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Pictorial and Verbal Encoding in Preschool Children[1]

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Pictorial and verbal encoding in short-term memory of geometric figures and their names was studied in preschool children, using reaction time to a same-different judgment task. Children, like adults, were able to encode either pictures or names in either a pictorial or verbal fashion, as appropriate and with equal facility, although responses to second pictures were faster than responses to second words. Children's latencies were far longer than adults in a comparable task, and children were relatively much slower in switching encoding modalities when so required.

Many theories of stimulus encoding hold that while adults tend to encode stimuli, whether verbal or pictorial, in a verbal fashion, children, particularly preliterate children, are better able to retain pictorial stimuli in a pictorial representation and less likely to recode them to a verbal form (Bruner, 1964; Neisser, 1967; Paivio, 1971). Presumably, the mediating processes observed to develop at about the age when reading is taught are primarily verbal in nature (Kendler & Kendler, 1962; White, 1965) and serve to shape the schemas by which events are encoded, organized, and retrieved. While considerable research has demonstrated verbal encoding of nonverbal stimuli by adults (Brown & Lenneberg, 1954; Glanzer & Clark, 1963) and many theories of memory explicitly assume it (Sperling & Speelman, 1970; Waugh & Norman, 1965), evidence is accumulating that adults can pictorially encode pictorial stimuli in spite of the availability of a verbal code, and can, moreover, generate a pictorial code of a verbal stimulus when it is advantageous to do so (Posner, 1969; Posner, Boies, Eichelman & Taylor, 1969; Smith & Nielsen, 1970; Tversky, 1969).

The problem of demonstrating which encoding modality subjects use has been overcome in these studies by using reaction time in a same-different task. In this technique, pairs of stimuli, each either a picture or a word, are presented in succession. Subjects respond "same" by pressing a key if the stimuli have the same name (e.g., a picture of a face and its corresponding name, or a picture and an identical picture) and "different" if the situation is otherwise. If the subject has encoded the first stimulus in the modality of the second, his responses should be faster than if he had encoded the first stimulus in a different modality from the second stimulus. That is, the subject should respond faster comparing a second stimulus picture (word) to a pictorial (verbal) memory representation than to a verbal (pictorial) one.

In a given block of trials, 80% of the second stimuli are of one type, pictures or words; while 20%, selected at random, are of the other type. It is to the subject's advantage to encode the first stimulus—either all pictures or all words in blocks—in the mod-

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ality of the more frequent second stimulus. That adults do this is evidenced by faster reaction times to the more frequent type of second stimulus, irrespective of the type of the first stimulus, provided that sufficient time (about .5 second) is given for encoding the first stimulus in the expected modality of the second (Posner & Boies, 1971; Tversky, 1969; Tversky, 1972a). These subjects were, on the aggregate, equally facile at either verbal or pictorial encoding of both pictures and words as indicated by their relative reaction times, though certain individual subjects did seem to be more proficient at one or the other of the modalities. The present research uses this task to investigate whether children, like adults, can encode pictures and names either pictorially or verbally according to task demands, and to find out if preliterate children are more adept at retaining visual than verbal events or more proficient encoding pictorially than verbally.

Method

Subjects and Experimenter

The subjects were 20 middle-class children at the WIZO nursery school in Bet-Hakarem, Jerusalem, Israel. There were 10 boys and 10 girls, ranging in age from 3 years 9 months to 5 years, with a mean age of 4 years 4 months. The experimenter, a graduate student in psychology, was a native Israeli woman in her mid 20s.

Procedure

On any given trial, the experimenter either showed a picture with one of four shapes drawn on it or named a shape, and 1 second later, showed or named another one, simultaneously initiating the reaction time apparatus. The names and shapes were egg (ellipse), ball (circle), box (square), and stick (rectangle). Since automated equipment was not available, the experimenter practiced all combinations of presented pictures and vocalized names so that (*a*) the first and second stimulus presentation took the same amount of time irrespective of the stimulus type; (*b*) all facial and body movements of the experimenter visible to the subject were identical irrespective of the stimulus type; and (*c*) the timer was initiated at exactly the same point in the sequence of stimuli on every trial.

