DOCUMENT RESUME

ED 085 077 PS 006 841

AUTHOR Ornstein, Peter A.; Liberty, Charles
TITLE Rehearsal Processes in Children's Memory.
SPONS AGENCY Public Health Service (DHEW), Washington, D.C.
PUB DATE Mar 73
NOTE 15p.; Paper presented at the biennial meeting of the Society for Research in Child Development (Philadelphia, Pennsylvania, March 29 - April 1, 1973)

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS *Age Differences; *Elementary School Students; *Junior High School Students; Learning Processes; *Memory; Mental Development; *Recall (Psychological); Thought Processes
IDENTIFIERS Rehearsal Processes

ABSTRACT

This study investigates developmental trends in free recall, with emphasis on rehearsal processes. An overt rehearsal technique was used in which 28 children in grades 3, 6, and 8 were instructed to rehearse out loud while trying to memorize a list of unrelated nouns. Control groups at each age level received standard free recall instructions, with no mention of rehearsal. Findings were consistent with earlier studies: older children performed better than younger subjects. The major developmental differences occurred over the primacy and middle sections of the serial position curve. Analysis of the data indicates that younger children use more passive rehearsal strategies than older children. They tend to rehearse only the item currently presented, while eighth graders intermix large numbers of items. Discussion is based on this observation, and the implication is that the number of rehearsal contexts may be more important than the number of times an item is rehearsed in long-term memory storage. (DP)

Rehearsal Processes in Children's Memory[1]

Peter A. Ornstein and Charles Liberty
Princeton University

Developmental studies of free recall have consistently, and not surprisingly, shown that older children outperform younger children in this task. However, the mechanisms underlying this improved recall performance are far from clear. Today I should like to examine free recall in children, and in particular, rehearsal processes in free recall, from the point of view of Atkinson and Shiffrin's (1968) information processing model of memory. Atkinson and Shiffrin's framework has been selected as a guide for discussion because it stresses the role of rehearsal in memory, and rehearsal is thought to be of critical importance in understanding memory development in children.

Atkinson and Shiffrin distinguish between the structural features of memory, i.e , those aspects of the memory system which are permanent and "built-in,"and control processes, i.e., those features which are readily modifiable by the subject and can be changed from situation to situation depending upon the task demands of the moment. Examples of structural features are the sensory register, short-term store, and long-term store. Control processes include encoding techniques, search plans, and rehearsal strategies. In a sense, Atkinson and Shiffrin distinguish between the basic hardware of the memory system (i.e, the structural features) and the software (i.e., control processes) that can be utilized to "operate" the memory system. The control processes are of particular importance in the movement of information through the memory system. In terms of Atkinson and Shiffrin's model, information that is not lost from the

---

[1] Draft of a paper presented at the meetings of the Society for Research in Child Development, Phila., Pa., Spring, 1973. This research was supported by grant MH 22042 from the United States Public Health Service to the first author.

sensory register may be passed into the short-term store. If information resides in the short-term store for sufficient duration, it may be transferred into the long-term store. Rehearsal is a control process which is thought to be important both for maintaining information in short-term store as well as for transferring it to long term store.

The importance of rehearsal in inderstanding the development of memory in children is suggested, in part, by serial position evidence from free recall experiments. By now there is a fair amount of evidence (e.g., that of Glanzer and Cunitz, 1966) indicating that the serial position curve in free recall can be viewed as being composed of two separate components. Recall from the beginning (primacy) and to some extent the middle positions is thought to be from long-term store, while recall from the terminal positions is assumed to be from short-term store. When one examines serial position functions generated by children of different ages, such as those presented by Cole, Frankel and Sharp (1971), the major differences in performance are observed over the beginning and middle positions, with the older children recalling more at these positions than the younger ones. In contrast, there are no large differences in terms of the recall of items from the terminal positions. If these findings are interpreted in terms of Atkinson and Shiffrin's model, it may be that there are interesting developmental changes in terms of subjects' abilities to store and retrieve information from long-term store. Since rehearsal is a process which is under subject control, and which greatly influences the transfer of information from short- to long-term memory, it was thought that an analysis of rehearsal processes could be important in understanding these developmental data.

