

JOURNAL OF EXPERIMENTAL CHILD PSYCHOLOGY 14, 53-65 (1972)

## A Developmental Comparison of Verbal and Pictorial Mnemonics in Paired-Associate Learning<sup>1</sup>

KEITH HOLYOAK, HATTIE HOGETERP AND JOHN C. YUILLE

*University of British Columbia*

Using a mixed-list design, two types of *E* verbalization (verb and conjunction) were varied factorially with three types of depiction (side-by-side line drawings, interactive line drawings, and interactive photographs) in a picture PA task. Ss were kindergarten and third-grade children. Both recall and recognition procedures were employed. Verbs produced more facilitation than conjunctions, interactive drawings were superior to photographs, but both produced greater learning than noninteractive drawings. These effects did not vary significantly across ages or procedures. The recognition procedure elicited more correct responses overall than the recall procedure only for the elementary group. An error analysis supported the conclusion that imagery is an important mechanism underlying both sentential and pictorial facilitation of learning.

Mnemonics research has become increasingly concerned with the developmental emergence of the capacity to utilize verbal and pictorial mnemonics effectively (e.g., Milgram, 1967; Reese, 1965, 1970b; Rohwer, 1967, 1968; Rohwer, Lynch, Suzuki & Levin, 1967). These studies have demonstrated that placing a paired-associate (PA) in a sentence containing a verb connective is more facilitative than employing a context with a conjunction connective, or simply naming the items. These same studies have also found that a parallel relationship holds for pictorial translations of these types of verbalization. That is, pictures of stimulus and response items engaged in an interaction produce more facilitation than side-by-side pictures of the stimulus and response.

An issue of considerable theoretical importance concerns the relative facilitation provided by verbal and pictorial contexts. Is a sentence with a verb connective more effective than the corresponding action picture, or vice versa? Does the relative effectiveness of the two contexts vary as a function of age? Such questions relate to the general difficulty

<sup>1</sup>This research was supported by grants to the third author from the National Research Council of Canada (Grant APA-327) and from the University of British Columbia.

encountered in attempting to separate analytically, the covert verbal and imaginal processes involved in mediation.

Rohwer (1967) found that sentences plus coincidental (side-by-side) pictures were more facilitative than naming coupled with action pictures for kindergarten and first-grade children, while the reverse was true for children in grades three and six. In the same study, Rohwer found that verb-coincidental elaboration was consistently superior to naming-action elaboration for Ss younger than kindergarten age. Milgram (1967) found that the superiority of sentential as opposed to pictorial mnemonics was greater for 4-year-olds than for older children, up to the age of 9. Davidson and Adams (1970) have reported that for second-grade children, side-by-side pictures coupled with prepositional verbalization facilitate learning more than joined pictures with conjunctive verbalization. These results suggest the following developmental trend in the effectiveness of mnemonics in PA learning: the facilitation produced by pictorial elaboration, relative to parallel verbal elaboration, increases with age.

However, several other studies have failed to replicate the suggested age differences. The developmental trend was not significant in a study by Reese (1965), which included children aged three to seven. Rohwer (1968) found that the naming-action condition was superior to the verb-coincidental condition at all age levels studied (kindergarten, first- and third-grade). At least two other studies (Rohwer *et al.*, 1967; Reese, 1970b) have found no evidence at all for an interaction of materials with age. The former study involved grades one, three and six; the latter study included 3- to 5-year-olds. Consequently, one of the purposes of the present study was to attempt to replicate the finding that the facilitative effect of pictorial materials increases as a function of age.

Several suggested explanations for an interaction between type of elaboration and age were experimentally tested. Paivio (1970) has hypothesized that pictorial materials elicit imagery in the young child, and this imagery functions in mediation; however, the requirement that the child must respond verbally on the recall test interferes with his performance if he has the correct response stored as an image. The older child has acquired more facility in decoding from imaginal mediator to verbal response. It follows from this explanation that the deficiency in pictorial facilitation of PA learning in young children is essentially an artifact engendered by the use of verbal recall as the dependent measure. In the Davidson and Adams study (1970) a recognition procedure was used so that the inferred transition from covert imaginal mediator to overt verbal response was not required. Verbal elaboration was still found to be superior to pictorial elaboration, contrary to Paivio's hypothesis. In order to furnish a more extensive test of this hypothesis,



the present study measured and compared both recognition and recall performance at different age levels.

