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Developmental Trends in the Use of Perceptual and Conceptual Attributes in Grouping, Clustering, and Retrieval

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In Experiment I, two tasks were administered to children aged 4, 5, and 9 in order to investigate preference for perceptual versus conceptual attributes in grouping of common objects, and in various aspects of memory. The grouping task revealed a clear chronological progression: color and form determined the youngest children's grouping about equally; form dominated in the 5-year-olds; and most of the oldest children grouped primarily by conceptual attributes. In the memory task, three lists—one organized by color, one by form, one by superordinate category—were presented for free, followed by cued recall. Clustering showed the developmental shift from color to form to concept, while cued recall showed conceptual superiority at all ages. Experiment II replicated the memory task, yielding the same results. The results were discussed in terms of the relative abstractness and predictability of conceptual versus perceptual attributes and the difficulty of abstraction in encoding and the function of predictability in retrieval.

There has been conflicting evidence on the ability of young children to utilize superordinate taxonomic categories, such as vehicle or furniture,

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to organize memory (Lange, 1978; Moely, 1977). On the one hand, there is little, if any, unambiguous evidence that children under 6 spontaneously use superordinate category for clustering (Lange, 1978). On the other hand, experimentally imposed organization by taxonomic categories has been found to aid young children's recall (e.g., Cole, Frankel, & Sharp, 1971; Kobasigawa & Middleton, 1972; Nelson, 1969; Tenney, 1975; Vaughan, 1968) and to act as effective retrieval cues for young children (Eysenck & Baron, 1974). One possible resolution of these findings comes from the observation that the experiments showing no benefits of superordinate categories use tasks emphasizing *encoding* aspects of memory, while those experiments finding a benefit of superordinate categories use tasks emphasizing *retrieval* aspects of memory. So, whereas young children may not spontaneously encode stimuli together by category, they may nevertheless, use superordinate categories as retrieval cues.

There is considerable evidence that, when confronted with a choice, preschool children prefer to organize or group objects by perceptual attributes, such as superordinate category (Kagan, Moss, & Siegel, 1963; Melkman & Deutsch, 1977; Olver & Hornsby, 1966; Sharp, Cole, & Lave, 1979). Moreover, in memory tasks, perceptual encoding or organization is used spontaneously by children at an earlier age than conceptual organization. Perceptually related items yield more false recognitions in younger children while conceptually related items induce more false recognitions in older children (Cramer, 1976; Felzen & Anisfeld, 1970; Means & Rohwer, 1976). Clustering of items in recall occurs predominately on the basis of perceptual features for young children and conceptual features for older children (Denney & Ziobrowski, 1972; Hasher & Clifton, 1974; Naron, 1978; Melkman & Deutsch, 1977).

It appears, then, that young children do not spontaneously use superordinate categories to organize or encode information into memory. Young children do group and organize, but prefer to do so along perceptual rather than conceptual features. Since increases in recall depend primarily on increases in organization (Tulving, 1968), and since semantic or conceptual encoding improves recall more than shallow or perceptual encoding (Craik & Lockhart, 1972; Craik & Jacoby, 1979), understanding how children organize and encode is requisite to understanding children's successes and failures in recall. According to the encoding specificity hypothesis, recall is facilitated when organization at retrieval matches organization at encoding (Tulving & Thomson, 1973). Recent evidence suggests, however, that retrieval cues may augment effects of initial encoding (Moscovitch & Craik, 1976; Tulving & Watkins, 1975), and that conceptual retrieval cues may be superior to perceptual ones even when initial encoding was not conceptual (Moscovitch & Craik, 1976).

