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A DEVELOPMENTAL STUDY ON THE EFFECTS OF VISUAL AND VERBAL CODING ON RECOGNITION MEMORY

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INTRODUCTION

The problem of this study was to determine at what stage of development recognition memory begins to be influenced by processes which is based on the transformation of a representational mode of learning materials, that is, visual processes for verbal materials and verbal processes for visual materials. Recent research has demonstrated that the strategies used to process informations, particularly pictorial information, may differ according to age (see the review by Reznick 1977). Reznick suggested in his review that a subject's covert verbalization (labeling and/or rehearsal) for pictorial information plays an important role in processing it. He also suggested that this strategy can be applied to pictorial information more efficiently in older children than in younger children. Rohwer (1970) showed empirical data suggesting that a child is more likely to supply the verbal label for a pictured object as he gets older, which suggests that the ability to profit from an image evoked by pictured objects depends on the child's ability to store verbal representations of the objects along with the stored image, and that such simultaneous storage can be accomplished better by older children.

Reese (1975) examined whether a child's own verbal descriptions for pictorial materials influenced recognition memory. Although it is known that organized (elaborated) materials are easier to learn than unorganized (unelaborated) ones, he tried to determine whether recognition accuracy of the elaborated-unelaborated pictorial materials could be influenced by the elaborated-unelaborated verbal descriptions. He found that for younger children (4-year-olds), recognition accuracy did not depend on how elaborately pictures were described, but that it rather depended on whether the pictures were presented elaborately. On the contrary, performance of recognition memory in older children (5-year-olds) depended on elaborated descriptions rather than on how elaborately the pictures were presented. Thus, he concluded that while younger children depended more on visual rather than verbal coding for pictures, older children depended more on verbal than on visual coding.

The findings mentioned above imply that in the child's strategies for processing pictorial information, there appears to be a developmental change from visual coding, i.e., processes by the same representational mode as that of visual materials, to verbal coding, i.e., processes which is based on the transformation of a visual mode of materials into a verbal mode. This view is consistent with that of Bruner (1966) who suggested the existence of a developmental trend from iconic to verbal-symbolic processing.

How then do these strategies for processing verbal information develop? Is there

also a developmental change from processing information by the same representational mode as that of verbal materials, to processing information by the transformation of a representational mode of verbal materials such as that in processing pictorial information mentioned above? Or, is it simply erroneous to suggest such a developmental trend, since verbal-symbolic representation is the last stage in the development of stages of "representation" (Bruner et al., 1966) ?

In examining these questions, Paivio's (1970) finding seems to provide some clues. He showed that nouns, rated high in their capacity for arousing imagery (high-imagery nouns) are easier to learn than low-imagery nouns. This evidence suggested the existence of processes by the transformation of a verbal mode of materials into a visual representational mode, and also indicated that visual processes are more conducive to learn verbal materials than are verbal processes. Although Paivio's results were derived mainly from adult's samples, they suggested that for processing verbal information there could be a developmental change from verbal coding to visual coding.

However, there has been little evidence to support the developmental aspect of strategies used by children for learning verbal information. Thus, our first task in this study was to examine whether or not there is a developmental change from verbal to visual coding in children.

Our next interest, assuming there was an affirmative answer to the first problem, was to determine which emerges earlier, visual coding for verbal information or verbal coding for visual information. Considering Bruner's hypothesis on the development of "representation", it appears that visual coding for verbal information may become influential after the emergence of the stage of verbal-symbolic representation in which verbal coding for visual information is going on. Although there are some empirical data to support the above consideration (Tajima 1973), one of the methodical problems such as inadequate control of the levels of difficulty between verbal and visual materials prevented its complete substantiation. Thus, in this study, we have attempted to solve the problem by limiting the materials used within the same categories.

