DOCUMENT RESUME

ED 114 207 PS 008 181

AUTHOR Trabasso, Tom; Foellinger, David B.
TITLE Seeing, Hearing and Doing: A Developmental Study of Memory for Actions.
SPONS AGENCY National Inst. of Mental Health (DHEW), Rockville, Md.
PUB DATE 11 Apr 75
NOTE 27p.; Not available in hard copy due to marginal legibility of original document; Paper presented at the Biennial Meeting of the Society for Research in Child Development (Denver, Colorado, April 10-13, 1975)

EDRS PRICE MF-$0.76 Plus Postage. HC Not Available from EDRS.
DESCRIPTORS Age Differences; Cognitive Development; Cognitive Processes; Elementary School Students; *Memory; *Motor Reactions; Perceptual Motor Learning; Primacy Effect; *Recall (Psychological); Serial Learning; *Verbal Ability; *Verbal Learning; Verbal Stimuli

ABSTRACT

This study examining children's ability to organize information for the purpose of recall was designed to control for verbal ability differences. The participants were 10 boys and 10 girls each from kindergarten, 2nd, 4th and 6th grades. A modified "Simon Says" game was used to enable the children to respond to eight selected verbal and motor commands with an appropriate motor act. The experimenter first read or demonstrated each of the eight commands in a random order and, after all the commands had been presented, asked the child to execute as many of the commands as he could. Each child received 20 presentations of the eight commands. Results revealed recall effects typically observed in studies on memory development in which words were used as stimuli or responses. These included: (1) serial position effects, with younger children showing more recency and older children more primacy effects, and (2) better recall by older children. However, since the younger children structured their responses in recall as well, and in the same way as older children, the developmental differences in amount recalled would not seem to depend on response organization. (JMB)

Seeing, Hearing and Doing: A Developmental Study of Memory for Actions

Tom Trabasso

and

David B. Foellinger

Princeton University

Footnotes

Paper read at the Society for Research in Child Development Meetings, Denver, Colorado, April 11, 1975. This research was supported by Grant No. MH 19223 from The National Institute of Mental Health to T. Trabasso and is based upon a senior thesis by D. B. Foellinger, Princeton University, 1974.

Under the influence of advances in the study of memory on adults (especially Atkinson & Shiffrin, 1971) investigations on the development of memorial abilities have increased considerably during the past decade. Most of these investigations have shown young children to be at a considerable disadvantage. In particular, they are imputed to have a smaller information processing capacity (Pascual-Leone, 1970), to rely more upon retrieval from short-term than long-term memory and to be deficient with respect to organizational and rehearsal strategies (Belmont & Butterfield, 1969; Cole et al., 1971; Liberty & Ornstein, 1973; Shuell, 1969).

While it would be foolhardy to assert that there are no qualitative differences in the growth of memorial abilities, an examination of the tasks used to assess these talents may have been designed, inadvertently, to obtain some of the effects found. For example, most of the materials used in free recall experiments on children are words; occassionally the stimuli are pictures or objects but the responses are invariably words, either spoken or written. To the extent that organizing depends upon the use of shared taxonomic categories or semantic features, one would expect to find developmental differences in organization since it requires time and experience to learn these concepts (Gerjouy & Spitz, 1966, Nelson, 1969). In the absence of obvious class concepts, one might expect that it also requires time and experience with words in various contexts in order to derive semantic relations which may

be used to associate the words in a temporary organization for purposes of recall. These problems do not exist if one is interested in whether the child knows certain concepts and will use them. However, the heavy reliance upon verbal materials becomes problematical when one is interested in the question: Can a young child organize information for purposes of recall? Here, the development of semantic organization is confounded with the development of organizing strategies *per se*.

Motor-Action Sequences as Responses

It is almost a truism in developmental psychology that the child initially represents his world via sensory-motor action sequences and it is possible that these sequences, once internalized, become organized in terms of the common properties of the motor responses, in particular, the location of the action with reference to one's body. From a mnemonic point of view, a person may certainly use kinesthetic and sensory feedback to remember an activity or event and the body provides a highly structured spatial referent for associating all sorts of things using the well known method of loci. Something like the method of loci must operate when you ask a child of two years of age, Where is your nose? Where's your belly-button? etc.

The idea that action sequences may be better responses than verbal ones in recall seems to be embodied in the well-known game of "Simon Says". Here the child readily learns to translate a

verbal command, e.g. "Touch your nose" into the appropriate action, and he or she seems to enjoy it. In our experiment, we used a modified "Simon Says" game to study the free recall of eight different actions. These are shown in Figure 1.

In our study, we varied the modality of the command. As can be seen in Figure 1, we either overtly performed each command or we stated them. Thus from the child's point of view, the information was either visual or auditory, and the response was an equivalent motor act. In order to make the experiment comparable to a free recall study, we first read or demonstrated each of the eight commands in a random order. After all of the commands were presented, the child had to execute as many commands as he could.

Please note some aspects of the commands in Figure 1. Each command consists of an action (verb) and an object (or instrument). The location of the body where the action is performed may serve as the basis for a possible mnemonic organization. Note that the locations have to do with the head (e.g. touch nose, shake head, wink eye, open mouth), the arms and torso (raise hands, pat tummy, fold arms) and feet (kick foot).

A second source of organization could lie in the actions themselves and could thus serve as a basis for organizing responses in long-term memory. However, it is unclear how these actions would be organized.

The Experiment

In the main experiment, 20 children each from kindergarten,

second, fourth and sixth grade levels in the town of Rochester, Indiana, served as subjects. There were 10 girls and 10 boys in each age group.

