposne data were not uniformly reflected in the error data. The Observational Condition x Trials interaction was displayed only in the Extralist error type ($\underline{F} = 3.44$, $\underline{df} = 9/720$, $\underline{p} < .001$). Extralist errors declined more rapidly in the Passive than in the Active condition. The Observational Condition x List Length x Trials interaction which was obtained in the correct response data was significant only for the Extralist errors ($\underline{F} = 2.07$, $\underline{df} = 9/720$, $\underline{p} < .05$). The List Length x Grade x Trials interaction was significant only for Associative errors, ($F = 2.41$, $df = 9/720$, $p < .025$).

DISCUSSION

The major findings of the present study can be summarized as follows: (a) Overt rehearsal of the response patterns resulted in slower learning than passive observation. (b) Performance improved with age. (c) In general, more information was recalled when the amount to be learned was small than when it was large. However, list length interacted with several variables so that qualifications of this statement are required. During early trials, performance was better on the Short than on the Long list for the Passive group, but the Active group showed the same low level of recall on both lists. The effect of list length was also dependent upon grade level, with Fourth-grade _S_s performing better on the Short than on the Long list during early trials, while Sixth-grade _S_s did equally well on both lists.

The grade level difference in performance is in agreement with general findings on the relation between age and learning, and needs no special comment. Similarly, it is not surprising that retention was easier for a smaller than for a larger number of items, especially for younger children. The finding that motoric involvement hindered learning in the present task, however, while confirming the pilot study data, is nevertheless puzzling. The fact that the Active and Passive groups reached the same terminal level of performance but at different rates suggests that early in the learning process, rehearsal produced a source of interference which was later overcome. We can only speculate as to the nature of the interference.

A possibility that quickly comes to mind is that the initially depressed performance of the Active group may have been due to certain laxness in procedure which would have allowed Active Ss to rehearse erroneous response patterns. These errors would then have become resistant to elimination and would have interfered with the fixation of correct responses. However, in as much as was possible, care was taken to insure that the correct dots were being connected so as to minimize this likelihood.

The detrimental effect of observer involvement in the present study is consistent with several other studies in which observers and performers were compared (Hillix & Marx, 1960; Rosenbaum, 1967; Rosenbaum & Schutz, 1967). In these experiments, which involved multiple-choice maze-type learning, performers were required to carry out certain activities not directly relevant to the acquisition of responses to be tested (e.g., decisions concerning the correct response, performance of the motor response). Although in the present study Ss in the Active group were performing precisely those responses which were necessary for the test, it is quite possible that the extraneous activity involved in locating the dots on their practice sheets corresponding to the dots on the model's chart resulted in a fading of part of the memory trace in the Active condition, whereas the Passive Ss could immediately engage in some sort of covert rehearsal while sustaining their attention to the model's chart, which still possessed some cue value even though no actual connecting lines could be seen.

Delayed rehearsal in the Active condition may have contributed to the differences between the present findings on the effect of active involvement on retention and those of Bandura, Grusec, & Menlove (1966) where participation was found to facilitate performance. Although great caution must be exercised in making comparisons between types of involvement (i.e., verbal vs. motoric) when different tasks have been used, in the Bandura _et al._ study, observer participation accompanied the model's performance, whereas in the present study participation followed the model's demonstration. It could be that encoding must occur while the memory trace is strongest in order for facilitation of performance to result.

The notion of a rapidly decaying memory trace which is dependent upon immediate rehearsal for reinstatement may also be thought of in terms of a selective attention theory such as Broadbent's (1958). In this approach immediate memory is viewed as the passage of information from a temporary storage system through a filtering device into a limited capacity system which acts on small portions of information. After passing through the limited capacity system information can be returned to the short-term store. This recurrent circuit or continuous loop operation permits indefinitely long storage as long as no response to other stimuli is required. If, however, the limited capacity system is occupied by other stimuli and information is allowed to remain in the short-term store beyond its time span, loss of that information would result. With respect to the present study, the additional demands on the Active Ss before they could begin actual rehearsal may have been enough to occupy the limited capacity system for a time exceeding the limits of the short-term store.