The importance of rehearsal in children's memory has also been suggested by the work of Flavell (1970), Hagen (1971) Belmont and Butterfield (1971), Liberty and Ornstein (1973) and others. Data gathered by these investigators suggest that

the frequency of spontaneous rehearsal in memory tasks increases with age, that children may become more active memorizers as they mature, and that rehearsal training procedures can be employed to enhance performance in certain situations. However, in contrast to the detailed analyses of adult rehearsal patterns, this work on children has been incomplete. While it is now clear that rehearsal is important in understanding memory development, detailed information about the dynamics of rehearsal is lacking. The present investigation utilized Rundus' (1971) overt-rehearsal technique to gather some of this needed information concerning age changes in rehearsal strategies in free recall.

By instructing college-age subjects to rehearse aloud while each stimulus item was being presented, Rundus obtained a "rehearsal set" for each to-be-remembered item for each list presented to his subjects. An analysis of the composition of these sets indicated that it was possible to relate rehearsal patterns to the form of the serial position curve. For example, Rundus has argued that the primacy effect in free recall is mostly due to the greater rehearsal afforded the initial items on the list. In addition, it was shown that the recall of items from the initial and middle serial positions, those sections presumably due to retrieval from long-term store, is influenced by the number of times the items have been rehearsed. In contrast, the recall of items from short-term store, i.e., the recency effect, is not affected by the number of rehearsals.

In the present investigations, groups of 28 third, sixth, and eight grade children, drawn from schools near Princeton, New Jersey, were presented with a list of 18 unrelated nouns for five trials. These subjects were asked to rehearse aloud during the 5-second presentation of each item. In addition, control groups of subjects at each grade level were given stan-

dard free recall instructions. An oral recall period followed each of the five trials. Subjects were free to recall the items in any order they wished.

Recall performance, both for the overt rehearsal and control subjects, was comparable to previously reported data. Recall improved over trials for subjects of all ages, and the older children performed better than the younger ones. Furthermore, the performance of the overt rehearsal groups was slightly below the level of the control groups for subjects of all ages. The recall data, as a function of blocks of two serial positions, for the three overt rehearsal groups are shown in Slide I. In

---

Present Slide I

---

accord with already published data, it can be seen that the major differences between these functions occur over the prerecency portions of the curve. Note that there is virtually no primacy effect for the third graders, while that for the sixth graders is below the level of the eighth grade subjects. Thus, the major developmental differences in recall performance occur over the primacy and middle sections of the serial position curve. The serial position functions generated by the control groups were similar, although the primacy effect for the two older groups was somewhat reduced.

How do the obtained rehearsal data relate to these serial position data? Slide II shows a plot of the number of rehearsals

---

Present Slide II

---

for each item as a function of serial position. Note that the items initially presented were rehearsed more frequently than the middle and terminal items. The data for the sixth and

eighth graders are rather similar to that presented by Rundus. Thus, the items that these subjects recalled from long-term store were accompanied by greater amounts of rehearsal. There are aspects of these data, however, which suggest that the number of times an item is rehearsed is not the critical determiner of recall performance. First note that the items in the middle serial positions are actually rehearsed more by the third graders than by the sixth and eighth graders, and of course, they are recalled less well. Also note that the third graders rehearse the beginning few items more than the middle items, but there is no difference in the recall of these two classes of items. Thus, the serial position curve for the third graders is flat over the entire pre-recency portion, indicating that the greater rehearsal of the initial items did not result in their greater recall.

