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ABSTRACT

This paper describes studies which investigated the nature of the relationship between number of categories and recall performance in children, and attempted to determine whether the category-recall effect increases developmentally. A series of three studies was designed so that grade level and stimulus difficulty would not be confounded. Different-aged subjects within each study (second, fourth and sixth graders) used the same stimulus materials. The difficulty of the stimulus list was increased for each successive study. Subjects were required to sort unrelated words into either 2, 4, or 6 categories until two identical sorting trials were produced. Recall followed. The overall results revealed a strong effect of categorical organization on recall. The increase in recall associated with greater numbers of sorting categories was not a function of differential sorting time, as shown in partial correlations. The major finding of these studies was that the effect of number of categories on recall appeared to increase with increasing age, above the fourth grade level. This result suggests a developmental increase in the effect of categorical organization on recall which occurs mainly in later childhood and adolescence. (Author/SB)

THE DEVELOPMENT OF THE CATEGORY-RECALL RELATIONSHIP IN THE SORTING-RECALL TASK

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In recent years researchers in the area of memory development have realized that young children do not automatically produce strategies which older children and adults employ in memory tasks. In particular, young children show a lack of spontaneous rehearsal, planful study, and especially chunking of items into categorical groups. This means that memory for young children does not automatically take advantage of well-known principles of organization in information processing. For this reason, it is important to note that the procedure we used in this experiment is especially effective for inducing children to use organization in memory. It is called the sorting-recall task, and it requires the children to participate actively in the formation of an organizational structure for use in storage and retrieval of the stimulus items.

In the sorting task, the children were presented with all the stimuli simultaneously. They were given a set of categorically unrelated concrete nouns on 3 x 5 cards. The children sorted the words into groups of "things which go together or that are alike

in some way." They continued sorting for as many trials as were necessary to achieve a stable organization of the stimulus materials. That is, the children sorted until their organization schemes were identical on two consecutive sorting trials. This means that the amount of exposure to stimulus items was subject-determined, in that some children took more trials to reach criterion than others. The point is that the subjects were equated on the basis of a stable organization of the stimulus materials, not on the basis of a fixed amount of exposure to items prior to recall. After the sorting criterion was met, the pictures were removed, a buffer period was provided, and then the children's recall was recorded.

We varied the number of categories into which the stimulus items were sorted by the subjects. The children sorted into either two, four, or six categories. Adult research has shown that the number of items recalled increases as a function of the number of categories in the sorting scheme. The first slide illustrates this relationship between number of categories and recall. This figure is from George Mandler's 1967 paper on the organization of memory. It shows that, for adults, recall is an increasing function of number of categories, up to the hypothesized limit for information processing of 7 $\pm$ 2 chunks. The slope of the function for these adult subjects was 3.88, which means that adults are able to retrieve approximately four items for each additional category in the sorting scheme. The first question addressed in our

research was whether the category-recall relationship would be found in children's memory performance. Such evidence would support our contention that memory, for children, is guided by the same general principles of information processing as are the memory processes of adults.

Secondly, we were interested in measuring the category-recall functions of children at various grade levels. The slope of the obtained functions would show the number of items children could retrieve from each additional category in the sorting scheme. Our hypothesis was that the slope of the category-recall function would become steeper as a function of increasing age. That is, we expected to find that the category-recall slopes of the youngest children would be relatively slight, when compared, for instance, with the adult slope shown here. If the slopes of young children were relatively flat it would indicate less ability to retrieve items from additional categories in the sorting scheme. In contrast, we expected to find that the category-recall relationship for older children would be more pronounced. As age increased the steepness of the category-recall slopes would approach the adult level. This increased retrieval of items from individual categories was expected to be an important factor in the superior memory performance of older subjects.

In summary, we asked two primary questions in this experiment. First, is there a category-recall relationship for children such that increasing the number of categories in the sorting scheme will

result in increased recall? Second, given that we find such a relationship, will the effect of categorical organization on recall be stronger for older subjects?

The design of the experiment is shown on the next slide, as well as the overall recall results. Three separate studies were conducted, using increasingly difficult stimulus sets. Study 1 presented second and fourth graders with a short, easy list. Study 2 tested fourth and sixth graders and employed a list of medium length and frequency. Sixth graders were compared with adults in Study 3, using a long list of low-frequency items.