The question may also be raised as to whether the mode of rehearsal forced upon the Active Ss was actually the most efficient one for the task. Cook (1961) conducted a study similar to the present one in which Ss either copied a visual stimulus or merely observed a model's presentation. Copying was found to interfere with learning. In accounting for the results, Cook suggested that the verbal "guiding" responses which S might have used in copying the figure (e.g., "Now I start here and draw the line down to here, etc.") interfered with a more efficient encoding (such as, "This figure looks like a gully."). The response patterns in the present study, however, were not easily described verbally. A method of encoding which relied on vocalizing the direction of hand movements or on association of the pattern with some object would not be likely to incorporate the fine discrimination between dots which was necessary for accurate reproduction of the response patterns. Moreover, in the pilot study during the procedure for the Passive condition, the E noted that Ss frequently had to be discouraged from furtively rehearsing the patterns by tracing in the air and on the table. This observation suggests that the motoric rehearsal which was required of Active Ss would have been spontaneously chosen by many Ss as an aid to recall. Obviously, spontaneous choice is no guarantee of success.

Although care was taken in the present study to insure that Passive Ss were not making any kind of movements, there was no way to prevent Ss from practicing covertly in the form of miniaturized muscular movements and thus they were far from being "passive". Evidence that such covert activity does occur comes from a study by Berger, Irwin & Frommer (1970) in which a considerable amount of electromyographic activity was found to occur in the hand and arm of observers who were watching the demonstration of hand signals.

The error data analyses did not reveal much about the process underlying the differences in acquisition rate of Active and Passive groups and interpretation of the results is very difficult. Motoric rehearsal did not produce a greater number of Extralist and Intrusive errors, but did result in a higher number of Associative errors than passive observation. It should be noted, however, that Associative errors were quite infrequent in all conditions. Moreover, there seems to be no reason why rehearsal should interfere with the learning of letter-pattern association more than with the integration of the response patterns. The finding that Extralist errors dropped out more quickly in the Passive than in the Active condition, however, and that this error type was the only source of the Observational Condition x Trials interaction, suggests that rehearsal may have prevented the discrimination of relevant from irrelevant response patterns, and that perhaps once the relevant "response pool" was established, pattern integration and letter-pattern association proceded at the same rate as in the Passive condition.

A final point which should be discussed concerns the developmental changes in the use of enactive representation. It was pointed out earlier that the reliance on action-produced imagery is dominant in early childhood and that with increasing age, that mode of encoding is probably reserved for specific tasks having large motor or mechanical components. It may be that the motor requirements of the present task were relatively simple and that, for the age groups used, not sufficient to require motoric feedback in order to form a representation of the stimuli. Indeed, forcing the S to revert to a developmentally inappropriate mode of encoding could have produced a decrement in performance as was evidenced here.

SUMMARY

Eighty-eight fourth- and sixth-grade children observed a model demonstrate a paired-associate task in which the stimulus items were letters of the alphabet and the response items were connected-dot patterns. Half of the *S*s at each grade level observed the model passively, while half practiced connecting the dots. In each of the two observational conditions, half of the *S*s learned a list of eight pairs and half learned a list of four pairs. Performance improved with age and in general was better on the shorter list. Contrary to prediction, however, practicing the response items resulted in slower learning than passive observation.

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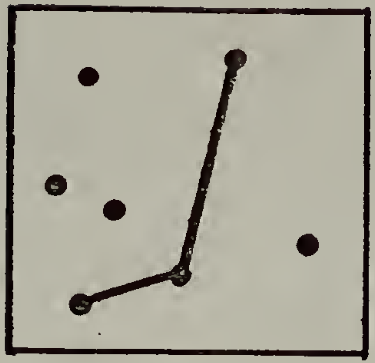
APPENDIX A