The preceding analysis suggests that young children may spontaneously organize, but may prefer perceptual groupings; however, because of the effectiveness in retrieval of conceptual, semantic attributes as opposed to superficial, perceptual ones, imposed conceptual organization may facilitate even young children's performance. This analysis was explored in the present study by presenting two tasks to preschool and school-aged children: a grouping task, to assess relative preferences for perceptual and conceptual attributes in organization of objects, and a memory task, in which lists were organized by either perceptual or conceptual features. Drawings of familiar objects served as stimuli, with natural color and shape as the perceptual attributes and common superordinates as the conceptual features. A transition from color to form groupings has been shown for meaningless geometrical figures (e.g., Brian & Goodenough, 1929; Melkman, Koriat, & Pardo, 1976; Suchman & Trabasso, 1966). With drawings of real objects, a shift from color to conceptual category as a basis for matching has been found by Melkman and Deutsch (1977). The existence of a developmental progression of all three attributes has been documented by Greenfield, Reich, and Olver (1966) and Olver and Hornsby (1966), but in a complicated task that did not allow assessment of transitivity of attribute preferences.

The present memory task allowed assessment of the effects of experimentally imposed perceptual or conceptual organization on encoding, that is, clustering, as well as on retrieval, that is, cued recall. These processes were investigated by Melkman and Deutsch (1977) as a function of self-determined organization. Their results do not bear, however, on the claim that retrieval is superior when conceptual organization is imposed on the input. To substantiate such a claim, an assessment is required of the effects of organization independent of preference. Organization was imposed by allowing only one kind of organization per list and by grouping the related items in presentation. For example, in the color list, all the red objects were presented, then the brown ones, then white, then yellow. The items in the color list were selected so that they could not be cross-classified by concept or by form. For each list, only one kind of classification successfully partitioned all of the items, and that classification was made more prominent by grouping items in presentation.

On the basis of previously reported findings and discussion, clustering in recall was expected to be highest where imposed organization corresponded to preferred organization. Thus, the same progression with age from perceptual to conceptual features was hypothesized for both similarity groupings and for clustering in free recall. As for cued recall, if speculations about the superiority of conceptual cues for search and retrieval are correct, then conceptual retrieval cues should yield superior performance even at an age where perceptual encoding is preferred.

EXPERIMENT I

Method

Subjects. Thirty Israeli middle- and upper-middle-class children from each of three age groups, preschool, kindergarten, and fourth grade, served as subjects. These ages were selected on the basis of previous research to cover as much of the perceptual–conceptual shift as possible with these tasks. The mean ages of the children in the three respective groups were 4 years, 3 months; 5 years, 3 months; and 9 years, 6 months. There were 14 males and 16 females in the first group, 12 males and 18 females in the second, and 21 males and 9 females in the third.

Stimuli. Four sets of drawings of common objects, one set for the grouping task and three sets for the recall task, were prepared. Each drawing was glued on a 10 by 10-cm piece of cardboard.

The recall sets consisted of 16 stimuli each, with four additional ones at the end of each set to offset the recency effect. In each set, four instances of each of four categories were included. In one set (color) the categories consisted of objects sharing the same color, in the second set (form) categories consisted of objects of similar shape, and in the third set categories consisted of objects of the same taxonomic superordinate.

In order to emphasize the categorized nature of the arrays, the drawings were colored in the color set only. Colors were selected to be common, typical colors of the particular objects. In the remaining two sets, black line drawings on white backgrounds were used. In the form set, the common shape was emphasized by using a basic outline (e.g., a circle) of the same size to portray all the objects in the same category. Each list was presented blocked by categories in a fixed order, as follows:

Color list: Flower, roof, fire, tricycle (red); carton, table, bread, shoe (brown); candle, rabbit, envelope, ambulance (white); popsicle, basket, butterfly, sun (yellow).

Form list: Clock, wheel, ball, coin; light bulb, mirror, tree, tennis racket; hat, tent, sail, triangle (musical instrument); book, window, television, suitcase.

Concept list: Salami, egg, cheese, grapes; bird, giraffe, cow, fish; sock, shoe, bathing suit, dress; bureau, lamp, chair, couch.