We will first examine whether the subject's own drawing descriptions for verbal materials influence recognition memory. Here, we will adopt Reese's paradigm which was originally used for the examination of the influence of verbal descriptions for visual materials. Following this, we will also examine the influence of verbal descriptions for visual materials in samples older than those of Reese's. By comparing two groups of data on the influence of those two strategies it will be possible to determine which strategy emerges earlier. Our study was based on the following two hypotheses :

1. that the subject's own drawing descriptions for verbal materials begin to influence his recognition memory in the same way that his own verbal descriptions for visual materials do ;
2. that the influence of drawing descriptions for verbal materials takes place later than that of verbal descriptions for visual materials.

METHOD

Subject: A total of 230 children served as subjects in the experiment. The sample consisted of 26 preschool children (age range, 5:08 -6:08, mean age, 6:02) selected from a kindergarten in Sapporo city, Hokkaido, and 57 first-(mean age, 7:04), 77 third-(mean age, 9:04), and 70 fifth-(mean age, 11:03) grade children selected from an elementary school in the same district.

The subjects in each grade level were divided into two experimental groups, one group for drawing descriptions, and the other for verbal descriptions. There was roughly the same number of girls and boys in each group.

Design and Materials: Two experimental tests were designed. In the first test, the subjects were required to draw pictures of verbal learning materials, and in the second, the subjects were asked to describe verbally what could be seen in the visual materials. In both tests there were principal factors in a $4 \times 2 \times 2$ factorial design such as grade (K. vs. First vs. Third vs. Fifth); the type of materials (presented elaborately vs. unelaborately); the subject's own drawing/verbal description type (elaborated vs. unelaborated).

TABLE 1

ELABORATED VERSIONS OF THE ITEM PAIRS USED IN THE DRAWING DESCRIPTION TEST

A SHEEP is flying a KITE.
A DEER is holding a pair of SCISSORS.
A CAT is sitting in a CHAIR.
An ELEPHANT is sitting on a DRUM.
A PIG is wearing a HAT on his head.
A COCK is holding a FLAG.
A HORSE has a KEY in his mouth.
A TURTLE is talking on the TELEPHONE.
A CRANE is wearing a SHOE.
A MOUSE is going into a CUP.
A FISH is driving a CAR.
A DOG is holding an UMBRELLA over his head.
A PENGUIN is reading a BOOK.
A PANDA is blowing a TRUMPET.
A CRAB is carrying a LANTERN.
A MONKEY is clicking a CAMERA.
A RABBIT is sliding on SKI.
A SQUIRREL is putting a PIPE in his mouth.
A FOX is rowing a BOAT.
A SNAKE is holding a BALLOON.

NOTE—The unelaborated versions of the verbal materials showed the capitalized items. The elaborated versions of the visual materials consisted of line drawings expressing full sentences (table 1). The unelaborated versions of the visual materials were the line drawings of the capitalized items depicted parallelly.



FIGURE 1 Elaborated and unelaborated versions of two item pairs used as visual materials.

The verbal materials consisted of 40 cards (28×38 cm). Twenty cards were printed with sentences that described the relationship between one animal and one object (see table 1). They formed the “elaborated” versions. The remaining 20 cards were printed with names of one animal and one object, as shown in the capitalized items in table 1. They formed the “unelaborated” versions. The visual materials consisted of two versions of line drawings, “elaborated” and “unelaborated”, of the animal-object pairs mentioned above. These corresponded to the two versions of verbal materials. The unelaborated versions differed from the elaborated versions in the aspect of greater spatial separation, as shown in figure 1.

The first 12 pairs of items were minor corrected versions of Reese’s (1975) list, and the remaining 8 pairs were adopted from the first author’s (1973) list. All of the items could be understood in both their printed and pictorial form by a different group of 6-year-olds in a preliminary study. To allow for limitation of memory ability, only the first 12 pairs were shown to the kindergarten children, while the older children were shown the entire 20 pairs.

Procedure : In the kindergarten age group, the task was administered individually. On the other hand, the elementary school children were tested in a small group setting in classroom.

Each child was shown either 12 or all the 20 animal-object pairs, at a time, in two 6/10 pair sets. In one set, each pair was shown in the elaborated versions, and in the other set, each pair was shown in the unelaborated versions. Each animal-object pair was shown in both versions across subjects; however, for any one subject only one version of a pair was shown.