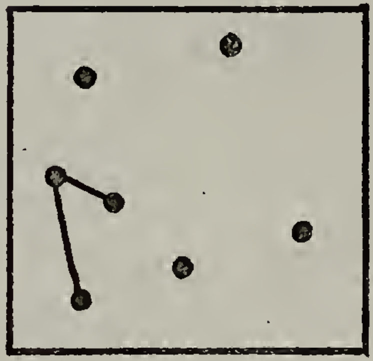
List of Letter-Pattern Pairs

A



B

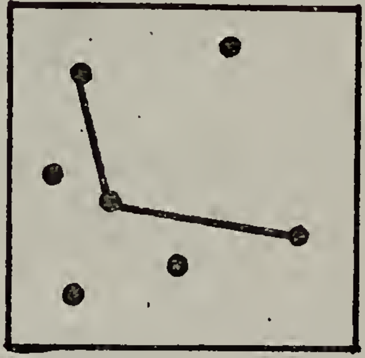
C



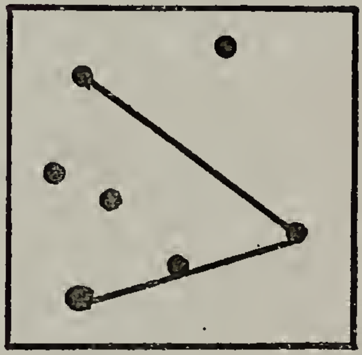
D

E

F



G



H

APPENDIX B

Summaries of Analyses of Variance

Correct Response Data

Source of Variance	df	SS	MS	F
Between				
Observational Condition (O)	1	5277.30	5277.30	3.26
List Length (L)	1	62143.21	62143.21	37.77***
Grade (G)	1	10550.24	10550.24	65.12***
O x L	1	1407.69	1407.69	<1.00
O x G	1	1484.60	1484.60	<1.00
L x G	1	1019.10	1019.10	<1.00
O x L x G	1	1989.01	1989.01	1.23
S/OLG	80	129470.31	1618.38	----
Within				
Trials (T)	9	277334.94	30814.99	180.75***
O x T	9	5662.82	629.20	3.69***
L x T	9	9714.78	1079.42	6.33***
G x T	9	2482.29	275.81	1.62
O x L x T	9	6062.39	673.59	3.95***
O x G x T	9	1962.29	218.03	1.21
L x G x T	9	4104.75	456.08	2.67**
O x L x G x T	9	2720.02	302.22	1.08
ST/OLG	720	122744.60	170.48	----

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

APPENDIX B (cont.)

Extralist Errors

Source of Variance	df	SS	MS	F
Between				
O	1	252.95	252.95	<1.00
L	1	4275.94	4275.94	8.94**
G	1	2180.43	2180.43	4.55*
O x L	1	1811.54	1811.54	3.78
O x G	1	84.82	84.82	<1.00
L x G	1	29.97	29.97	<1.00
O x L x G	1	3.72	3.72	<1.00
S/OLG	80	38273.25	478.42	----
Within				
T	9	72969.91	8107.77	107.71***
O x T	9	2332.18	259.13	3.44***
L x T	9	2942.22	326.91	4.34***
G x T	9	1297.83	144.20	1.81
O x L x T	9	1403.52	155.95	2.07*
O x G x T	9	862.14	95.79	1.27
L x G x T	9	921.98	102.44	1.36
O x L x G x T	9	628.95	69.88	<1.00
ST/OLG	720	54192.52	75.27	----

APPENDIX B (cont.)

Intrusive Errors

Source of Variance	df	SS	MS	F
Between				
O	1	58.14	58.14	<1.00
L	1	41907.84	41907.84	93.48***
G	1	3428.60	3428.60	7.65**
O x L	1	3.24	3.24	<1.00
O x G	1	145.64	145.64	<1.00
L x G	1	1013.94	1013.94	2.25
O x L x G	1	36.49	36.49	<1.00
S/OLG	80	35864.71	448.31	-----
Within				
T	9	30836.25	3426.35	7.65***
O x T	9	498.77	55.42	<1.00
L x T	9	9446.69	1049.63	18.11***
G x T	9	453.34	50.37	<1.00
O x L x T	9	535.39	59.49	1.05
O x G x T	9	390.99	43.44	<1.00
L x G x T	9	184.22	20.47	<1.00
O x L x G x T	9	1224.34	136.04	2.37*
ST/OLG	720	41720.48	57.94	-----

APPENDIX B (cont.)

Associative Errors

Source of Variance	df	SS	MS	F
Between				
O	1	2177.91	2177.91	8.63**
L	1	8769.64	8769.64	34.75***
G	1	586.48	586.48	2.32
O x L	1	24.62	24.62	< 1.00
O x G	1	1725.92	1725.92	6.82**
L x G	1	308.69	308.69	1.22
O x L x G	1	2041.67	2041.67	8.08**
S/OLG	80	20187.35	252.34	-----
Within				
T	9	18851.27	2094.59	19.89***
O x T	9	557.71	61.97	< 1.00
L x T	9	2644.99	182.78	1.73
G x T	9	432.43	48.04	<1.00
O x G x T	9	1021.07	113.45	<1.00
L x G x T	9	2278.04	253.12	2.41*
O x L x G x T	9	1156.43	128.49	1.12
ST/OLG	720	75825.25	105.31	-----