No object appeared in more than one category and all relationships among stimuli within one list other than the intended category were eliminated as far as possible. The stimuli of each set were arranged in a separate folder and presented by turning the pages. The average frequencies from the *American Heritage Word Frequency Book* (Carroll, Davies, and Richman, 1971) count for children's literature were 52 for the color list, 56 for form, and 53 for concept.

The grouping task consisted of 63 colored drawings, again of common objects, divided into three sets of triads, in order to assess separately preferences for color versus form, color versus concept, and form versus concept. As before, colors and forms were selected to be natural and typical of the objects. One drawing of each triad served as the standard and the other two as comparison stimuli. Each comparison stimulus matched the standard on a different attribute. Some examples appear in Table 1. In the color–form triads, for example, one comparison stimulus matched the standard in color but not in form, while the other matched it in form but not in color. The three drawings of each triad were glued on cardboard with the standard on the upper half and the comparison stimuli below and equidistant from it. The comparison stimulus matching the standard on one attribute appeared on its right about an equal number of times as on its left. Two additional triads were used to illustrate the task.

Procedure. Each child was escorted individually to a quiet room in the school the child attended and was seated at a table opposite the experimenter. The recall task was administered first, followed by the grouping task.

For the recall task the child was told (free translation from Hebrew): "We are going to play a memory game. I am going to show you some pictures and when I finish you will tell me what you saw." The two practice stimuli were then shown and the child recalled. Then, the experimenter said, "Now I will show you some more pictures and you try to remember them." The pictures of the first set were presented for 3 sec each, with an interval of 2 sec between pictures. Recall began and continued until the child could remember no more (about 2 min). Cueing was introduced as follows: "I am going to help you remember some more of the pictures. Can you remember any ________? (e.g., red objects)." Each of the four categories was cued successively with as much time allowed after each cue as was necessary. Since form categories did not always have a commonly accepted label, they were cued by an outline drawing of the form. The same procedure was followed for all lists. Each

TABLE 1
SOME EXAMPLES OF STIMULUS TRIADS USED IN THE GROUPING TASK

Color match	Anchor	Form match
Blackboard	(Top) hat	Cake
Umbrella	Tire	Drum
Color match	Anchor	Category match
Tree	Frog	Monkey
Fire engine	Rose	Sunflower
Form match	Anchor	Category match
Bow	Butterfly	Fly
Pencil	Flute	Accordion

set was presented to a third of each age group in each ordinal position. Subjects were randomly assigned to each order of presentation.

Following a break in which the experimenter conversed freely with the child, the grouping task was administered. First, the child labeled all of the 63 objects. Subsequently, the folder was opened to the first practice triad with the standard in view and the comparison stimuli concealed by an index card. Pointing to the standard the experimenter said: "See this picture? Now which of these (revealing comparison stimuli) goes with it? This one (pointing left) or this one (pointing right)?" The second practice trial was then administered and additional instruction was given where necessary. No mention, however, was made of bases for grouping, nor were subjects reinforced if they spontaneously offered such information. The 21 trials were then administered in the same order for all subjects: form–concept triads first, color–concept next, and color–form last. For reliability purposes, the whole matching task was readministered in the same order following a short break. As part of another experiment, the grouping task was run on three new groups of 20 subjects of the same ages. In this second study, the grouping task preceded other tasks and the order of triads was counterbalanced. The same results were obtained as in the present experiment where the memory task preceded the grouping task, and where order of triads was fixed.

Results

Grouping task. For each child, the number of color, form, and concept choices was determined for each set of the grouping triads (color versus form, color versus concept, and form versus concept) and for each presentation separately. The median correlations between the choices in the two presentations of each set were .57 for the 4-year-olds, .78 for the 5-year-olds, and .60 for the 9-year-olds. These correlations indicate that stimulus pairs are grouped fairly consistently by subjects as young as 4 years of age. Even where preference for one feature over another was not pronounced (e.g., color versus concept at 4) this was not due to random choices. These results substantiate reliability data previously reported by Melkman et al. (1976).