For the drawing description test the subject was told that he would be shown written descriptions of 12/20 animal-object pairs and then be asked to draw what he imagined when he saw the printed pair. In the verbal description test, the subject was asked to tell the experimenter (kindergarten children) or to describe in writing on paper (school children) what he saw after each pair of line drawings was presented. Before presenting the next pair in the sequence, the experimenter asked, “Is that all?” if there was some question that the subjects had not completed their descriptions.

One week after the initial session, a recognition-memory test was performed. For each trial, the subject was asked to identify which one of the two printed-words/pictures had been shown in the initial session. In each trial the choice was between the elaborated

and the unelaborated versions of an animal-object pair. The left-right positions of the elaborated versions were varied among the trials and alternated among the subjects. Figure 1 gives an example of a test trial of the "cock-flag" pair used in the verbal description test.

Ratings of Descriptions: Each drawing/verbal description given by the subjects was rated as "elaborated" or "unelaborated". The descriptions were rated "elaborated", if the two closely related items were described in drawings or if the two items and their relationship were described verbally. Descriptions such as "A cock is holding a flag," or "A cock is carrying a flag" were rated as elaborated verbal descriptions. Descriptions were rated as "unelaborated", if the two items were described in parallel and in greater spatial separations in the drawing descriptions, if the only relation was expressed by the conjunction "and" or the preposition "with", or if no relation at all was mentioned in the verbal descriptions. Examples of "unelaborated" verbal descriptions were as follows; subject-"A cock"; experimenter-"Is that all?"; subject-"A flag"; or subject-"cock, flag"; experimenter-"Is that all?"; subject-"Yes".

Agreement by independent pairs of raters for the drawing descriptions was 92.5% and for the verbal descriptions 96.2%. Disagreement were resolved by discussion after all ratings were made.

RESULTS

The relation of recognition accuracy to the type of materials (elaborated or unelaborated) and the type of descriptions (elaborated or unelaborated) in the two experimental tests were examined. For each subject there were four possible conditional probabilities, each of which was derived from combinations of the type of materials and the type of descriptions (see table 2 and table 3).

In the drawing description test, the mean conditional probabilities of correct recognition for each grade level are presented in table 2 and figure 2, and those for the verbal description test are shown in table 3 and figure 3. Figure 2 indicated, for example, that in the kindergarten age group, the probability of correctly recognizing elaborated printed words which they had made an unelaborated drawing for was about .80.

A 2×2 (material type \times description type) analysis of variance for percentage (Cochran, 1943) using inverse sine transformational values was carried out for each grade level and each description test.

Effect of Drawing Descriptions

As mentioned before, it is known that elaborated materials are easier to remember than unelaborated ones (see Reese, 1975). In this study we were interested in determining whether recognition accuracy of the elaborated-unelaborated verbal materials could be influenced by the elaborated-unelaborated drawing descriptions. Figure 2 demonstrates that the effect of verbal and visual elaboration varied with each grade level.

For the kindergarteners, verbal elaboration seems to have been more important than the drawing elaborations, because they recognized the elaborated verbal materials more accurately than the unelaborated ones regardless of how they drew the verbal materials.

TABLE 2

SAMPLE SIZES AND MEAN CONDITIONAL PROBABILITIES OF CORRECT RECOGNITION IN DRAWING DESCRIPTION TEST

MATERIAL TYPE	DESCRIPTION TYPE	K		FIRST		THIRD		FIFTH	
		NUMBER OF CORRECT RECOGNITIONS	PROBABILITY OF CORRECT RECOGNITIONS	NUMBER OF CORRECT RECOGNITIONS	PROBABILITY OF CORRECT RECOGNITIONS	NUMBER OF CORRECT RECOGNITIONS	PROBABILITY OF CORRECT RECOGNITIONS	NUMBER OF CORRECT RECOGNITIONS	PROBABILITY OF CORRECT RECOGNITIONS
		N ^a		N		N		N	
Elaborated	Elaborated	49	.803	155	.686	240	.825	250	.874
	Unelaborated	23	.793	41	.719	26	.722	30	.556
Unelaborated	Elaborated	9	.529	41	.418	81	.653	43	.796
	Unelaborated	45	.672	135	.746	136	.607	265	.927

NOTE—Total number of Kindergarteners, 26 subjects ; First-graders, 57 subjects ; Third-graders, 77 subjects ; Fifth-graders, 70 subjects.
a; total number of items across subjects used to compute conditional probabilities.