All the children received 20 presentations of the 8 commands. Half of the presentations were auditory and half visual, and each modality occurred for 10 presentations in row, their order counterbalanced over the children. Within each presentation, the commands were random and two different random orders of the presentations were used. The commands were shown or spoken as depicted in Figure 1 except that the word "your" always preceded the object of the action, and the presentation rate was about four seconds per command. When demonstrating the command, the experimenter always returned to the same neutral sitting position before initiating another command.

The median ages of the children (and their ranges) were 5-8 (5-3 to 6-0), 7-8 (7-2 to 8-3), 9-11 (9-3, 10-7) and 11-10 (11-4 to 12-2). They were tested in December and January of the school year and for convenience, we shall refer to them as 5, 7, 9 and 11 year olds.

We shall present the results on the main points of interest with respect to age differences in recall:

(1) serial position or primacy and recency effects

(2) modality effects

(3) command effects

(4) organizational strategies

Serial Position Effects

Although the input order of the commands varied randomly, we found typical serial position effects on recall. The percentage of commands correctly recalled for each input position is shown for each age group in Figure 2. Note that there were primacy and recency effects.

One can see the developmental differences in these more clearly by comparing the 5-year-old children with the 11-year-old children on the relative proportion of correct responses as is shown in Figure 3. Figure 3 was obtained by finding, for each age group, the proportion of correct responses for each position relative to the total number of correct responses. (We have labelled this inverse relative difficulty since these curves are usually plotted relative to total errors. We should have labelled the ordinate relative percent correct instead.)

Figure 3 clearly shows that the younger children gave relatively more recent commands than did the 11-year-olds; the older children are better, however, at the initial and middle portions of the curve. These data are consistent with those of Cole, Frankel and Sharp (1971) who did one of the first systematic studies of memory development using words as stimuli and responses. Thus serial position effects do not appear to depend upon the nature of the response per se. (We may note in passing that all the children improved over trials to some extent, although the amount

of improvement was not dramatic and that the serial position curves over trials replicated the findings of Cole, Frankel and Sharp (1971): for early trials, there is greater recency and for later trials there is more primacy, suggesting that more information is being transferred into long-term storage and that this information may be organized.)

Modality Effects

Seeing was clearly better than hearing the commands, especially for the younger children. Figure 4 compares the performance of the age groups for each modality. Note that the visual presentation aided the younger children more than it did the older ones, i.e. there was a modality-age interaction.

While one may be tempted to conclude that seeing or visual information is processed better by young children, in line with Bruner, Olver and Greenfield's (1966) hypothesis that young children rely more on iconic storage than acoustic storage, our subsequent analyses and experiments on command differences suggest a different interpretation. The visual presentation is less ambiguous or vague as to what is being asked for and provides a direct representation of the action-object relation than does the auditory command.

Commands

The difficulty of the commands per se is shown in Figure 5. Here we have arranged the commands on the abscissa according to

how difficult they were on average with the most difficult on the left. Note that this order holds for the 5-and 7-year-old children but increasingly less so for the older children.

When we examined the improvement in performance over trials, we found that improvement occurred only for the first four commands (touch, shake, fold and pat). No improvement with practice was noted for the other four commands.

These data forced us to look more carefully at the commands as a source of developmental differences. An action-object or action-instrument analysis suggested that those commands which were the easiest to perform were also the least vague or ambiguous. That is, with respect to one's body, some actions are performed on or with a few parts while other actions apply more widely. Actions which are restricted in scope were the easiest to recall.

Ambiguity Study

We carried out another small experiment to measure the amount of ambiguity in the commands with respect to the locus of the action. We asked 26 children in a third grade class in Princeton to tell us, separately, for each command, "How many different ways can you (verb) some part of your body?" The children wrote, for each action, the number of objects on a separate sheet of paper.

The relation between the ambiguity or vagueness of the locus of the action and difficulty of the commands is summarized in Figure 6. The figure shows the number of possible objects given

for each command by the children and then correlation with ease of recall. Note that the overall correlation is quite high and that strong positive correlations were obtained for all groups except the 11-year-old children. Clearly, understanding fully an instruction is at issue and for some reason, the oldest children are able to disambiguate the command with respect to locus better than children ranging in age from 5 to 10 years.

An analysis of the commands and their vagueness suggests that younger children are more susceptible to interference or competition of responses than are older children. Note that each command could be viewed as having two response components: The action and the object of the action. Differential forgetting out out of short-term store could occur for either component but more possible objects would make it difficult to code the entire action sequence. Thus the response interference would be in the coding or the representation of the action sequence in memory and not at the point of execution.

<u>Organizational effects</u>

The recall protocols were examined for possible organizational structures and developmental differences in two ways: (1) subjective organization (SO) (as indexed by Bousfield and Bousfield's (1966) measure of intertrial repetitions) and (2) hierarchical cluster analysis (as measured by Friendly's (1971) diameter method on inter-item proximities).

First, Figure 7 summarizes the SO results. For all groups except the 7-year-olds, a significant majority of the children showed net positive so (observed-expected inter-trial repetitions). However, an analysis of variance on these scores yielded a borderline, p=.083, developmental difference.

For ages 5-10, there were no numerical differences worthy of note. Thus, so and developmental differences in recall are not related except for the oldest age group (cf. Laurence, 1966, for similar results).

Figure 8 shows the hierarchical cluster analysis results for all the children in terms of modality of input. The analysis is as anticipated, the children structure their actions as output in terms of the locus of the action:

(1) by head (wink, open, touch, shake)

(2) by torso and arms (fold, raise, pat)

and

(3) by legs (kick)

This organization holds for either input modality (cf. Bousfield and Cohen, 1955) indicating that it occurs in the response output and not at input or storage. In the development of this organization, the bottleneck may be on the response side also. The child is restrained to give one response at a time and delay out of iconic or auditory store may result because of time due to execution rather than coding and translation. These issues are not resolved here or in the adult literature, for that matter.