Rohwer (1970) has developed a alternative explanation of the developmental increase in the effectiveness of pictorial mnemonics. He suggests that maximum facilitation cannot be obtained with imaginal mediators unless the visualized interaction of stimulus and response items is accompanied by a covert verbalization of the interaction. The developmental trend is ascribed to the failure of young children to spontaneously generate such verbalizations when presented with pictorial materials. It follows that more facilitation should be observed for young children than for older children when the *E* provides a descriptive sentence as well as a pictures interaction, as the older children are assumed to produce such verbalizations spontaneously. This deduction was tested in the present study using both recall and recognition measures.

Reese (1970c) hypothesizes that a stored interactive image tends to be "leveled" through forgetting in the direction of simplified images, or "figurative conceptions," of the separate stimulus and response. During this transformation the mediator is effectively lost. He further hypothesizes that detail serves to retard the leveling process. Given this basis, Reese suggests two possible mechanisms that could result in a developmental increase in the effectiveness of compound pictures as mnemonics. These involve two assumptions regarding the perceptual and cognitive activities of younger children in the PA situation, when presented with a compound picture depicting an interaction between the stimulus and response items. First, the young child is less likely to attend to and store the pictured interaction; secondly, he is less likely to spontaneously supply details if the picture is deficient in them. Consequently the leveling process proceeds more quickly in the younger child, and pictorial materials are less effective as mnemonics.

As Reese (1970a) mentions, the visual materials in all experiments related to the question under consideration have been either line drawings (Davidson & Adams, 1970; Milgram, 1967; Reese, 1965, 1970b) or black and white photographs of objects on a uniform gray background (Rohwer, 1967, 1968; Rohwer *et al.*, 1967). These pictures have thus been deficient in details. The present study was designed to test the effects of manipulating detail of compound pictures as an experimental variable, by comparing the effect of line-drawn depictions of stimulus and response interactions with that of color photographs of the same interactions. In this connection, a study by Paivio, Rogers and Smythe (1968) found no significant differences between the free recall of colored and black and white pictures, and Palermo (1970) reports a study by Wicker which found no difference between color photographs and line

drawings as stimuli in a PA task. However, these studies employed adult Ss, and no comparable data are available for children. Reese's hypothesis predicts that detail of stimulus materials should be a more potent variable in learning with younger Ss.

Finally, the present study included an analysis of errors which attempted to further clarify the processes underlying verbal and pictorial elaboration.

#### METHOD

*Subjects.* Ss were 24 kindergarten and 24 elementary school children (23 males and 25 females). The children were selected randomly from a school in a Vancouver suburb. The kindergarten children ranged in ages from 60 to 74 months, with a mean age of 66 months. The elementary school group consisted of children from 96 to 120 months of age, with a mean age of 108 months. Testing location difficulties resulted in 18 of the kindergarten children being tested during class time, while the remainder of Ss were tested at the home of one of the *Es*.

*Materials.* Thirty  $3.5 \times 5$  in. color photographic prints were made of pairs of common objects engaged in interactions (e.g., a puppy chewing an umbrella). Some photos were of toy models, others of actual objects. The background in the photos was either an even, light-colored wall, or, in the case of outdoors shots, the unobtrusive natural setting (e.g., in the photo of a cow wearing a tie, the background was a green pasture field). From these photographs line drawings of the same size and configuration were made using black felt pen on white pieces of cardboard. Finally, separate line drawings were made of all the stimuli and response objects, also on  $3.5 \times 5$  in. cardboard.