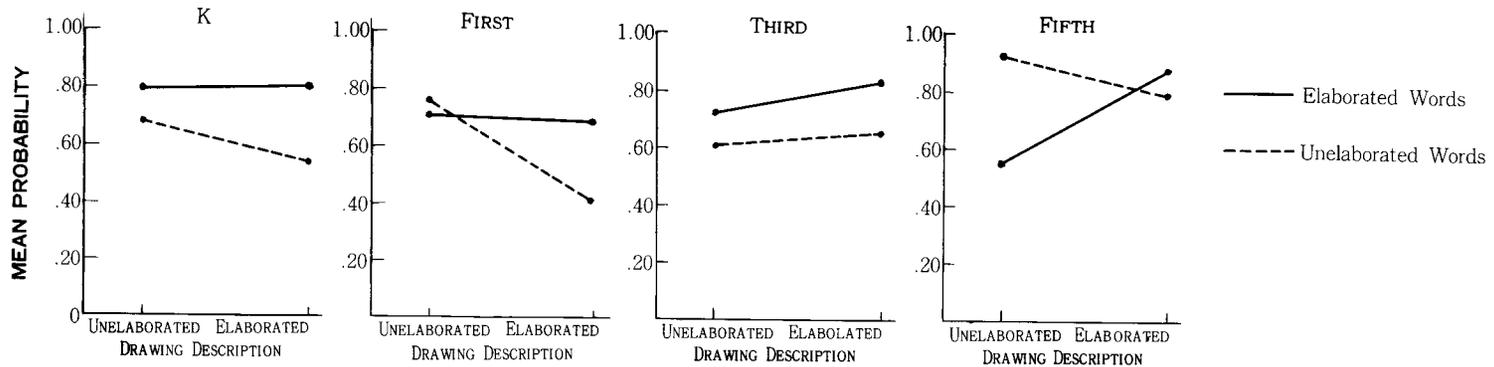


FIGURE 2 Mean conditional probability of correct recognition-test response in the drawing description test, given one or the other type of description. Means are given separately for the elaborated and unelaborated words and for each grade level.

TABLE 3

SAMPLE SIZES AND MEAN CONDITIONAL PROBABILITIES OF CORRECT RECOGNITION IN THE VERBAL DESCRIPTION TEST

MATERIAL DESCRIPTION TYPE TYPE		K		FIRST		THIRD		FIFTH	
		NUMBER OF CORRECT RECOGNITIONS	PROBABILITY OF CORRECT RECOGNITIONS						
Elaborated	Elaborated	39	.813	169	.934	166	.856	211	.946
	Unelaborated	16	.667	67	.788	183	.867	105	.854
Unelaborated	Elaborated	5	.625	67	.698	26	.839	59	.881
	Unelaborated	47	.671	134	.784	206	.786	260	.903

NOTE—Total number of Kindergarteners, 26 subjects; First-graders, 57 subjects; Third-graders, 77 subjects; Fifth-graders, 70 subjects.
a; total number of items across subjects used to compute conditional probabilities.