A three-way analysis of variance was performed on choices for each of the three attributes, with age, replication, and comparison type as factors. In none of the analyses did the effect of replication (first versus second presentation) or any of the interactions with replication reach significance. The data for the presentations were therefore combined, and are presented in Table 2 as a function of age and type of comparison. In the analysis of color choices, significant effects emerged for age ($F(2, 87) = 14.6, p < .01$) and for the age by comparison type interaction ($F(1, 87) = 9.5, p < .01$) indicating that color choices decreased with age, more so when the alternative was concept than when it was form. In the analysis

TABLE 2
MEAN FREQUENCY OF CHOICES BY AGE, REPLICATION, AND TYPE OF COMPARISON

Type of comparison:	Age 4			5			9		
Replication:	First	Second	Sum	First	Second	Sum	First	Second	Sum
Color vs	3.2	2.9	6.1	2.6	2.1	4.7	1.8	1.5	3.3
form	3.8	4.1	7.9	4.4	4.9	9.3	5.2	5.5	10.7
Color vs	3.4	3.7	7.1	2.6	2.4	5.0	0.6	0.5	1.1
concept	3.6	3.3	6.9	4.4	4.6	9.0	6.4	6.5	12.9
Form vs	5.0	4.8	9.8	4.1	4.4	8.5	2.0	2.5	4.5
concept	2.0	2.2	4.2	2.9	2.6	5.5	5.0	4.5	9.5

of form choices, significant effects of comparison type ($F(1, 87) = 13.8$, $p < .01$) and of the age by type interaction ($F(2, 87) = 26.6$, $p < .01$) were obtained. Form was chosen over color more frequently than over concept, and whereas form choices decreased with age when the alternative was concept, they increased when it was color. In the analysis of concept choices, age and type yielded significant effects ($F(2, 87) = 39.4$, $p < .01$, and $F(1, 87) = 42.2$, $p < .01$, respectively). Choice of concept increased with age and was more frequent when the alternative was color than when it was form. These results support the hypothesized chronological order of the three features and suggest that such preferences are relative: where a strongly preferred feature was not an alternative (i.e., form versus concept for the youngest subjects or color versus form for the oldest) the feature closest to it in the hypothesized ordering (i.e., form) gained in preference.

A more stringent test of the developmental progression of the three features as bases for grouping was provided by examination of the preference patterns of individual subjects. In many of the individual protocols, a strict ordering of attributes was evident; these were termed dominance patterns. There are six possible strict orderings or dominance patterns: (1) color > form > concept, (2) form > color > concept, (3) form > concept > color, (4) concept > form > color, (5) color > concept > form, (6) concept > color > form. Of these, only the first four are consistent with the hypothesized developmental ordering of color, form, concept. Intransitive patterns, such as form > color, color > concept, concept > form, are also inconsistent with the hypothesized progression. Support for the hypothesized chronological progression entailed first, predominant occurrence of the first four patterns, and second, an orderly change in their frequency with age.

The preference protocol of each child was assigned to one of the six dominance categories or to the intransitive category, or to the no dominance category where no strict ordering was evident (e.g., where any pair of attributes were equally preferred). The frequencies of these patterns in the three age groups are presented in Table 3. The data in Table 3 indicate first, that the number of patterns that are consistent with the hypothesized ordering exceeded chance expectation for all age groups. A binomial test that the obtained proportion of predicted patterns exceeded chance yielded z scores of 1.86, 2.19, and 2.92 for the 4, 5, and 9-year-olds, respectively, all significant at $p < .05$. Second, the number of inconsistent patterns and the number of patterns in which no dominance was exhibited was independent of age ($\chi^2(1) = .05$ and $\chi^2(1) = 2.2$, respectively). Third, the frequency of patterns 1 to 4 changed with age in the predicted direction, $\chi^2(6) = 42.83, p < .05$ (patterns 1 and 2 were combined for this analysis to reduce the number of cells with few entries). Thus, the group data as well as the within-subject data support the hypothesized developmental order of the attributes used by children in grouping of object pictures.