If the number of rehearsals received by an item is not related to recall, at least with the youngest subjects, then what is? We now turn to an examination of the content of the rehearsal sets for the different age groups. Slide III presents

---

Present Slide III

---

sample rehearsal sets, i.e., the words rehearsed when a given item was presented, for a typical eighth grade and a typical third grade subject. Please examine the top half of this slide first. Note that when the first item (YARD) is presented, this eighth grade subject repeats the word three times. When the second item is presented, both words are rehearsed (CAT, YARD, YARD, CAT). Now, when the third item (MAN) is presented, note that the first three items are rehearsed together. Similarly, when the fourth word is presented, all four items are rehearsed together in the same rehearsal set. Obviously this pattern cannot be maintained over all of the items on the list, but the point

is that we are viewing a rather active pattern of rehearsal where there is a considerable effort being made to incorporate several items into each rehearsal environment. This pattern, in fact, is very similar to that found by Rundus with college students. In contrast, now let us examine a third grader's protocol. Note that this subject tends to rehearse the item that is currently being viewed only, or that item in combination with only one other item. In comparison with the rehearsal technique of the eighth grader, this is a very inactive or passive strategy. Data such as these, for all of the subjects, are summarized in Slide IV which contains a

---

Present Slide IV

---

plot of the number of different items present in a rehearsal set, i.e., the number of different items rehearsed together, as a function of serial position blocks for the three age groups. By definition, only one item can be present in the first rehearsal set (on trial 1, at least), while two can be present in the second set, three in the third, and so on. The curves for all three groups rise over the first few serial positions, and then level off. The difference between the asymtotes for the three age groups is very striking. Note that while the sixth and eighth graders are rehearsing between four and four and a half items together over the bulk of the rehearsal sets, the third graders are only rehearsing two and a half items. Thus, while the older subjects are intermixing a relatively large number of items, the third graders seem, by and large, to be rehearsing the item currently being presented in a very limited context.

Another way of viewing the obtained rehearsal data is to examine the number of different rehearsal sets in which an item appeared. These were considerably greater for the older

subjects, the mean values being 2.25, 3.56, and 3.74 for the third, sixth, and eighth grade children, respectively. Again, these data indicate that the rehearsal environment of older children is much more varied than is that of younger children. In a sense, the third grade subjects appeared to rehearse in a rote fashion by repeating an item in a very limited context, while the older subjects showed more active patterns of rehearsal. These data imply that the rehearsal environment of items may be a more critical determiner of recall performance than is the number of times an item is rehearsed. For the older subjects, the items that were rehearsed a great number of times were in fact rehearsed in a great variety of different contexts. On the other hand, the items that the third graders tended to rehearse a great deal tended to be rehearsed in a very restricted environment. These data are also consistent with Fagen's (1972) recent finding that the greater recall of children of above average intelligence, in comparison with that of average children, was accompanied by more active patterns of rehearsal.

It should be noted that these patterns of rehearsal for the subjects of different ages, and the corresponding forms of the serial position curve, are completely consistent with a number of rehearsal training experiments. Thus, for example, Palmer and Ornstein (1971) found that the primacy effect is eliminated in serial probed recall, and Atkinson and Shiffrin (1971) obtained similar findings in free recall, when adults were forced to rehearse only the item currently being presented. Also, Palmer and Ornstein found comparable effects when subjects were instructed to rehearse the item currently being presented along with the previously presented item. Palmer and Ornstein's data for adult subjects are shown in Slide V. Note that the primacy effect was clearly eliminated for those subjects re-