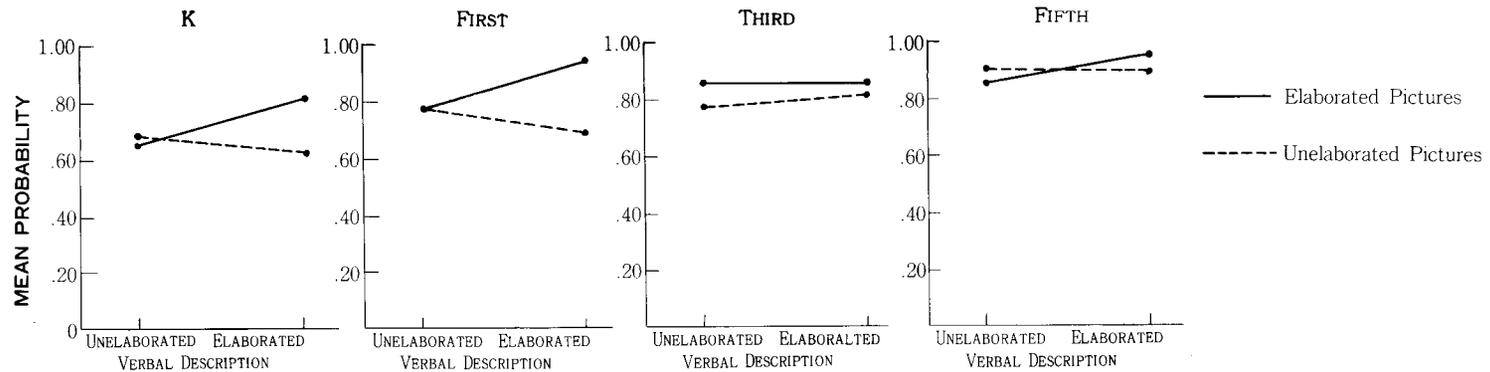


FIGURE 3 Mean conditional probability of correct recognition-test response in the verbal description test, given one or the other type of description. Means are given separately for the elaborated and unelaborated pictures and for each grade level.

The only significant effect was the main effect of the verbal material type ($x^2=6.175$, $df=1$, $p<.02$). This result indicated that recognition by kindergarteners was influenced more by the material type than the description type ; that is, their recognition ability depended more on verbal coding, the processes by the same representational mode as that of the verbal materials, than on visual coding, which required the transformation of the representational mode of verbal materials.

In contrast, the first-grade children depended more on visual than verbal elaboration. An analysis of variance revealed a significant interaction between the verbal material type and the drawing description type ($x^2=7.252$, $df=1$, $p<.01$) in addition to the main effect of the verbal material type ($x^2=6.390$, $df=1$, $p<.02$) and the drawing description type ($x^2=15.176$, $df=1$, $p<.001$). The significant interaction suggested that elaborated drawing descriptions tended to facilitate recognition of elaborated verbal materials and to interfere with recognition of unelaborated verbal materials. In other words, recognition by the first-grade children was influenced more by the description type than by the material type ; that is, their recognition ability depended more on visual coding than on verbal coding which is corresponding to the verbal mode of materials.

For the third-graders, however, the only significant effect was the main effect of verbal material type ($x^2=9.736$, $df=1$, $p<.005$), which corresponded to the result obtained in the kindergarten age group.

On the contrary, the results for the fifth-graders were similar to those of the first-graders. An analysis of variance revealed that there was a significant interaction between the verbal material type and the visual description type ($x^2=28.631$, $df=1$, $p<.001$) in addition to the significant main effect of the verbal material type ($x^2=11.117$, $df=1$, $p<.001$)

All of the above-mentioned findings offer evidence that the effect of drawing descriptions on recognition memory of verbal materials emerges first at the first-grade level, but that it may not continue to have such an effect in the third-grade children. In this study, however, it appeared that the subject's own drawing descriptions for verbal materials came to influence recognition memory.

Effect of Verbal Descriptions

Figure 3 shows that verbal elaboration was more important than visual elaboration among the grade levels except in the case of the third-graders, in that the elaborated verbal descriptions tended to facilitate recognition of the elaborated visual materials and to interfere with recognition of the unelaborated visual materials. This finding was further supported statistically by the significant interaction between the visual material type and the verbal description type which was noted in both the first-grade ($x^2=13.920$, $df=1$, $p<.001$) and fifth-grade groups ($x^2=4.957$, $df=1$, $p<.05$). Although there was no such significant interaction noticed in both kindergarteners and the third-graders, the above-mentioned tendency also could be seen in the kindergarten age group alone.