Figures 9 and 10 show the hierarchical structures for visual presentation and auditory presentation, respectively, for each age level. Note that the same head-torso-legs grouping exists for all groups, with the exception of the 7-year-olds to some extent. In Figures 8, 9, 10 the number at the left for each hierarchy is an index of how structured the data were. This index is called by Friendly (1971) the "root-mean square ultrametric distortion", and a value less than .10 is considered to be an index of low stress or a good fit. All of our values are considerably lower (in fact, less than .05). Furthermore, there is only a slight developmental trend in these data, indicating that the younger children organized their action sequences "as tightly" as did the older children (cf. Moely and Shapiro, 1969).

Thus, while the ability to recall commands and translate them into actions was developmental, the differences would not seem to be in the ability to organize *per se*.

We found, using action-sequences as responses and direct auditory or visual codes as stimuli, the typical recall effects observed by other investigators on memory development who have used words as stimuli or responses:

(1) Serial position effects with the younger children showing more recency and the older children showing more primacy effects and (2) better recall by older children. However, since the younger children structured their responses in recall as well

and in the same way as the older children, these developmental differences in amount recalled would not seem to depend at all upon response organization. While one may have to recall in order to organize, one may not have to organize in order to recall.

References

Atkinson, R.C. and Shiffrin, R.M. The control of short-term memory. Scientific American, 1971, 224, 82-89.

Belmont, J.M. and Butterfield, E.C. The relations of short-term memory to development and intelligence. In L P. Lipsitt and H.W. Reese (Eds.), Advances in Child Development and Behavior, Vol. 4, New York: Academic Press, 1969.

Bousfield, A.K. and Bousfield, W.A. Measurement of clustering and sequential constancies in repeated free recall. Psychological Reports, 1966, 19, 935-942.

Bousfield, W.A. and Cohen, B.H. General review of a program of research on associative clustering. Technical Report No. 11 on Contract Nom - 631 between The Office of Naval Research and the University of Connecticut, 1955.

Bruner, J S., Olver, R. and Greenfield, P. Studies in Cognitive Growth. New York: Wiley, 1966.

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

Friendly, M.L. Proximity analysis and the structure of organization in free recall. Unpublished Ph.D. dissertation, Princeton University, 1971.

Gorjouy, I.R. and Spitz, H. H. Associative clustering in free recall: Intellectual and developmental variables. American Journal of Mental Deficiency, 1966, 70, 918-927.

Laurence, M.W. Age differences in free recall learning. Canadian Journal of Psychology, 1966, 20, 388-399.

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

Moely, B.E. and Shapiro, S.J. Free recall and clustering at four age levels: Effects of learning to learn and presentation method. Developmental Psychology, 1971, 4, 490.

Nelson, K.J. The organization of free recall by young children. Journal of Experimental Child Psychology, 1969, 8, 284-295.

Pascual-Leone, J. A mathematical model for the transition rule in Piaget's developmental stages. Acta Psychologica, 1970, 32, 301-345.

Shuell, T.J. Clustering and organization in free recall. Psychological Bulletin, 1969, 72, 353-374.

Figure Captions

Figure 1. Modes of presentation: Visual and auditory examples of the eight commands used in the study.

Figure 2. The percentage of commands correctly executed as actions for each position of presentation input and each age group.

Figure 3. The number of commands correctly executed at each position of presentation input relative to the total number correct for each age group.

Figure 4. The percentage of commands correctly executed for each age group under each modality of presentation.

Figure 5. The difficulty of various commands expressed as the percentage correctly executed in terms of the order of difficulty . The commands are indicated by the first letter of the action.

Figure 6. The relationship between order of difficulty in recall and ambiguity of the locus of the command. The correlations are rank order correlations. The number of different commands given is the total number of different commands for 26 children.

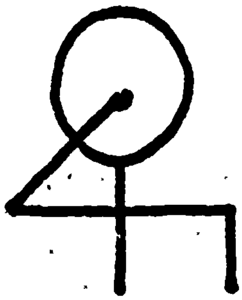
Figure 7. Mean subjective organization (SO) and proportion positive (observed-expected ITR's) scores for each age group.

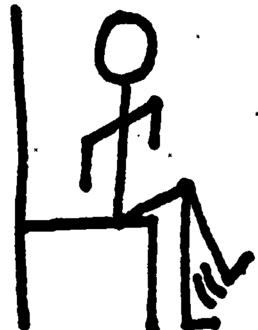
Figure 8. Hierarchical cluster analysis structure for all children and for each presentation modality. The number in parenthesis is Friendly's (1971) root mean square ultrametric distortion index. A value of less than .10 is considered

to index a good hierarchical fit.

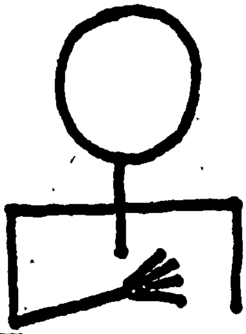
Figure 9. Hierarchical cluster analysis results for each age group for the visual mode of presentation.

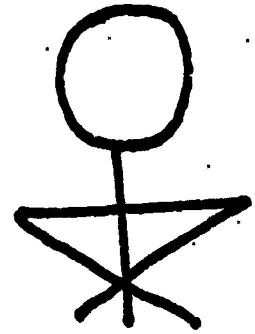
Figure 10. Hierarchical cluster analysis results for each age group for the auditory mode of presentation.