As you can see, we found the expected category-recall relationship. In each of the studies there was a significant effect on recall of increasing the number of sorting categories. That is, the more categories in the sorting scheme, the greater was the level of recall. Furthermore, this category-recall relationship was highly reliable, with an overall significant correlation between number of categories and recall of .63.

The reliability of the category-recall relationship brings up an important point about the sorting-recall procedure. As I mentioned when describing the procedure, subjects sort until they achieve consistency of sorting on two consecutive trials. This means that the amount of exposure to items is subject-determined. This has bothered people who hold a view that memory ought to be a function of the amount of exposure to items. That is, the more often you see an item the better you are able to remember it. If

subjects in certain experimental groups take more trials in sorting, won't their recall performance reflect the increased exposure time? In particular, what if children who sort into six categories take more time than subjects who use two categories? In that case, the category-recall effect might be an artifact of differential exposure time, rather than an effect of increased retrieval from greater numbers of categories.

So we measured the total amount of time it took children in the various conditions to complete the sorting task. The next slide shows the results of our analysis. The first column shows the high and significant correlations between number of categories and recall for all age groups. The issue in question is whether this highly reliable effect would still be found when total sorting time was statistically held constant. The second column shows that the strong category-recall correlations remained essentially unchanged when sorting time was controlled statistically. These results show a critical relationship between number of categories and recall that is independent of subject-determined exposure time to stimulus items. We have thus shown that the category-recall relationship exists for children, and incidentally that it is not an artifact of differential sorting time. The answer to our first question, therefore, is that children, like adults, show improved recall performance when the items to be remembered are chunked into more, rather than fewer, categorical groups.

The second question concerned the effects of age level on the

strength of the category-recall relationship. The next slide presents the category-recall functions for subjects at the various age levels we tested. As a control factor, we tested fourth and sixth graders at two levels of stimulus difficulty. There appeared to be a trend for subjects using the more difficult stimulus materials to have steeper category-recall slopes.

The impact of increasing age on the category-recall relationship can be assessed by making within-study comparisons of the slopes of subjects from different grade levels. While there was no increase between second and fourth grades, the category-recall functions in Studies 2 and 3 were more pronounced for the older subjects in each of these studies. Note that these comparisons were made under conditions where stimulus materials were held constant within each study. These data tended to support our expectation that as age increased, the slope of the category-recall function would increase as well.