The experimenter trained first with a clock and then with internalized counting to maintain the pace. She periodically checked herself to make sure that the same pace was maintained. The child responded by pressing a clown-adorned button which stopped the timer and by simultaneously vocalizing "yes" if the shape and name or two shapes or two names had the same referent, or "no" otherwise. Each child was tested individually and was given practice before each session until he could perform all aspects of the task correctly and easily. This procedure was chosen because it was felt that a choice of two buttons, one for "same" responses and one for "different," was too difficult for children of that age, and because a voice key would be operated by extraneous vocalizations, which are difficult to avoid in that age group. In fact, synchronization of button press and vocalization of response proved very easy to the children, easier then either response alone, as, indeed, is suggested by Luria's (1961) research on the development of verbal control of behavior.

The gist of instructions explained to each child was as follows:

> Let's play a game; first I'll explain it to you —listen carefully—and when you understand, we'll start to play.
>
> In this game, we have four shapes: egg, ball, stick, and box [experimenter demonstrated the cards]. First let's see if you know them well. I'll point to a shape and you tell me its name quickly [practice].
>
> Now, in this game, I show you one picture of a shape, then cover it and show another one [I say the name of one shape and then say the name of another; I show you one picture and then say one name] [demonstration]. The first and the second might be the same or different [experimenter explained and demonstrated all possibilities]. Our clown here wants to know every time whether the two were the same or different. So you tell him yes when they're the same or no when they're different. He can't hear you, though, unless you press this button here while saying yes or no [demonstration and practice].
>
> Sometimes, I show you the first picture [say the first name] as usual but then instead of showing you another one, I say a name [show a picture]. This is just the same as if I showed you the picture. You say yes to the clown if I say the name of the first [show you the same picture again. . . .] [demonstration].
>
> Let's try to play the game for a while to see if you've understood [practice of all types of trials for that session, same, different, surprise, and regular trials].

Design

Each subject had 96 experimental trials, half on one day, and half a day or two later, in sessions of half an hour to an hour. For half of the children, the second stimulus was a picture on 79% of the trials of both sessions, and a name on the others (called "surprise" trials). For the other subjects, the predominant second stimulus was a name, while a picture appeared on surprise trials. For each subject, the first stimuli of one session were always pictures, and of the other, words, with the order counterbalanced within each group. In each

session, half of the stimulus pairs were same (correct answer, yes) and half were different. Each subject was informed of the arrangement of stimuli he was to see. Each of the four stimuli appeared equally often in each position, with order of trials randomly determined. Surprise trials were selected to be half "sames" and half "differents," to equally represent each of the four stimuli, and to appear equally at the beginning, middle, and end of each session so that practice effects were evenly distributed. Otherwise, surprise trials were randomly chosen. Order of trials was constant across subjects of a particular group.

Results

The means of the subjects' mean reaction times are reported in Table 1 for nonsurprise trials where the second stimulus appeared in the expected or frequent modality, and in Table 2 for surprise trials. The data are broken down by conditions, modalities of first and second stimuli, and same or different pairs. Erroneous responses, which constituted a rather low 5% of the data, were excluded from the analysis. For all 20 subjects, reaction times were longer by 1.026 seconds on the average on surprise trials than on nonsurprise trials, a result significant beyond the .001 level by a sign test. Change in expected modality added more to reaction time when the surprising second stimulus was not in the same modality as the first. Subtracting the entries of the right-hand third of Table 1 from the comparable entries of Table 2 yields a difference in reaction time of .893 second for picture-picture pairs, and .825 second for word-word pairs, but a difference of 1.286 seconds for picture-word pairs and 1.98 seconds for word-picture pairs.