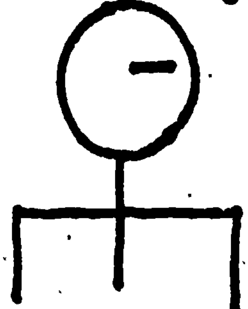


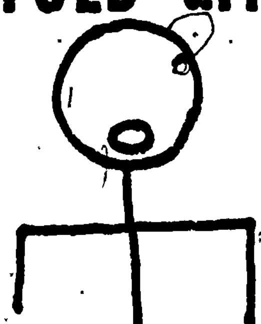
TOUCH nose KICK foot



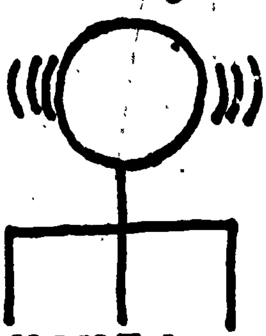


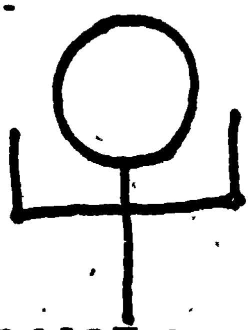
PAT tummy FOLD arms



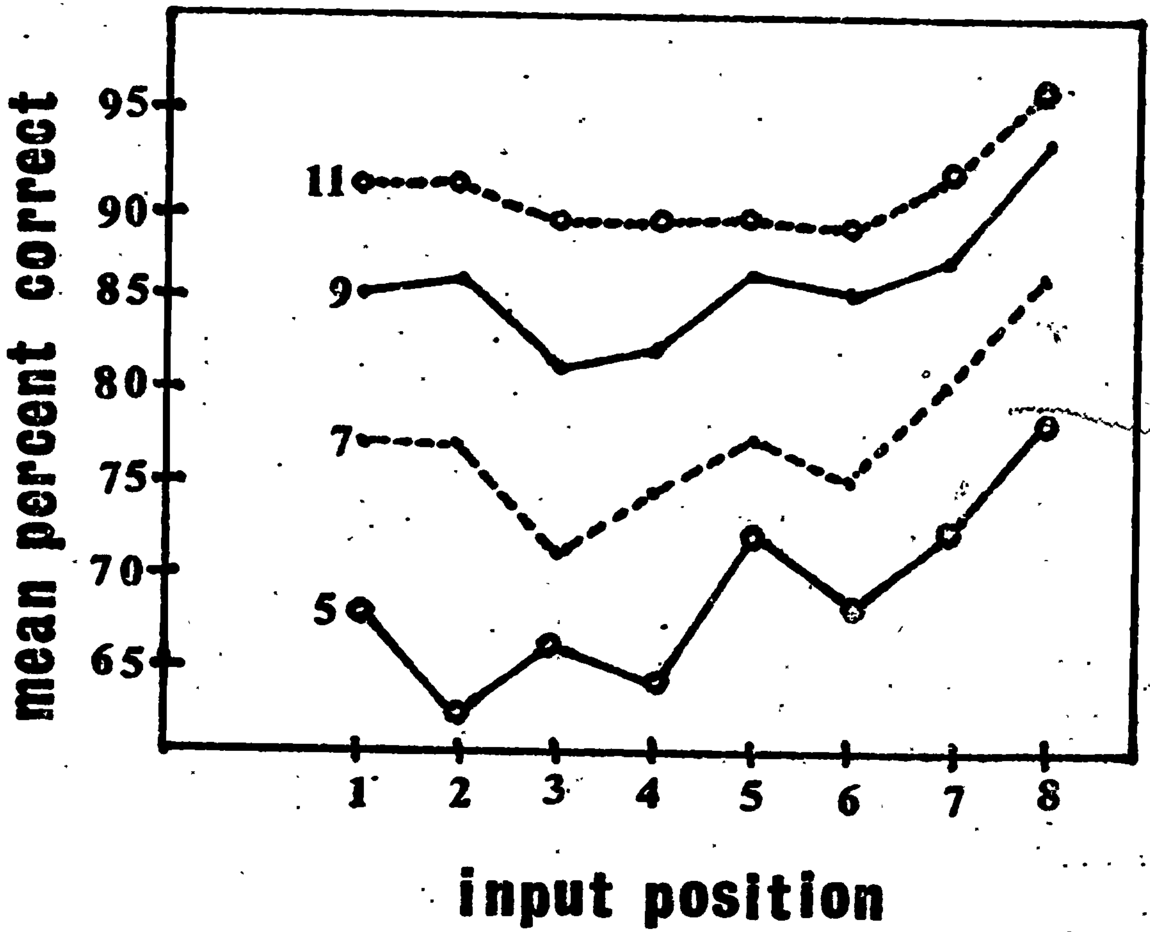


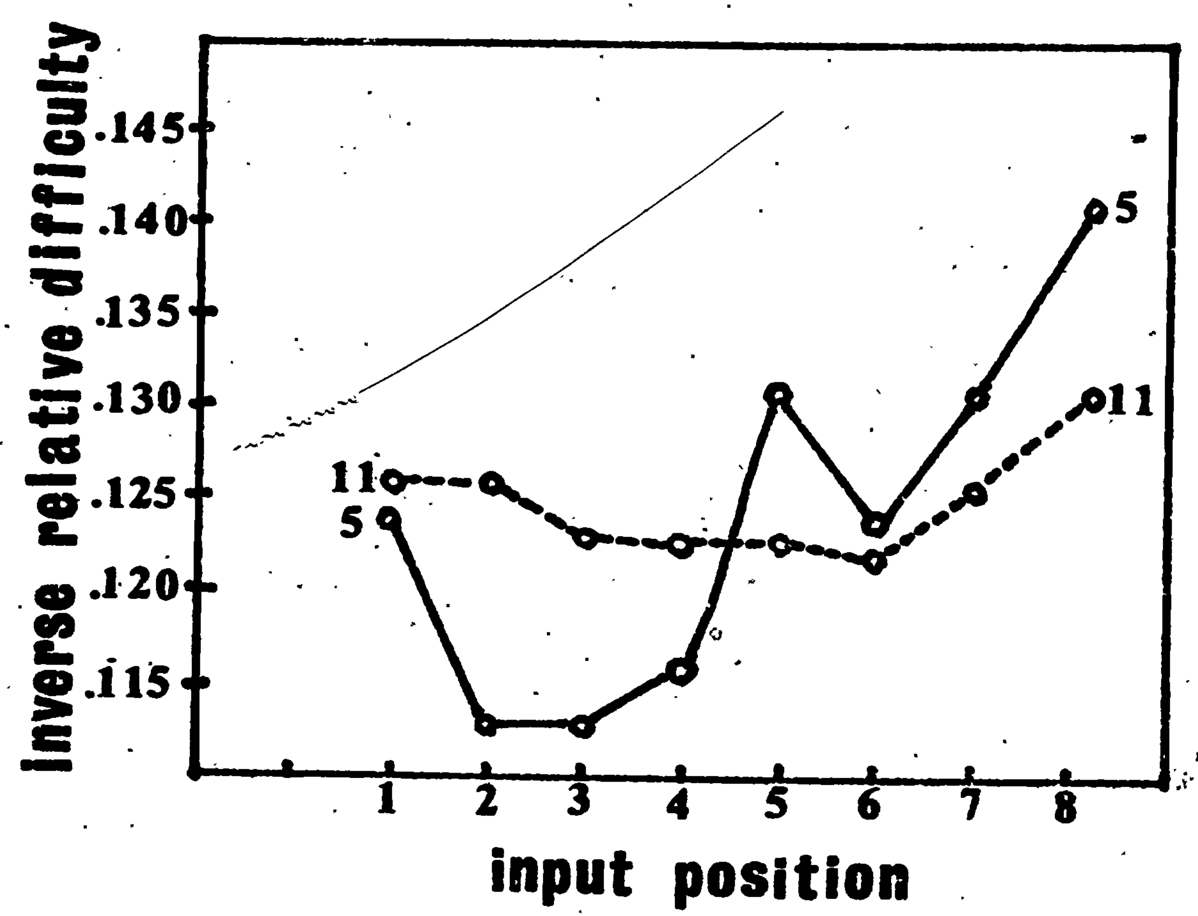
WINK eye OPEN mouth

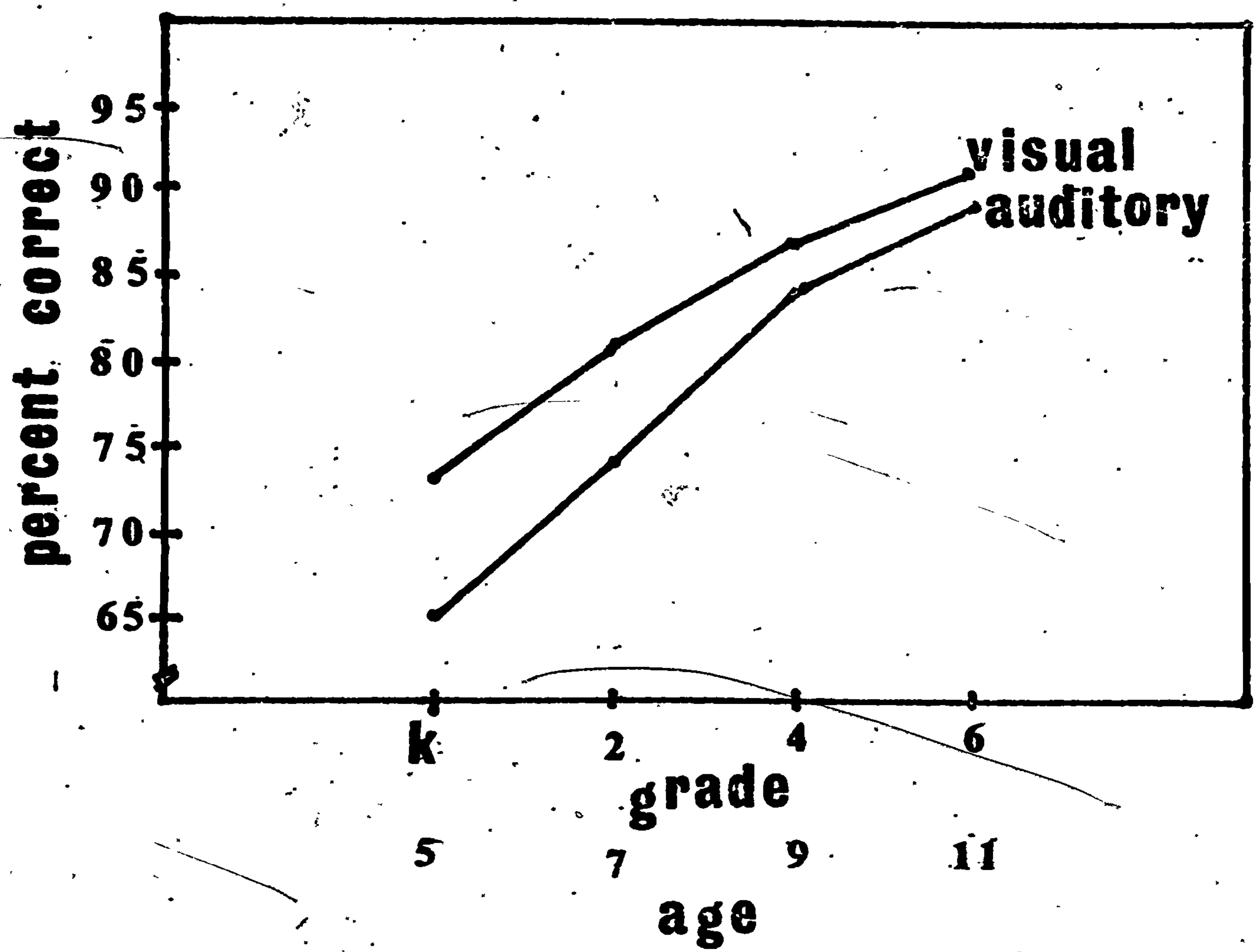