Various combinations of these photographs and line drawings were then photographed on color film and mounted as 35-mm slides. The study trial materials were of three types, corresponding to three levels of the depiction variable. One type simply showed side-by-side line drawings of the stimulus and response items. The second type also showed the same side-by-side drawings of the stimulus and response, but beneath them appeared a line drawing of the interaction between the two. The third type was the same as the second except that the interaction was taken from the appropriate color photographs. Slides for the recall and recognition tests each showed the line-drawn stimulus only.

For the recognition task a board was used, on which all the response items, each line-drawn on a  $3.5 \times 5$  in. piece of cardboard, appeared in five columns and six rows. The position occupied by each response picture was random.

*Procedure.* A study-test PA method with individual testing was em-



ployed. A practice trial with six pairs was followed by two trials with a 30-pair list. The first trial consisted of a study phase followed by a recall test and then a recognition test; the second trial contained only a study and a recall phase.

On the first study trial each *S* was presented a mixed list of 30 picture pairs. Each pair was given one of six different treatments. Ten pairs represented each level of the depiction variable: noninteracting line drawings (NL), interaction line drawings (IL), and interacting color photographs (IP). Within each of these conditions were five pairs for each level of the verbalization variable. In the conjunction condition (C), when the slide appeared *E* named the stimulus and response, and then said "the (stimulus) and the (response)." In the verb condition (V) *E* also named the pictured objects, but then said "the (stimulus) (verb) the (Response)," which described the interaction depicted in the IL and IP conditions. The assignment of pairs to conditions was latinized, so that each pair served in each condition for an equal number of *Ss* in each age group. The order of presentation of the pairs was counterbalanced with respect to conditions. The presentation rate was 4 sec/pair.

Immediately after the first study trial, the stimuli were shown alone in a series of slides in an order randomized in blocks of six with respect to the study trial order, at a rate of 4 sec/item. When each slide appeared *E* named it, and *S* attempted to orally produce the correct response in the given interval. All responses were recorded by *E*.

At the completion of the recall test, *Ss* were shown a board with all the response pictures on it. Then the same set of slides of the stimuli alone was repeated. As each stimulus was shown *S* was required to try to point out the correct response. The time interval provided for each response was virtually unlimited; the next slide was shown after a response had been made, or *S* indicated that he was unable to make a response.

Immediately upon completion of the recognition trial the pairs were presented to *S* once more in a second study trial. This was followed by a second recall test, in which the stimuli were reordered.

It should be noted that this procedure confounds recognition performance with Trial 1 recall. This procedure was chosen deliberately to test Paivio's hypothesis concerning recognition. His prediction is that recall differences favoring verbalization in young children will disappear when a recognition task is employed. Hence an age by depiction interaction for recall scores should disappear in the recognition trial. Thus the purpose of the recognition phase was not to obtain a pure measure of recognition, but a contrast recognition with recall.

## RESULTS

The mean total correct for each condition are presented in Table 1. Analysis of variance of the recall data involved the variables: Age, Trials, Verbalization (V vs C), and Depiction (NL vs IL vs IP). In addition to trials,  $F(1,46) = 211.96$ ,  $p < .001$ , the main effects of Verbalization,  $F(1,46) = 31.20$ ,  $p < .001$ , and Depiction,  $F(2,92) = 17.64$ ,  $p < .001$ , were significant. Consistent with earlier findings, pairs in a sentence context were learned more easily than were pairs joined by a conjunction. *Post hoc* analysis of the Depiction effect revealed that all possible comparisons were significant,  $p < .01$ . That is, both the IL and the IP conditions produced greater learning than the NL condition, but the IL condition was more effective than the IP condition.

Although the main effect of Age was not significant, an examination of the interaction revealed that the older children achieved a greater increase in overall performance from Trial 1 to Trial 2 than did the younger children.