Recall and clustering. The number of spontaneously recalled words and the number of words retrieved in response to cues but not previously recalled (cued recall) was obtained for each child for each list. Preliminary analyses revealed no sex differences on any of the recall measures, nor were there any significant effects due to order of list presentations. The distinction between the sexes and orders of presentations were therefore not maintained in the analyses to follow. The mean scores for free and cued recall are presented in Table 4. Separate analyses of variance were performed on the data from free and cued recall, with age and list type as factors. For free recall, the effects of both age ($F(2, 87) = 42.6, p < .001$) and list type ($F(2, 174) = 4.78, p < .01$) were significant, and the interaction between them was not. Performance improved with age, and was

TABLE 3
FREQUENCIES OF PREFERENCE PATTERNS IN GROUPING OVER AGE

Preference pattern	Age 4	Age 5	Age 9
Consistent with chronological progression			
1. Color > form > concept	8	3	0
2. Form > color > concept	4	4	0
3. Form > concept > color	8	10	5
4. Concept > form > color	0	4	18
Inconsistent with chronological progression			
5 & 6. Transitive and inconsistent	2	2	4
Intransitive	3	1	0
No dominance	5	6	3

TABLE 4
MEAN FREE RECALL AND CUED RECALL SCORED BY AGE AND LIST IN EXPERIMENT 1

List	Age 4	Age 5	Age 9
Color			
Free recall	2.23	3.56	5.40
Cued recall	0.90	1.10	0.90
Cued recall as a percentage of unrecalled items	6.6%	8.8%	8.5%
Total recall	3.18	4.66	6.30
Form			
Free recall	2.13	2.73	4.26
Cued recall	2.03	1.53	1.86
Cued recall as a percentage of unrecalled items	14.6%	11.5%	15.8%
Total recall	4.16	4.26	6.12
Concept			
Free recall	2.27	3.46	5.70
Cued recall	2.60	1.80	2.73
Cued recall as a percentage of unrecalled items	18.9%	14.4%	26.5%
Total recall	4.87	5.26	8.43

Note. Sixteen items possible per list.

poorer on the form list than on the other two lists at all ages. For cued recall, only the effect of cue type was significant ($F(2, 174) = 23.88$, $p <$ .001). Substituting the total number of items accessed to cues (old and new) for cued recall in this analysis did not change the nature of the results. In marked contrast to the grouping task, the concept cues were most effective at all ages, followed by the form cues, followed by the color cues.

Bousfield's (1953) ratio of repetition (RR) was used to assess output clustering. This measure yields scores which are relatively independent of total recall, which varies with age and with list type. In addition it does not involve assumptions regarding the relationship between clustering and category recall which may not apply to young children in whom the spontaneous use of categories as cues for items-within-category recall is questionable. Three RR scores were obtained for each child, one for each list, by dividing the number of category repetitions (two successive items of the same input category) by free recall minus one. Cases in which free recall was less than two were treated as missing data since no category repetitions could occur in such protocols. The means of these RR scores are presented in Table 5 together with the number of subjects on which

TABLE 5
MEAN RATIO OF REPETITION (RR) SCORES BY LIST TYPE AND AGE IN EXPERIMENT I

	Age		
List	4 (n = 9)	5 (n = 17)	9 (n = 25)
Color	.47	.24	.36
Form	.32	.41	.35
Concept	.31	.28	.44