A three-way analysis of variance performed on the nonsurprise reaction times yielded a significant effect of same versus different pair types ($F = 10.85$, $df = 1/18$, $p < .01$) with same pairs .136 second faster than different, and an almost significant effect of second stimulus modality ($F = 3.98$, $df = 1/18$, $.10 > p > .05$). Responses to second pictures were .545 second faster than responses to second words. Neither the effect of first stimulus modality, with a small difference of .026 second in reaction time, nor the effects of the interaction terms were significant. The girls, with a mean of mean reaction times of 1.414 seconds, were faster than the boys, with a mean of means of 1.803 seconds, though this result was not significant ($t = 1.71$).

Discussion

The large and consistent difference in reaction times between those trials where the second stimulus appeared in the expected modality, and those trials where that stimulus appeared in the unexpected modality (surprise trials), indicates that subjects were able and did encode the first stimulus in the expected modality of the second stimulus. Preschool children, then, like adults, can remember simple pictures and their names in either a pictorial or a verbal fashion. This difference in reaction time between surprise and nonsurprise trials has been found re-

TABLE 1

MEAN CORRECT REACTION TIMES ON NONSURPRISE TRIALS

First stimulus	Second Stimulus						
	Same		Different		Mean of same & different		
	Pictorial	Verbal	Pictorial	Verbal	Pictorial	Verbal	*M*
Pictorial	1.349	1.866	1.439	1.826	1.394	1.846	1.620
Verbal	1.156	1.786	1.396	2.039	1.276	1.912	1.594
M	1.539		1.675		1.334	1.879	1.607

TABLE 2

MEAN CORRECT REACTION TIMES ON SURPRISE TRIALS

First stimulus	Second Stimulus						
	Same		Different		Mean of same & different		
	Pictorial	Verbal	Pictorial	Verbal	Pictorial	Verbal	*M*
Pictorial	2.085	2.879	2.489	3.385	2.287	3.132	2.710
Verbal	2.142	2.769	2.607	2.704	2.374	2.737	2.556
M	2.469		2.796		2.331	2.934	2.633

peatedly with adult subjects, where it has also been demonstrated that the effect cannot be attributed to relative unfamiliarity of the unexpected modality. When the infrequent or unexpected stimuli are visually very different, but not in a different modality, the difference in reaction times is not obtained (Tversky, 1969). However, the difference in reaction time to unexpected and expected modalities is obtained where second stimulus modality is randomized within blocks and where subjects are informed of the most likely second stimulus modality on each trial (Tversky, 1972b).

Moreover, the encoding of the first stimulus is sufficiently complete after 1 second that there is virtually no effect of the modality of the first stimulus on judgment time. That is, a pictorially encoded name is just as efficient for an expected pictorial match as the memory of a picture, and a verbally encoded picture functions as well in an expected verbal match as the memory of a word. On the average, this finding also holds for adults. While same-different judgments are faster to second pictures than to second words, even on surprise trials, this may be due to the simplicity of the particular pictures used, as adults also seem to perform faster with these pictures (Tversky, 1972a, 1972b). Like adults, children are faster at making "same" responses than "different" responses. This is consistent with the proposal (Bindra, Donderi, & Nishisato, 1968) that different responses are lengthened when the stimuli are easily codable, or when they possess a readily decomposable multidimensional structure.

Although children display the same flexibility in changing encoding modalities as adults, children take considerably longer to respond than adults in a comparable task. Well-practiced adults responded to more complex stimuli with a mean reaction time of .749 second on nonsurprise trials, and a mean reaction time of .933 second on surprise trials. In a study of letter discrimination, Yonas and Gibson (Gibson, 1969, pp. 454–455) found comparable differences in reaction times between children and adults; their second graders performed half as fast as their college sophomores. Of more interest is the finding that, for children, surprise trials increased reaction times by 1.026 seconds, an increase of 64% of the nonsurprise trial reaction time, whereas in adults, this increase was .184 second or 25%. There is evidence that adults used this time to recode the stimulus in memory to match the modality of the presented stimulus (Tversky, 1969) rather than coding the presented stimulus into the other modality and holding both stimuli in memory while making the judgment. This is a much more difficult strategy, especially since the children, like adults, performed better on surprise trials when the unexpected second stimulus modality was the same as the first stimulus modality. Presumably, it is faster to retrieve the memory of the first stimulus than to construct a new encoding of it.