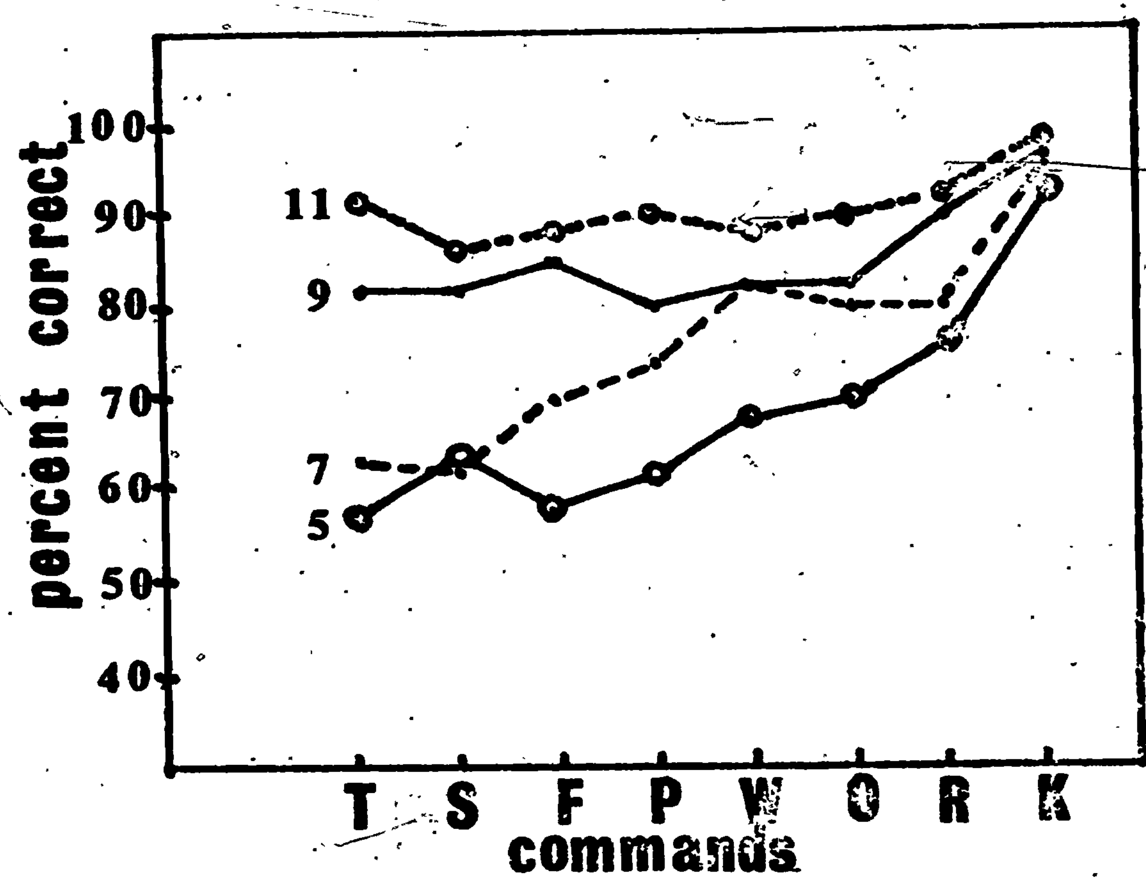


SHAKE head RAISE hands


mean percent correct
95
90
85
80
75
70
65
11
9
7
5
1
2
3
4
5
6
7
8
input position


inverse relative difficulty
.145
.140
.135
.130
.125
.120
.115
11
5
5
11
1
2
3
4
5
6
7
8
input position


percent correct
95
90
85
80
75
70
65
visual
auditory
k
2
4
6
grade
5
7
9
11
age