A second analysis of variance was performed, similar to the first except that the Trials variable was replaced by a Procedures variable,

TABLE 1  
MEAN CORRECT RESPONSES AS A FUNCTION OF AGE, TYPE OF VERBALIZATION,  
DEPICTION, AND TEST PROCEDURE (BASED ON A MAXIMUM OF 5.0)

Age		Kindergarten ( $n = 24$ )					
Depiction	Side-by-side NL		Interactive line drawing IL		Interactive color photo IP		
	Verb	Conjunction	Verb	Conjunction	Verb	Conjunction	
Trial 1 recall	2.25	1.42	2.75	2.42	2.58	2.17	
Recognition	2.29	1.46	2.92	2.54	2.71	2.63	
Trial 2 recall	3.33	2.46	3.88	3.29	3.46	3.08	
Age		Elementary ( $n = 24$ )					
Depiction	Side-by-side NL		Interactive line drawing IL		Interactive picture IP		
	Verb	Conjunction	Verb	Conjunction	Verb	Conjunction	
Trial 1 recall	1.92	0.83	2.58	1.75	2.25	1.88	
Recognition	2.79	1.42	3.42	2.67	3.08	2.42	
Trial 2 recall	3.58	2.58	3.92	3.29	3.96	3.46	

the two levels of which were Trial 1 recall and the recognition performance. The results closely resembled those obtained in the analysis of recall alone. Procedures,  $F(1,46) = 25.27$ ,  $p < .001$ , Verbalization  $F(1,46) = 35.16$ ,  $p < .001$ , and Depiction,  $F(2,92) = 20.69$ ,  $p < .001$ , were all significant, as was the Age  $\times$  Procedures interaction,  $F(1,46) = 10.81$ ,  $p < .01$ . No other effects achieved significance.

The main effect patterns were the same as those revealed by the first analysis. Tests of the simple main effects contained in the Age  $\times$  Procedures interaction indicated that the superiority of recognition over recall was contained entirely in the scores of the elementary school children,  $F(1,46) = 34.58$ ,  $p < .001$ .

Because of its particular theoretical interest, a comparison was made between the VNL (verb, side-by-side drawing) and the CIL condition (conjunction, interactive line drawing). The means for these two conditions were obtained by collapsing across all other variables, as neither the Verbalization nor the Depiction variable entered into any significant interactions. The resulting means did not differ significantly—8.08 correct in the VNL condition, 7.98 in the CIL condition.

In order to obtain a more complete picture of performance differences, an analysis of the types of errors was performed. All intrusion errors were tabulated, including overt errors in the recall condition and confusion errors on the recognition trial. Table 2 presents these intrusions as a percentage of the total errors, for each condition. Intrusions were more frequent for kindergarten children during recall,  $\chi^2(1) = 4.21$ ,  $p < .05$ , and with the elementary group on the recognition trial,  $\chi^2(1) = 10.06$ ,  $p < .005$ .

A second error analysis involved classification of errors as visual or semantic errors. Three adult judges classified each of the 30 response pictures in two ways. All responses semantically related to a particular

TABLE 2  
INTRUSION ERRORS AS A PERCENT OF TOTAL ERRORS FOR  
EACH AGE AND TEST PROCEDURE<sup>a</sup>

Age	Procedure		
	Trial 1 recall	Recognition	Trial 2 recall
Kindergarten	13.7 (54)	38.3 (143)	23.9 (58)
Elementary	8.8 (42)	55.1 (188)	19.9 (44)

<sup>a</sup> Note. Parentheses indicate absolute number.

response were grouped (e.g., foods, animals); and all responses judged to be visually similar to a response were grouped (e.g., hot dog, banana; pail and basket). On the basis of these groupings (upon which all judges agreed), the frequencies of two overlapping types of intrusion errors were tallied. Semantic errors were those incorrect responses semantically related to the correct response. Visual errors were those errors visually similar to the correct response.