each mean is based, for the different groups. A 3(age) by 3(list) analysis of variance with list type as a within-subject factor yielded no significant effects for age or list but a significant age by list interaction ($F(4, 92) = 2.77, p < .05$). Thus, there is no evidence that clustering varies only as a function of age or imposed mode of organization. In each age group, however, the tendency to cluster was most pronounced where the imposed mode or organization (list type) corresponded to the attribute that was preferred in grouping. These findings support the hypothesized developmental shift in memory organization and are consistent with the results obtained by Melkman and Deutsch (1977). It should be noted that the method of blocked presentation of items cannot account for the age by list interaction. In order to further ascertain that categorical clustering rather than recall by input order was involved, the number of repetitions by input order was obtained and compared to that of category repetitions. There were a total of 98 repetitions by input order as compared to 246 category repetitions. It appears, therefore, that the category composition of the lists accounted for most of the clustering in recall.

To analyze the nature of the developmental differences in free recall, free recall scores were partialled into the number of categories and the number of items per category recalled. The means of these scores are presented in Table 6. Both number of categories recalled ($F(2, 87) = 29.4$, $p < .001$) and the number of items per category recalled ($F(2, 87) = 17.52$, $p < .001$) increased significantly with age. List type was also significant for category recall ($F(4, 174) = 2.65, p < .05$) and item recall ($F(4, 174) = 3.54$, $p < .01$). More categories were recalled in the color list than the concept list, and more concept categories were recalled than form categories. However, more items per category were recalled in the concept list than in either of the perceptual lists, which were about equal. This suggests that the overall advantage of the concept list is in accessing more items per category.

Discussion

Experiment I yielded support for a perceptual–conceptual shift with age in children's preferences for grouping objects and a concomitant

TABLE 6
MEAN NUMBER OF CATEGORIES AND WORDS PER CATEGORY RECALLED, BY AGE AND LIST IN EXPERIMENT I

List	Age 4	Age 5	Age 9
Categories			
Color	1.40	2.37	3.00
Form	1.60	1.87	2.50
Concept	1.43	2.07	2.70
Words per category			
Color	1.64	1.47	1.80
Form	1.38	1.44	1.64
Concept	1.54	1.64	2.07

shift in the bases for clustering in free recall. Younger children grouped objects sharing color or form in preference to grouping objects sharing taxonomic category, but the oldest children showed the opposite preference. Similarly, the younger children clustered more in free recall of lists that could be categorized by color or form than in recall of lists that could be categorized by superordinate concept. In contrast, concept cues were more effective for retrieval in cued recall than perceptual cues at all ages. The results for grouping replicate and extend findings already in the literature. The results for clustering and for cued retrieval in memory are newer and more surprising. For this reason, the recall experiment was replicated, deliberately introducing changes in the stimuli and in the procedure to ascertain the robustness of the main findings of interest, the appearance of a perceptual–conceptual shift with age in clustering in free recall, but a superiority of conceptual cues for cued recall at all ages.

EXPERIMENT II

Method

The memory task from Experiment I was replicated with certain procedural improvements, enumerated below. In other respects, the procedure was the same as that of Experiment I.

Subjects. Sixty Israeli middle- and upper-middle-class children divided equally into three age groups, preschool, kindergarten, and fourth grade, served as subjects. The mean ages and age ranges of the children in the three groups were: 4 years, 6 months (from 3 years, 10 months to 4 years, 10 months); 5 years, 4 months (from 5 to 6 years); and 9 years, 3 months (from 8 years, 10 months to 10 years). Half the children in each age group were girls, half boys.

Stimuli. Three new sets of drawings were prepared, as follows:

Color list: Banana, key, butterfly, ring (yellow); potato, dog, boot, chair (brown); phone, blackboard, umbrella, mask (black); flower, fire truck, apple, crayon (red).

Form list: Sun, face, plate, wheel; watch band, spoon, drum, boat (primarily cylindrical shape); handbag, door, stove, book; triangle, roof, clotheshanger, tent.

Concept list: Cake, ice cream cone, sandwich, hotdog; coat, dress, undershirt, boots; sheep, bear, rabbit, cat; saw, hammer, scissors, ax.