percent correct
100
90
80
70
60
50
40
11
9
7
5
T
S
F
P
W
O
R
K
commands

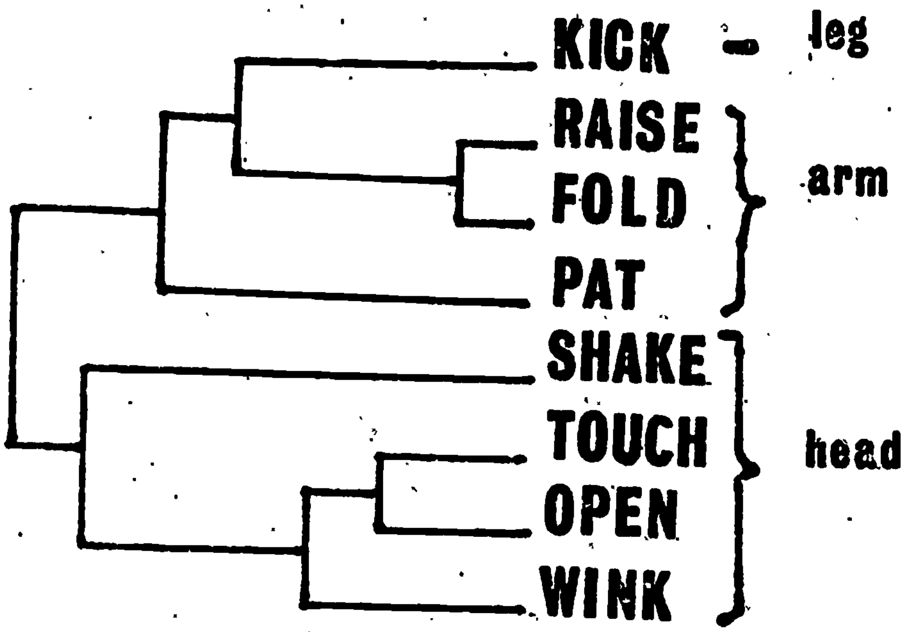
rank order	exp. 1 percent correct		ambiguity study number of different objects per command	
1	kick	96	wink	4
2	raise	86	open	6
3	open	81	kick	9
4	wink	81	raise	12
5	pat	77	fold	16
6	fold	75	pat	17
7	shake	74	shake	19
8	touch	74	touch	23