hearsing in a paired associate (PA) fashion. In the present

Present Slide V

---

experiment, third graders exhibited a great tendency to rehearse in this restricted fashion, and they too had a serial position function with a flat primacy portion. Similarly, when adults were asked to include items in many different rehearsal sets by rehearsing cumulatively, typical or enhanced primacy effects were observed by Atkinson and Shiffrin in free recall and by Palmer and Ornstein in serial probed recall. Palmer and Ornstein's data for the cumulative rehearsers are shown as the upper curve in this slide. In the present experiment, sixth and eighth graders showed a much greater tendency to incorporate each item into a number of different rehearsal sets, and they exhibited increasingly pronounced primacy effects. An implication of the data presented here today is that it may not be the number of times that an item is rehearsed that is important for storage in long-term store, but rather the number of different contexts (perhaps, for example, the number of different rehearsal sets in which an item appears). Although the rote repetition of material may be sufficient to maintain information in short-term store, it is interesting to speculate that active rehearsal is required for transfer to long-term store. If this interpretation is correct, then the transfer to long-term store observed for subjects rehearsing cumulatively by Palmer and Ornstein and Atkinson and Shiffrin may have been due to the greater number of contexts in which items were rehearsed, and not just the greater number of repetitions. Further, the primacy effect in free recall may be due to the fact that the initial items have been incorporated into a large number of rehearsal sets.

It seems clear, then, that improvement in recall with age is at least in part due to the development of active rehearsal patterns. In addition, findings such as these are related to general questions of massed versus distributed practice and the spacing effect in free recall, and in particular to variable encoding interpretations of this latter effect. The older children in this experiment appeared to be rehearsing in a distributed fashion and to be encoding the to-be-remembered items in a number of different contexts. It also seems clear that models of memory such as that of Atkinson and Shiffrin may need to account for at least two forms of rehearsal -- one for maintaining information in short term store and a second type for the more permanent encoding of information in long-term store.

REFERENCES

Atkinson, R. C., & Shiffrin, R. M. Human memory: A proposed system and its control processes. In Spence, K. W., & Spence, J. T. (Eds.) The Psychology of learning and motivation, Vol. 2, New York: Academic Press, 1968.

Atkinson, R. C., & Shiffrin, R. M. The control of short-term memory. Scientific American, August, 1971, 82-90.

Belmont, J. M, & Butterfield, E. C. What the development of short-term memory is. Human Development, 1971, 14, 236-248.

Cole, M., Frankel, F., & Sharp, D. Development of free recall learning in children. Developmental Psychology, 1971, 4, 109-123.

Fagen, J. F., III. Rehearsal and free recall in children of superior and average intelligence. Psychonomic Science, 1972, 28, 352-354.

Flavell, J. H. Developmental studies of mediated memory. In Reese, H. W., & Lipsitt, L. P. (Eds.) Advances in child development and behavior, Vol.5, New York: Academic Press, 1970.

Glanzer, M., & Cunitz, A. R. Two storage mechanisms in free recall. Journal of Verbal Learning and Verbal Behavior, 1966, 5, 351-360.