Even the youngest children in our study showed the effect of verbal descriptions on recognition memory of visual materials. This effect, however, was not so apparent in the third-grade children, as there were no large differences observed among the four condi-

tional probabilities. In spite of these problems, it can be said that the recognition ability of 6- and 7-year-old children depended more on verbal coding than on visual coding. This result agreed well with Reese's data which showed that recognition accuracy in 5-year-olds was influenced more by verbal descriptions of materials than by the visual materials themselves.

As compared with the finding that the effect of drawing descriptions for verbal materials emerged at the first-grade level, we found that the subject's own verbal descriptions for visual materials began to influence recognition memory earlier than did their drawing descriptions of the verbal materials.

DISCUSSION

The most important finding of this study was that visual coding for verbal materials showed a developmental course and in time influenced recognition memory. A clear difference in the influential factors of recognition accuracy, i.e., elaborated verbal materials vs. elaborated drawing descriptions, was observed between the kindergarteners and the first-graders. The kindergarteners recognized the elaborated verbal materials more accurately than the unelaborated ones regardless of how they first reproduced the verbal materials. Thus, recognition accuracy depended more on the material type than on the drawings of the materials. It appeared that drawing descriptions had little effect on recognition memory.

However, the first-grade children recognized the elaborated verbal materials more accurately than the unelaborated ones when both materials were given the elaborated drawing descriptions; however, this tendency was reversed when both materials were given the unelaborated drawing descriptions. It appeared that recognition accuracy of the first-graders depended more on their previous drawing of the materials than on the material type. More clearly, the drawing descriptions influenced recognition memory.

We concluded from these results that even in the processing of verbal materials the influential strategies show a developmental trend from verbal coding to visual coding, namely, from the processes by the same representational mode as that of verbal information, to the processes by the transformation of the representational mode of verbal information. This developmental change was observed first at the first-grade level.

However, the effect of drawing descriptions was not observed consistently in the upper grade children. A similar trend was observed in the third-graders as that in the kindergarteners, in that they recognized verbal materials more accurately than unelaborated ones regardless of the type of drawing descriptions. In contrast, the recognition ability of the fifth-grade children depended on the relation between the material type and the description type, as demonstrated by the first-grade children.

The disappearance of the effect of drawing descriptions for the third-grade children is difficult to interpret. There was not enough evidence to suggest the existence of a second developmental change that moved from verbal to visual coding throughout the 9 to 11-year-old children. It is more likely that what was observed among the upper graders was due to the inappropriateness of the task given. The task taken mainly from Reese's study of

children under 5 years of age may have been too simple for the 9-year-old children of our study so that they did not utilize their own drawing descriptions even though they could have the strategy of visual processes.

Another important finding was that the influence of visual coding for verbal materials emerged later than that of verbal coding for visual materials. As for the effect of verbal descriptions on recognition of visual materials, no clear developmental change throughout the grade levels was observed. In our study, even the kindergarteners tended to remember better how they described the pictures verbally than how the pictures actually looked, i.e., their recognition of pictures depended more on verbal than on visual coding, which agreed well with the results of Reese's study.

As regard the third-grade children, the effect of verbal descriptions on the recognition of visual materials was not clearly seen either. We considered that this may also have been due to the inappropriateness of the assigned task. Notwithstanding the above-mentioned problems, we concluded that the influence of verbal coding for visual materials in recognition memory emerged earlier than the first-grade level.

In summary, our study gave substantial evidence that in processing both the verbal and visual information, there is a developmental trend from the processing by the same representational mode as that of the information given, to the processing by the transformation of the representational mode of materials used. Moreover, there appears to be a developmental time lag in the emergence of the transformational processes of the representational mode of information. That is to say, verbal coding for visual materials precedes visual coding utilized for recognition of verbal materials. This suggests that the development of representational transformation goes from verbal-symbolic to iconic representational mode.

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