mean	r = .72
5yr	.62 s
7yr	.76 s
9yr	.67 s
11yr	.19 ns

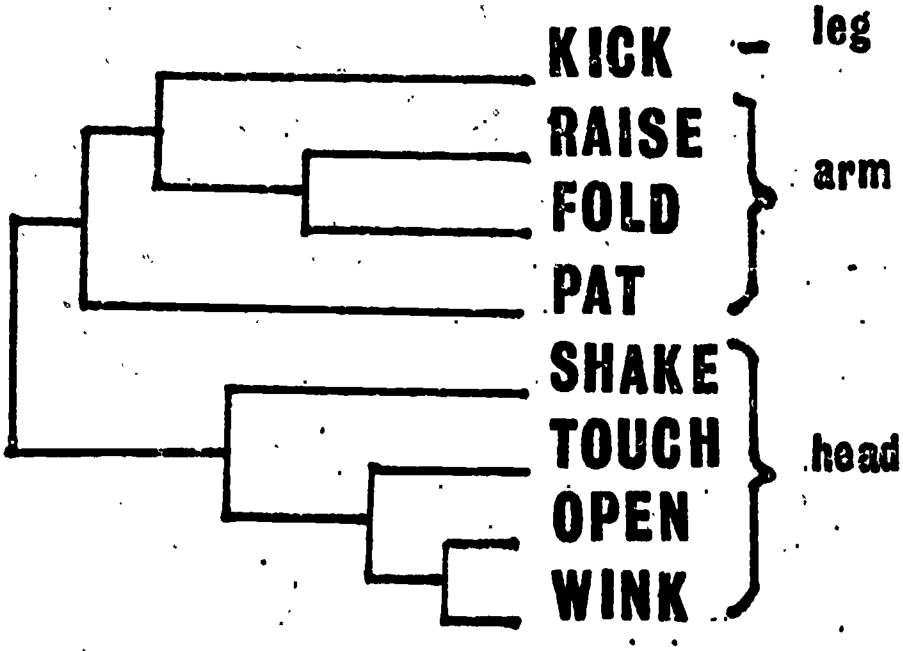
AGE	MEAN SO	PERCENT POSITIVE
5	.400	75 s
7	.318	50 ns
9	.446	85 s
11	.618	85 s

RESPONSE ORGANIZATION—ALL GROUPS

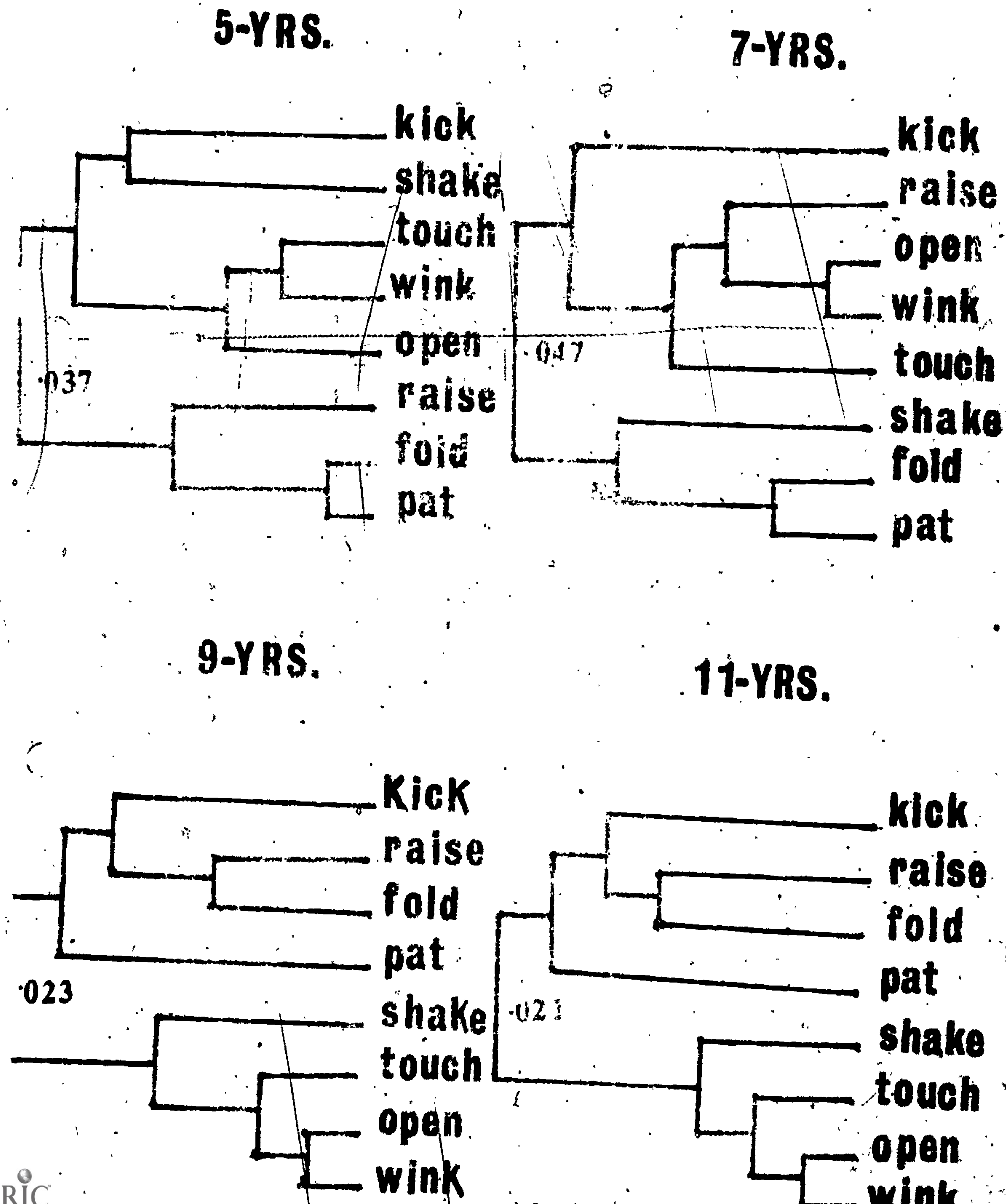
AUDITORY 2 (.010)