For each list, there were two filler stimuli at the beginning and two at the end of each list to absorb primacy and recency effects. These were not counted for recall. The average frequencies from the *American Heritage Word Frequency Book* (1971) were 53 for color, 56 for form, and 52 for concept.

Procedure. The two younger groups of children were tested in three separate sessions, one list per session. Stimuli were presented for 5 sec with 2 sec between stimuli. Subjects named each stimulus as it was presented to insure identification. Six different orders of presentation were used for approximately equal-sized groups of subjects.

In other respects, the procedure followed that of Experiment I.

Results

The means for free and cued recall by age and list type are presented in Table 7. An age by list type analysis of variance was performed on free recall means yielding significant effects of both age ($F(2, 57) = 22.37, p < .01$) and list type ($F(2, 114) = 3.85, p < .025$), but no effect for the age by list type interaction. An analysis of variance performed on cued recall means yielded significant effects only of cue type ($F(2, 114) = 61.68, p < .01$). While the means were higher than those of Experiment I, the overall pattern of results remained the same. In free recall, performance on the form list was poorer than on the other two lists at all ages. In cued recall, conceptual cues were the most effective at all ages, followed by form, and then color.

The free recall data were analyzed for clustering as before. The ratios of repetition by age and list type are reported in Table 8. The analysis of variance yielded significant effects for list type ($F(2, 68) = 4.57, p < .05$) and for the interaction of list type and age ($F(4, 68) = 3.89, p < .05$) but none for age alone. Again, the pattern of findings was very similar to that of Experiment I, with color receiving its highest clustering score in the youngest group of children, and concept receiving its highest clustering score in the oldest group of children.

GENERAL DISCUSSION

Clear evidence was obtained for a chronological progression of the attributes governing grouping of objects, from color to form to concept, in

TABLE 7
MEAN FREE RECALL AND CUED RECALL SCORED BY AGE AND LIST IN EXPERIMENT II

	Age		
List	4	5	9
Color			
Free recall	3.2	4.5	5.6
Cued recall	1.1	1.1	0.7
Cued recall as a percentage of unrecalled items	8.6%	9.6%	6.7%
Total recall	4.3	5.6	6.3
Form			
Free recall	2.7	2.9	5.3
Cued recall	1.4	1.7	0.9
Cued recall as a percentage of unrecalled items	10.5%	13.0%	8.4%
Total recall	4.1	4.6	6.2
Concept			
Free recall	2.7	3.5	6.2
Cued recall	4.0	3.5	3.9
Cued recall as a percentage of unrecalled items	30.1%	28.0%	40.0%
Total recall	6.7	7.0	10.1

Note. Sixteen items possible per list.

both individual patterns and group data. At age 4, color and form were preferred by about equal numbers of subjects, with only one subject showing concept dominance; at age 5, most subjects showed form dominance, a few reached concept dominance, and yet fewer still showed color dominance; by age 9, a large majority of subjects showed concept dominance, a few still showed form dominance, but no one showed color dominance. These results corroborate and extend previous findings (Brian & Goodenough, 1929; Greenfield et al., 1966; Kagan et al., 1963; Melkman & Deutsch, 1977; Melkman et al., 1976; Olver & Hornsby, 1966; Suchman & Trabasso, 1966) by demonstrating transitivity of preferences

TABLE 8
MEAN RATIO OF REPETITION (RR) SCORES BY LIST TYPE AND AGE IN EXPERIMENT II

	Age		
List	4 ($n = 9$)	5 ($n = 10$)	9 ($n = 18$)
Color	.35	.28	.34
Form	.18	.44	.45
Concept	.20	.31	.54

within children as well as evidence for the developmental shift with familiar objects in their natural shapes and colors.