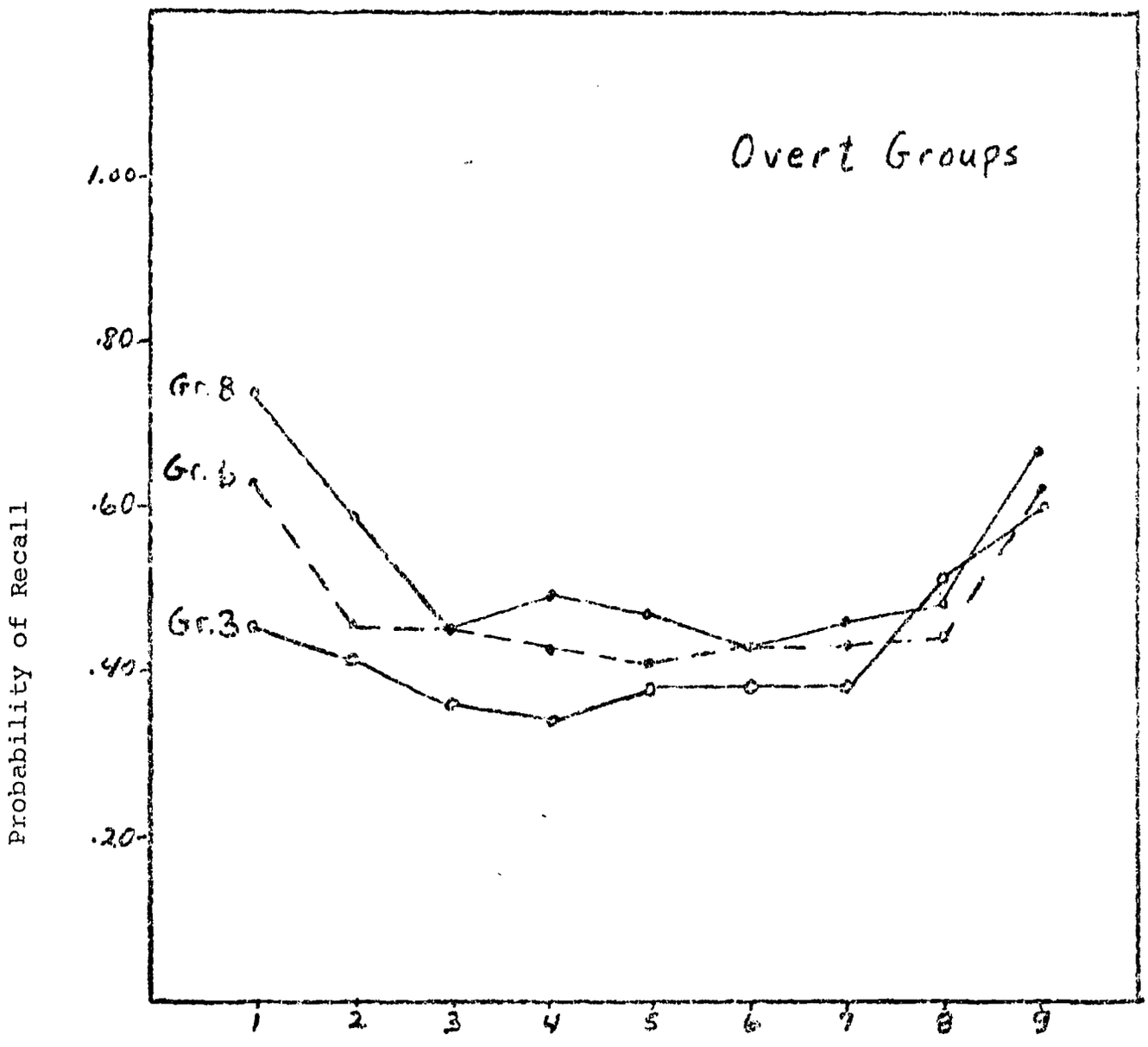
Hagen, J. W. Some thoughts on how children learn to remember. Human Development, 1971, 14, 262-271.

Liberty, C., & Ornstein, P. A. Age differences in organization and recall: The effects of training in categorization. Journal of Experimental Child Psychology, 1973, 15, 169-186.