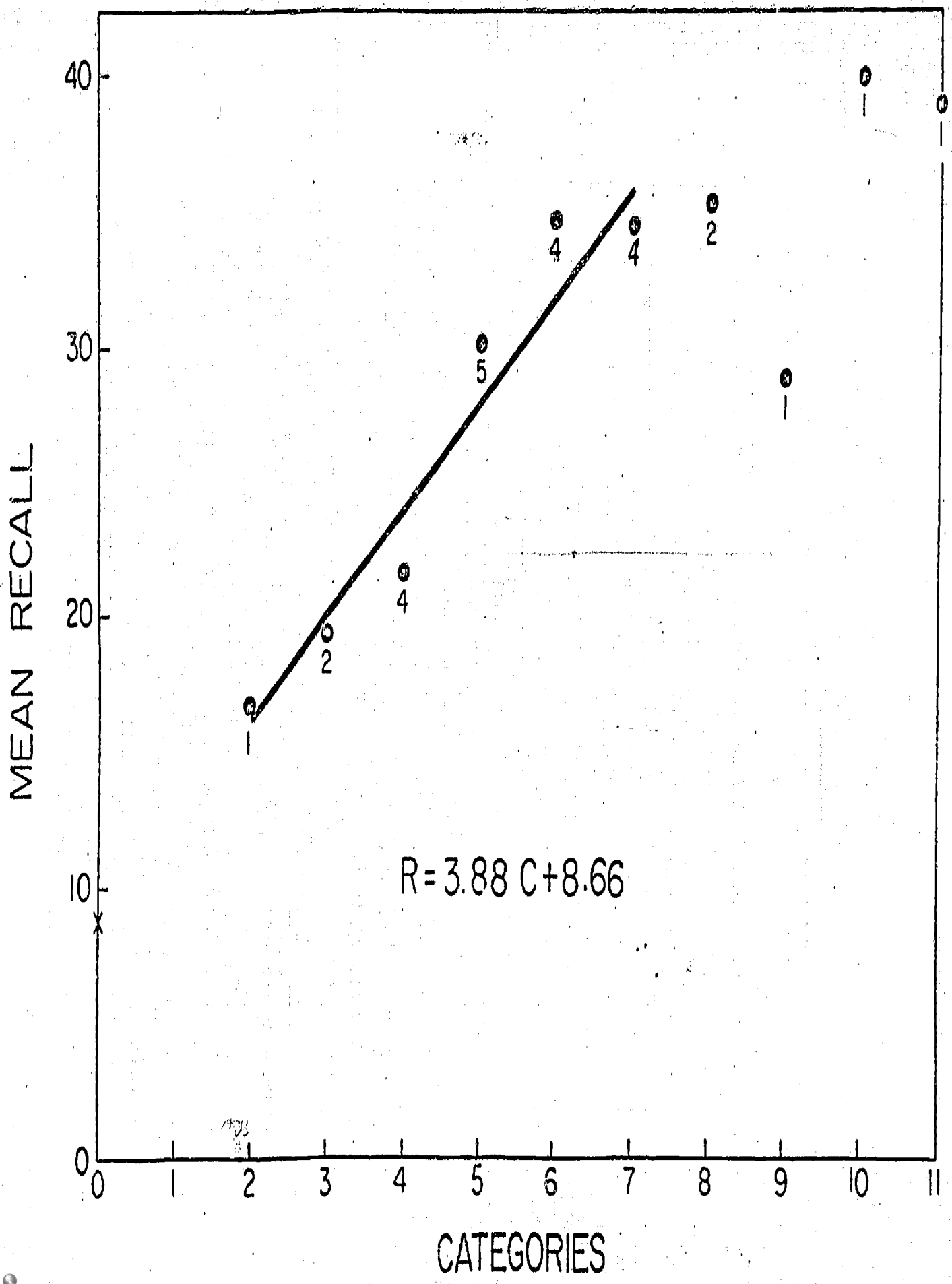
The effect was shown more dramatically when we compared the performance of subjects across studies in conditions which varied both in age level and in stimulus materials. The next slide shows the relevant recall data. Second graders from Study 1 using easy stimuli were compared with fourth graders from Study 2 using medium-difficulty materials and sixth graders from Study 3 who were given difficult stimulus materials. When these groups were compared, we found that differences in the category-recall functions reached acceptable levels of statistical significance. Thus, when the

difficulty of stimulus materials was increased appropriately we found that the category-recall slopes became significantly steeper with increasing age, and gradually approached the adult level.

It should be mentioned that the levels of clustering found in recall did not differ for children who sorted into different numbers of categories. Furthermore, clustering was found to be uniformly high for children at all grade levels, averaging about .75 out of a maximum possible 1.00. Children in all sorting conditions and down to the youngest age level showed equivalent amounts of organizational structure in their memory performance.

Thus, the differences we found in recall performance with increasing numbers of sorting categories and increasing age level were not a function of differences in amount of organizational structure per se. Rather, the age-related increase in the category-recall slopes may be interpreted as a gradually increasing capacity for storage or retrieval of items within organizational units. Our results indicate that at least part of the memory superiority of older children is due to an ability to retrieve more items from individual categories within an organizational structure. As children grow they acquire more knowledge about the meaning of words and the relationships between them. For older children this enrichment of semantic relations results in an increased number of associations between lexical items which serve to hold categories together. This is a possible explanation for why increasing the number of categories in the sorting scheme results in a greater increase in recall performance for older than for younger subjects.