The findings for the recall task are more complicated, and seem to result from the interplay of two factors, one a developmental factor affecting organization at encoding, and the other a stimulus factor related to retrieval. The developmental factor is again the chronological progression of attributes, color–form–concept, that governs similarity groupings of objects. It was expressed in the clustering of the recall data as well as in free recall. Clustering changed systematically over age, with color showing highest clustering in the youngest children, form in the middle group of children, and concept in the oldest. These results support the hypothesis that the attributes that determine grouping of objects serve to organize stimuli in memory, and that the preferred attributes in preschoolers are perceptual while the dominant attributes in school-age children are conceptual. The present findings extend those of Denney and Ziobrowski (1972), Hasher and Clifton (1974), Melkman and Deutsch (1977), and Perlmutter and Ricks (1979), who found clustering in recall according to perceptual features in younger children, and according to conceptual features in older children. The results for free recall were not as orderly. For the oldest children in both experiments, free recall was highest on the conceptually organized list, while in three out of four of the younger groups of children, free recall was best on one of the perceptually organized lists.

The second factor affecting the recall data seems to be stimulus dependent and nondevelopmental. In contrast to the grouping and clustering data, superordinate category was superior to either of the perceptual attributes in cue effectiveness, so effective that it resulted in superiority in total recall as well. This is true of children at all ages. Findings similar to these have also been reported in the literature: both imposed conceptual organization (e.g., Cole et al., 1971; Kobasigawa & Middleton, 1972; Vaughan, 1968) and conceptual category cues (Eysenck & Baron, 1974) facilitate young children's recall. Thus, those aspects of recall that depend primarily on encoding processes show a perceptual–conceptual shift with age, while those aspects of recall that depend primarily on retrieval processes reveal an advantage to conceptual cues at all ages.

Why is it that grouping and clustering—encoding processes—undergo a perceptual–conceptual shift, but cued recall—retrieval—does not? We offer a speculative analysis of that. The chronological progression, color–form–concept, reflects two different relations between attributes and the stimuli carrying them: (a) increasing abstraction of attributes from the stimuli (Posner, 1969; Craik & Lockhart, 1972) and (b) increasing predictability of stimuli from attributes. It seems plausible that color requires relatively less abstraction than form, because color is given immediately in perception, and form, since it varies with the position and orientation of the viewer, must be abstracted over different points of view and over time. The superordinate category of an object is not given in perception at all, and so requires relatively more abstractiom than attributes given in perception. As for predictability, the color of an object alone does not allow inference of other features of the object; for example, red things do not ordinarily share properties other than color. The shape of an object, however, is a very good cue to its identity at the basic level (Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976), and the superordinate category of an object is a good cue to its function (Smith, Balzano, & Walker, 1978). In encoding, we abstract attributes from objects, so that features that require less abstraction have an early advantage (White, 1965). This accounts for the perceptual–conceptual shift in grouping preferences and in clustering in recall. Retrieval is the reverse process; we use features or attributes to search for objects, so that highly predictive attributes have an advantage, regardless of age. This accounts for the ordering of cue effectiveness directly opposite that of emergence of preferences, with conceptual cues more effective than form cues, and form cues more effective than color cues at all ages. In cued recall, the experimenter provides the cues, not the child, and conceptual cues are more effective because they are more distinctive (Moscovitch & Craik, 1976) and more predictive than perceptual cues.

On the whole, memory organization based on conceptual attributes is more effective than organization based on perceptual attributes (Craik & Jacoby, 1979; Craik & Tulving, 1975). The previous analysis suggests that as children come to take a more active, strategic role in remembering (Brown, 1975; Flavell & Wellman, 1977; Neimark, 1976), and, in parallel, as they become able to resist initial, impulsive, perceptual responses (White, 1965), their initial encoding of objects changes from concrete, immediate, and perceptual to organization based on predictive, conceptual features. By age 9, attributes that dominate in encoding have come to conform to attributes effective for retrieval, a finding consistent with the hypothesis (Tversky & Teiffer, 1976) that children actively encode stimuli to facilitate later retrieval and use their knowledge of effective retrieval strategies to guide initial encoding.

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