VISUAL 2 (.014)

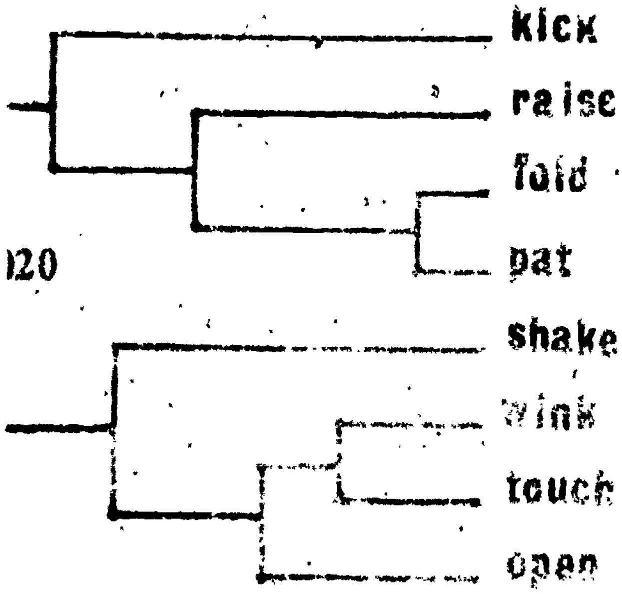


VISUAL-2 ORGANIZATION

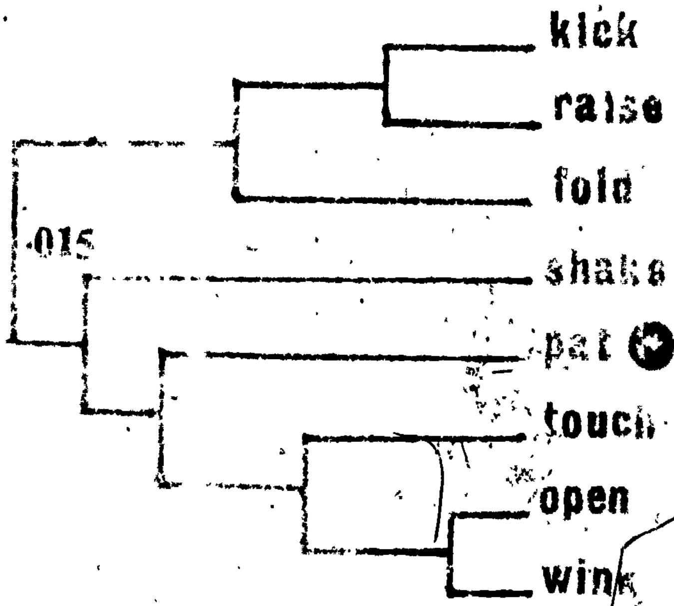


AUDITORY-2 ORGANIZATION

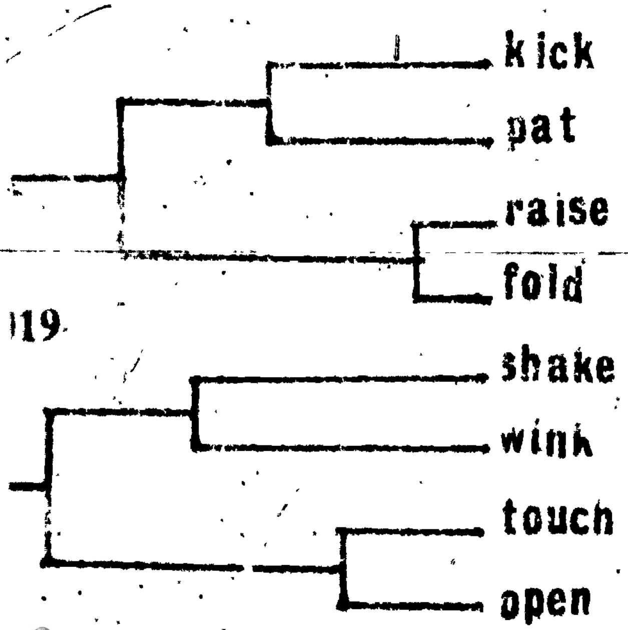
5-YRS.



7-YRS.



9-YRS.



11-YRS.