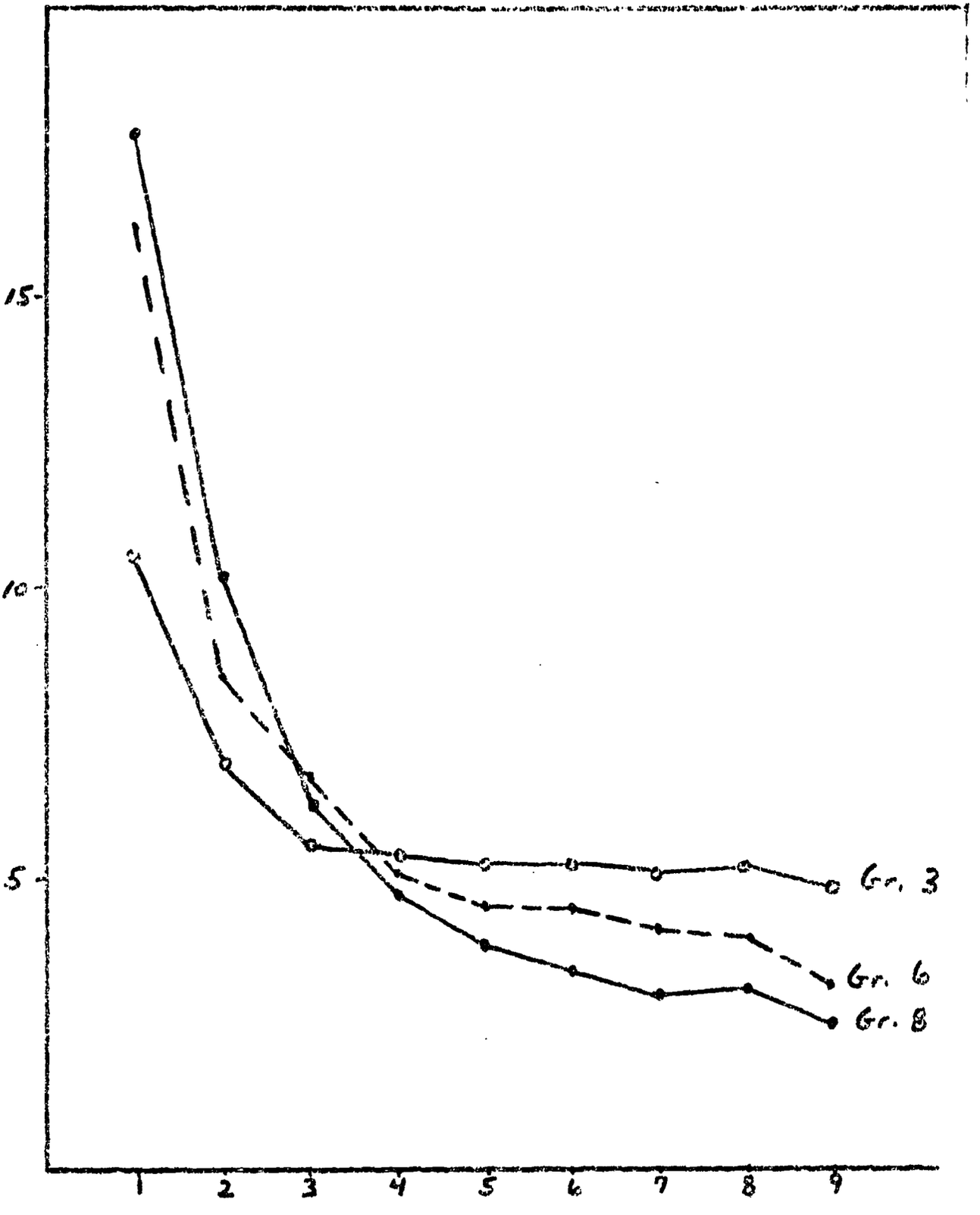
Palmer, S. E. & Ornstein, P. A. Role of rehearsal strategy in serial probed recall. Journal of Experimental Psychology, 1971, 88, 60-66.

Rundus, D. Analysis of rehearsal processes in free recall. Journal of Experimental Psychology, 1971, 89, 63-77.

Slide I


Overt Groups
1.00
.80
.60
.40
.20
Gr. 8
Gr. 6
Gr. 3
1
2
3
4
5
6
7
8
9
Probability of Recall
Blocks of Two Serial Positions