It is evident from this task that preschool

children can remember simple pictures as well as their names, that either pictorial or verbal codes can mediate memory of either pictures or words in accordance with task demands, and that same-different judgments tend to be faster to pictures than to words. In these respects, the performance of preschoolers resembles that of adults. Preschoolers, however, are proportionately much slower than adults to recode previously encoded stimuli when their prior encoding modality turns out to be inappropriate.

REFERENCES

BINDRA, D., DONDERI, D. C., & NISHISATO, S. Decision latencies of "same" and "different" judgments. *Perception and Psychophysics,* 1968, **3,** 121–130.

BROWN, R. W., & LENNEBERG, E. H. A Study in language and cognition. *Journal of Abnormal and Social Psychology,* 1954, **49,** 454–462.

BRUNER, J. S. The course of cognitive growth. *American Psychologist,* 1964, **19,** 1–15.

GIBSON, E. J. *Principles of perceptual learning and development.* New York: Appleton-Century-Crofts, 1969.

GLANZER, M., & CLARK, W. H. Accuracy of perceptual recall: An analysis of organization. *Journal of Verbal Learning and Verbal Behavior,* 1963, **1,** 289–299.

KENDLER, H. H., & KENDLER, T. S. Vertical and horizontal processes in problem solving. *Psychological Review,* 1962, **69,** 1–16.

LURIA, A. R. *The role of speech in the regulation of normal and abnormal behavior.* New York: Liveright, 1961.

NEISSER, U. *Cognitive psychology.* New York: Appleton-Century-Crofts, 1967.

PAIVIO, A. *Imagery and verbal processes.* New York: Holt, Rinehart & Winston, 1971.

POSNER, M. I. Abstraction and the process of recognition. In G. H. Bower & J. T. Spence (Eds.), *The psychology of learning and motivation.* Vol. 3. New York: Academic Press, 1969.

POSNER, M. I., & BOIES, S. J. Components of attention. *Psychological Review,* 1971, **78,** 391–408.

POSNER, M. I., BOIES, S. J., EICHELMAN, W. H., & TAYLOR, R. L. Retention of visual and name codes of single letters. *Journal of Experimental Psychology,* 1969, **79** (1, Pt. 2).

SMITH, E. E., & NIELSON, G. D. Representations and retrieval processes in short-term memory: Recognition and recall of faces. *Journal of Experimental Psychology,* 1970, **85,** 397–405.

SPERLING, G., & SPEELMAN, R. G. Acoustic similarity and auditory short-term memory: Experiments and a model. In D. A. Norman (Ed.), *Models of human memory.* New York: Academic Press, 1970.

TVERSKY, B. Pictorial and verbal encoding in a short-term memory task. *Perception & Psychophysics,* 1969, **6,** 225–233.

TVERSKY, B. Pictorial and verbal encoding as a function of retention interval. Unpublished manuscript, Hebrew University, 1972. (a)

TVERSKY, B. Pre- and post-cueing of stimulus modality in a same-different task. Unpublished manuscript, Hebrew University, 1972. (b)

WAUGH, N. C., & NORMAN, D. A. Primary memory. *Psychological Review,* 1965, **72,** 89–104.

WHITE, S. Evidence for a hierarchial arrangement of learning processes. In L. P. Lipsitt & C. C. Spiker (Eds.), *Advances in child behavior and development.* Vol. 2. New York: Academic Press, 1965.

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