In order to obtain a reliable estimate of semantic and visual errors within each of the six conditions defined by the factorial combination of the two levels of Verbalization and three levels of Depiction, scores were collapsed across the two age groups and all three test trials. The number of semantic errors as a percentage of intrusion errors are reported in Table 3. These results indicate a greater frequency of semantic errors for those pairs for which verbal and/or pictorial mnemonics were provided. Semantic errors were proportionately more frequent in the verb than in the conjunction conditions,  $\chi^2(1) = 6.68$ ,  $p < .02$ . The overall effect of the three levels of Depiction was not significant,  $\chi^2(2) = 3.63$ ,  $p < .05$ . However, a significant difference was obtained between levels of Depiction when the verbalization provided contained a conjunction,  $\chi^2(2) = 6.05$ ,  $p < .05$ . This difference was mainly the result of the disproportionately low number of semantic errors committed in the CNL condition. The same pattern of differences was obtained when proportions of total errors were examined.

Overall, 66.7% of all semantic errors were also classified as visual errors.  $\chi^2$  tests revealed that this proportion did not differ among the six experimental treatments, or between age groups or test procedures. In order to assess the meaning of this classification, it was necessary to estimate the relative magnitudes of the response sets from which visual and nonvisual semantic errors were drawn. As only 4.8% of all semantic errors obtained were extralist responses, this estimate was based on the set of possible intralist semantic errors agreed upon by the three judges. Fifty-five possible intralist semantic errors were identified, of which

TABLE 3  
PERCENTAGE OF SEMANTIC ERRORS AS A FUNCTION OF TYPE OF  
VERBALIZATION AND DEPICTION

Verbalization	Depiction		
	NL	IL	IP
Verb	30.4	24.4	35.1
Conjunction	10.7	22.8	24.4



only 15, or 27.3%, were also classed as visual errors. Such an estimate suggests that the obtained percentage of semantic errors which were also visual errors is considerably higher than that which would have been expected by chance.

Four possible intralist responses were rated as visually confusable but completely unrelated to the correct response on the basis of meaning. Only one instance of any of these possible errors was found in the data.

#### DISCUSSION

The present study once again demonstrates the powerful facilitative effects of both sentences and interactive pictures in PA tasks, replicating previous findings (Milgram, 1967; Reese, 1965, 1970b; Rohwer, 1967, 1968; Rohwer *et al.*, 1967). However, the present results offer no support to the hypothesis that the capacity to utilize pictorial mnemonics effectively develops later in childhood than the capacity to utilize verbal mnemonics. The operations of presenting a sentence with a verb connective, or a line-drawn interaction, appear to afford parallel and equal facilitation for kindergarten and older children, under both recall and recognition procedures. This equality cannot be attributed to "priming" effects: the highly significant main effects of Verbalization and Depiction, especially the fact that a combination of the two modes of mnemonic was more facilitative than either one alone, suggest that the mixed list context did not elicit any substantial amount of spontaneous S-generated mnemonics for those pairs which were presented without imposed mnemonics, or with only one mode of mnemonic. The present study is thus added to several other failures to replicate the suggested developmental trend (Reese, 1965, 1970b; Rohwer, 1968; Rohwer *et al.*, 1967).

The failure to reveal an interaction of mode of mnemonic with age affords little support to the hypotheses which various investigators (Paivio, 1970; Reese, 1970c; Rohwer, 1970) have advanced as possible explanations of such an interaction. Furthermore, none of the specific predictions concerning children's learning which were derived from the several models were supported. Some of the present results in fact contradict these models. Paivio's (1970) response availability hypothesis predicted that pictorial mnemonics would produce relatively greater facilitation under a recognition rather than a recall procedure for younger children. This difference did not emerge; in fact, the recognition procedure did not elicit a significant overall increase in the absolute number of correct responses made by the kindergarten children. This suggests that if the S-R pairs are stored imaginally, the young child encounters no more difficulty in retrieving the image and producing its verbal label than

he does in retrieving the image and matching it with a large number of possible picture responses.

Rohwer (1970) has suggested that pictorial elaboration is maximally effective only when a verbal label for the action depicted is stored along with the image, and that the young child is less likely to store such a label. This hypothesis predicts that the addition of *E*-supplied sentences to the IL and IP conditions should produce more additional facilitation with the younger than with the older *Ss*. Such an effect would have shown up in a Verbalization  $\times$  Depiction  $\times$  Age interaction. This interaction did not approach significance in either analysis, and the trend was in fact opposite to that predicted by Rohwer's hypothesis.