Slide II



Mean Number of Rehearsals

Blocks of Two Serial Positions

Slide III

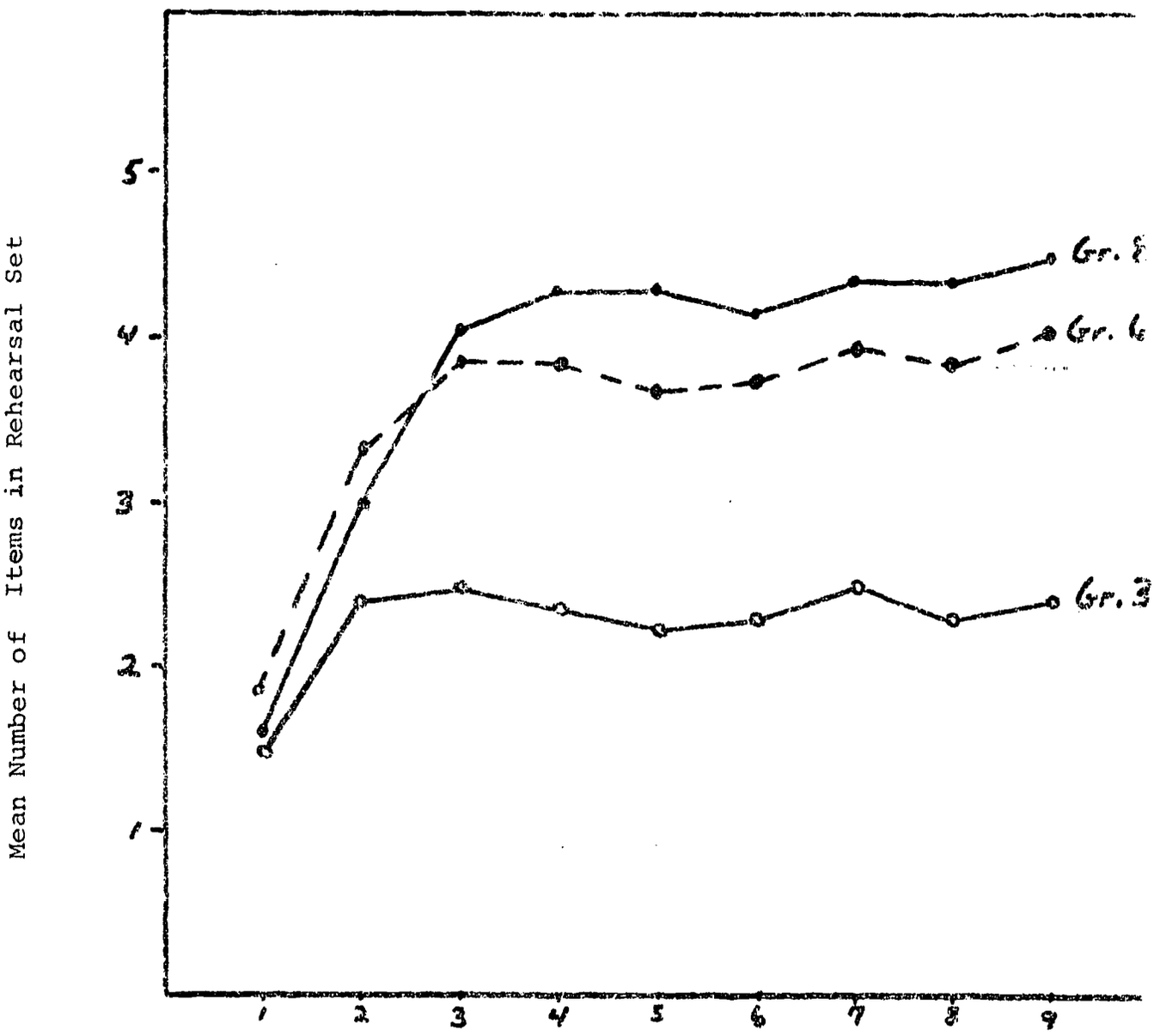
Eighth Grade Subject

Word Presented	Rehearsal Set
1. Yard	Yard, Yard, Yard
2. Cat	Cat, Yard, Yard, Cat
3. Man	Man, Cat, Yard, Man, Yard, Cat
4. Desk	Desk, Man, Yard, Cat, Man, Desk, Cat, Yard
5. Glass	Glass, Car, Yard, Man