FIGURE 1


MEAN RECALL
CATEGORIES
R = 3.88 C + 8.66
0
10
20
30
40
0 1 2 3 4 5 6 7 8 9 10 11

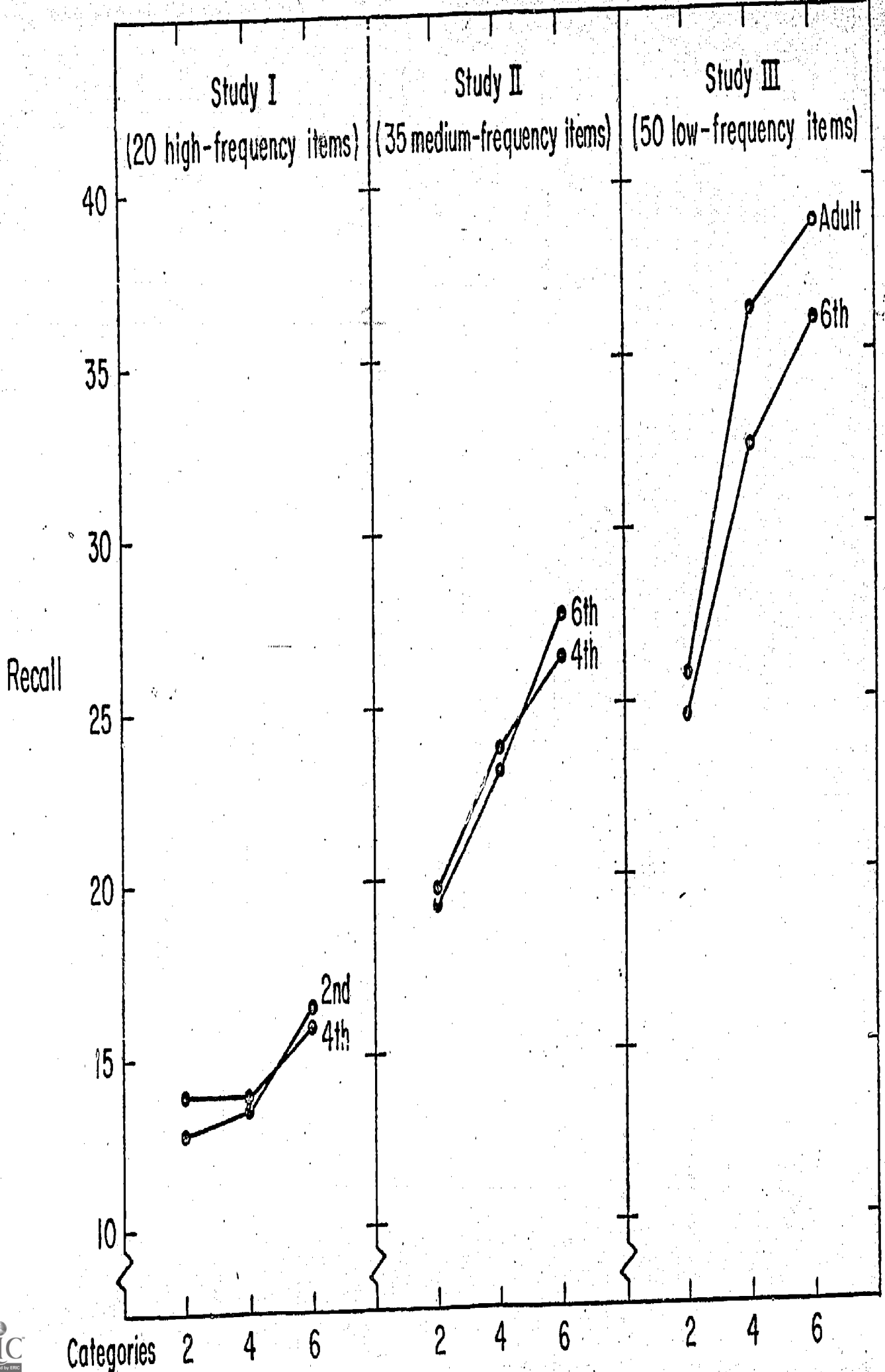

Study I
(20 high-frequency items)
Study II
(35 medium-frequency items)
Study III
(50 low-frequency items)
Recall
40
35
30
25
20
15
10
Adult
6th
6th
4th
2nd
4th
Categories 2 4 6
2 4 6
2 4 6

FIGURE 2

FIGURE 3

	Grade	Number of Categories and Recall	Number of Categories and Recall (Time held constant)
Study 1	Second	.57**	.56**
	Fourth	.37*	.34
Study 2	Fourth	.56**	.42*
	Sixth	.77**	.66**
Study 3	Sixth	.78**	.76**
	Adult	.73**	.73**

FIGURE 4

Slopes of

Category-Recall Functions and their Reliability (r^2)

Study 1

(20 high-frequency items)

Second	.94	(.32)
Fourth	.50	(.14)