Reese's (1970c) hypothesis that detail of stimulus materials is a major parameter of the effectiveness of pictorial elaboration for young children also finds no support in the present results. His model predicts that color photographs, which contain considerable detail, should be superior to simple line drawings as mnemonics, particularly with kindergarten children. The present data reveal no age differences in the effect of the Depiction variable; furthermore, while the IP condition was greatly superior to the NL condition, it produced slightly, but reliably, less facilitation than the IL condition. Greater detail of stimulus material thus was not associated with greater retention. This finding, along with the results of Paivio *et al.* (1968) and Wicker (Palermo, 1970) support the general conclusion that detail is not the prime determinant of the efficacy of imaginal processes in learning.

Two possible explanations for the reduced facilitation obtained with color photographs suggest themselves. It may be that the extra detail provided in fact interferes with storage and/or retrieval of the items, simply by burdening *S* with the need to process additional and superfluous information. An alternative possibility is based on the fact that the objects in the photograph, due to their greater detail, bear less resemblance to the line-drawn stimulus and response than do those in the corresponding interactive line drawing. Thus when the line-drawn stimulus is shown alone on a test trial, the *S* is perhaps less likely to match it with his stored image of the photographed interaction, and hence less likely to retrieve the correct response. This hypothesis could be tested experimentally, as it predicts that photographs would be as facilitative as line-drawn interactions if the side-by-side pictures of the *S*-*R* pairs were omitted on the study trials (or if they were also photographs when the interaction was presented as a photograph), and the stimuli on the test trials were presented as photographs for those pairs for which the study-trial interaction had been a photograph.

An unexpected aspect of the data was the absence of a main effect of



Age. The trend of the recall results actually favored the kindergarten children. Informal observation of the behavior of the two age groups in the test situation suggested that certain variables, probably best classed as motivational, depressed the absolute level of performance in the elementary group. These children seemed more anxious to "do well" on the test. They showed more hesitancy in responding on the recall tests, and more often appeared to miss responses due to the limited time in which they had to respond. The proportionately lower number of intrusion errors made by the older children on recall (Table 2) lends support to this observation. Their unwillingness to risk "foolish" answers may have resulted in some suppression of correct responses, and high anxiety level may have also interfered with their concentration on the study trials. The kindergarten children appeared much more relaxed in their perception of the testing situation. They were explicitly instructed that the experiment was a "game," while the older children were not. Furthermore, they were likely more familiar with oral responding on tests.

A motivational interpretation of the lack of an age effect is supported by the highly significant Age  $\times$  Trials interaction in the recall analysis. While the second trial produced a significant increase in the overall performance of both groups, the mean improvement was much greater for the older children. This suggests that the initial decrement in the performance of the elementary group was transient, and that the older children would have surpassed the kindergarten children if a trials-to-criterion measure had been used.

In the Trial 1 recall vs recognition trial analysis, an Age  $\times$  Procedures interaction qualified the significant superiority of recognition over recall performance; this difference was entirely contained in the scores of the older children. The dramatic increase in the overall means for the elementary group (from 11.21 to 15.80 correct), without an intervening study trial, was undoubtedly in part the results of the suppression of correct responses on Trial 1 recall. However, the magnitude of the effect, together with the complete lack of any parallel increase on the part of the kindergarten children, suggests that more than this may have been involved. The older children appeared to use more systematic scanning techniques in surveying the possible responses, and demonstrated more deliberation in choosing a response. As Table 2 shows, on the recognition trial a proportionately greater number of intrusion errors were made by the elementary than by the kindergarten group. When uncertain of the answer, the older children tended to adopt the strategy of eliminating as many responses as possible and then guessing. Further research is clearly necessary to determine whether this age difference in the



utilization of a recognition procedure may be attributed entirely to motivational differences in the present sample, or whether it reflects more basic developmental changes in cognitive abilities.