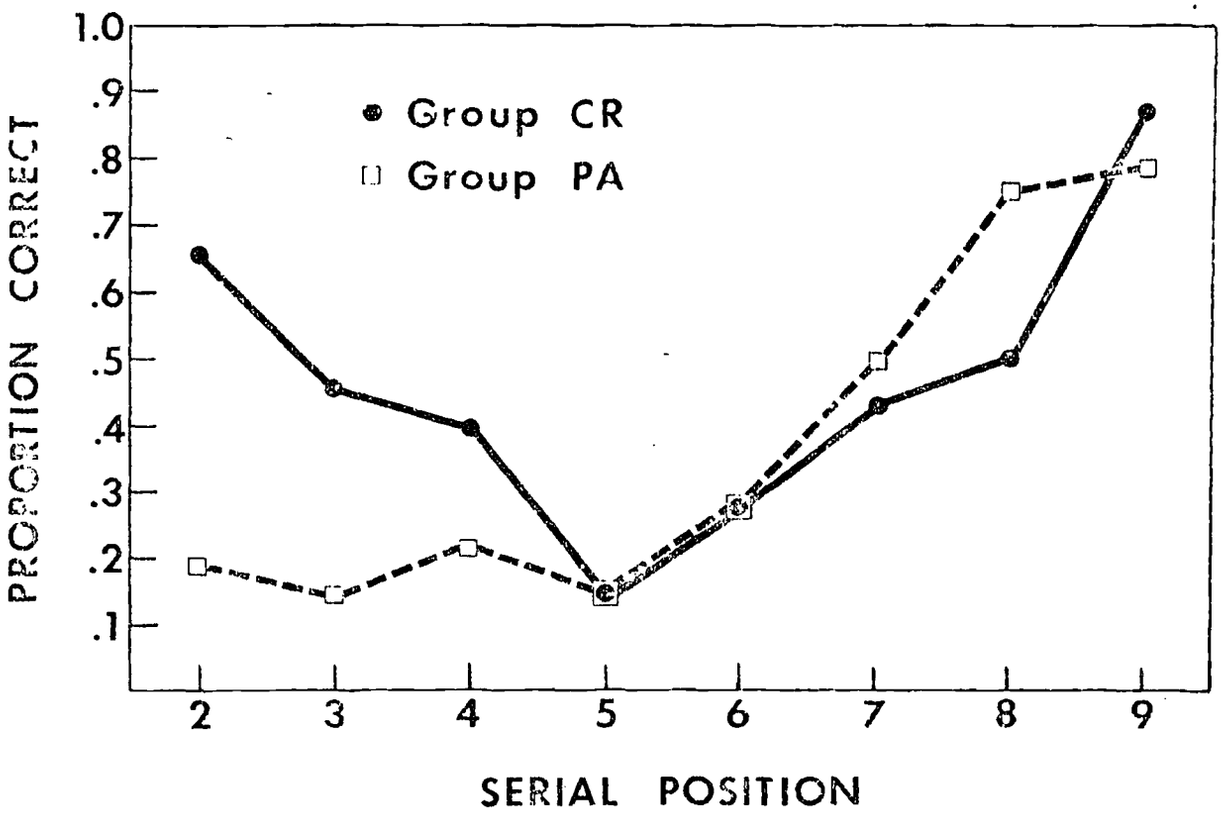
Third Grade Subject

Word Presented	Rehearsal Set
1. Tent	Tent, Tent, Tent, Tent, Tent
2. Year	Year, Year, Year, Year, Tent
3. Game	Game, Game, Game, Game, Game
4. Fence	Fence, Fence, Fence, Fence,
5. Rope	Rope, Rope, Fence, Rope, Fence

Slide IV


Mean Number of Items in Rehearsal Set
5
4
3
2
1
Gr. 8
Gr. 6
Gr. 3
1
2
3
4
5
6
7
8
9
Blocks of Two Serial Positions

Slide V



(from Palmer & Ornstein, 1971)