Study 2

(35 medium-frequency items)

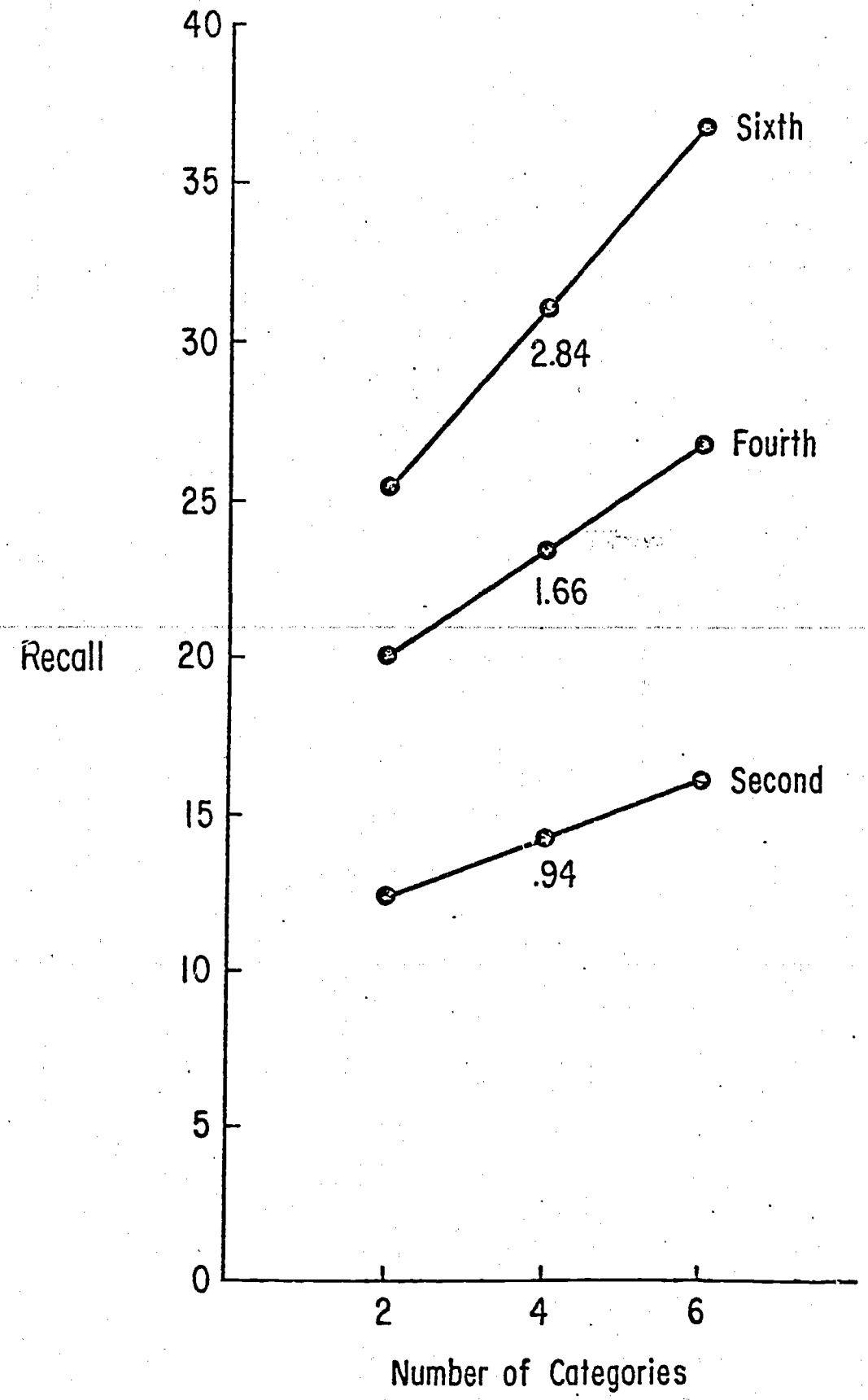
Fourth	1.66	(.31)
Sixth	2.09	(.59)

Study 3

(50 low-frequency items)

Sixth	2.84	(.61)
Adult	3.25	(.53)

FIGURE 5


40
35
30
25
20
15
10
5
0
Recall
Sixth
2.84
Fourth
1.66
Second
.94
2
4
6
Number of Categories