What can be said concerning the mechanisms underlying verbal and pictorial facilitation of PA learning? Table 3 presents the proportion of intrusion errors in each experimental condition which were classed as semantic errors. These proportions are sufficiently substantial to suggest that, on occasion when a *S* cannot produce the correct response, he nevertheless remembers its approximate meaning in some way. The proportions of semantic errors were greatest in those conditions which received sentential and/or pictorial mnemonics. Presumably, the pair members and their interaction, as presented in mnemonics, are stored as a meaningful unit on the study trials. On test trials this mediator is recalled, and the meaning contained in it is used as a criterion in a decision process involved in selecting a response. If mediator recall is incomplete, the *S* may be uncertain of the exact response, yet still be able to restrict his choice to items of a certain general meaning. If at this point he guesses incorrectly, he will make a semantic error.

The majority of semantic errors were also classified as visual errors, a type of confusion which might be expected to correlate positively with imaginal coding. This indicates that while verbal and other modes of representation no doubt play a role, the meaning of mediators is commonly stored along with a visual image. The fact that responses visually similar to the correct response, but unrelated to it in meaning, did not appear as intrusions, implies that the role of imagery in this task cannot be divorced from meaning. The image is always interpreted by the *S*; if the mediator is recalled imperfectly, he may make a visual error, but this response will always also relate to the mediator through meaning.

The present results thus support the conclusion that imagery is a preferred and effective mode of mediation in the PA learning of pictures, and may be elicited by both interactive pictures and by concrete sentences. The capacity to benefit from both types of mnemonic is well developed in children of age 5 and older.

#### REFERENCES

- DAVIDSON, R. C., & ADAMS, J. F. Verbal and imagery processes in children's paired-associate learning. *Journal of Experimental Child Psychology*, 1970, **9**, 429-435.
- MILGRAM, N. A. Verbal context versus visual compounds in paired-associate learning by children. *Journal of Experimental Child Psychology*, 1967, **5**, 597-603.
- PATVIO, A. On the functional significance of imagery. In H. W. Reese (Chm.), *Imagery in children's learning: A symposium. Psychological Bulletin*, 1970, **73**, 383-421.

- PAIVIO, A., ROGER, T. B., & SMYTHE, P. C. Why are pictures easier to recall than words? *Psychonomic Science*, 1968, **11**, 137-138.
- PALERMO, D. S. Imagery in children's learning: discussion. In H. W. Reese (Chm.), Imagery in children's learning: A symposium. *Psychological Bulletin*, 1970, **73**, 383-421.
- REESE, H. W. Imagery in paired-associate learning in children. *Journal of Experimental Child Psychology*, 1965, **2**, 290-296.
- REESE, H. W. Imagery and contextual meaning. In H. W. Reese (Chm.), Imagery in children's learning: A symposium. *Psychological Bulletin*, 1970, **73**, 383-421. (a).
- REESE, H. W. Imagery in children's paired-associate learning. *Journal of Experimental Child Psychology*, 1970, **9**, 174-178. (b).
- REESE, H. W. Implications of mnemonics research for cognitive theory. Paper presented at the Southeastern Conference on Research in Child Development, Athens, GA, April 1970. (c).
- ROHWER, W. D., JR. Social Class Differences in the Role of linguistic structures in paired-associate learning: Elaboration and learning proficiency. Final report on U. S. Office of Education Basic Research Project No. 5-0605, Contract No. OE 6-10-273, November 1967.
- ROHWER, W. D., JR. Socioeconomic status, intelligence and learning proficiency in children. Paper presented at the meeting of the American Psychological Association, San Francisco, September 1968.
- ROHWER, W. D., JR., Images and pictures in children learning: Research results and instructional implications. In H. W. Reese (Chm.), Imagery in children's learning: A symposium. *Psychological Bulletin*, 1970, **73**, 383-421.
- ROHWER, W. D., JR., LYNCH, S., SUZUKI, N., & LEVIN, J. R. Verbal and pictorial facilitation of paired-associate learning. *Journal of Experimental Child Psychology*, 1967, **5**, 294-302.