Developmental differences in the organization and recall of strongly and weakly associated verbal items

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The effect of presentation context on the organization and free recall of high-associate and unrelated words was examined in third-, fifth-, and seventh-grade children. The experiment contrasted (1) sorting a list of high-associate words before unrelated words with sorting under the opposite order of presentation and (2) sorting vs. rehearsal instructions for a list containing a mixture of high-associate and unrelated words. There were age-related increases in the proportion of items recalled, in subjective organization, in the ordering of recall according to previous subject-determined groupings, but not in the clustering of high-associate words. Results are discussed as reflecting developmental increases in the memory organization of unrelated words.

Age-level differences in the application of organizational strategies have been used frequently to explain the differences in the amount remembered at different ages (e.g., Flavell, 1970). Recently, more attention has been devoted to the nature of organizational strategies that children generate (e.g., Tenney, 1975) and there is evidence to suggest that they apply different strategies to organize strongly associated and unrelated verbal items. When instructed to organize strongly associated verbal items to be recalled later, children typically utilize semantic relationships similar to those used by adults (Ornstein, Hale, & Morgan, 1977). However, when instructed to organize words that are not members of taxonomic categories, young children more often resort to nonsemantic strategies such as organizing by position (Liberty & Ornstein, 1973) or by orthography (Bjorklund, Ornstein, & Haig, Note 1), strategies which are associated with lower recall levels (Bjorklund et al., Note 1).

In numerous memory development studies, age-related increases in the amount recalled have been paralleled by increases in the measured output organization of highly associated or conceptually related items. While the recall of "unrelated" items shows a similar increase with age level, several authors have reported no changes from ages 9 to 13 years in measures of subjective organization for these items (Ornstein et al., 1977; Shapiro & Moely, 1971). But when Steinmetz and Battig (1969) presented a systematically mixed list of strongly related and unrelated items, 4-year-old children showed as much clustering in the recall of strongly related items as 13-year-olds.

This suggests the possibility that age-related increases that have been typically reported for clustering in free recall result from an increase in the use of semantic relationships to organize weakly related category items. Yet, there is the additional possibility that children organize items in a mixed list differently than they organize the same items in a homogeneous list. To investigate the latter possibility, the present research compared children's performance on mixed and unmixed lists of high-associate and unrelated items.

An additional purpose of this study was to find out if young children's use of semantic organization could be modified by practice. Specifically, would children transfer semantic strategies they normally used in organizing highly associated words and apply them to the organization of unrelated words presented immediately afterward? Similarly, would the presentation of difficult-to-organize unrelated words lead children to apply inappropriate position or orthographic strategies on subsequently presented highly related words?

The effects of the two presentation sequences were compared with those obtained with mixed lists of items including both high-associate and unrelated words in each list. The sorting procedure used in these three conditions (adapted from Mandler & Stephens, 1967) was designed to cue subjects to the organizability of the lists, yet not restrict them to the use of experimenter-defined organization. It was also possible to identify subject-defined groupings so the sequence of recall could be evaluated with respect to the subjects' organization of the lists. Recall performance in the sorting conditions was contrasted with recall in a mixed-list rehearsal condition to compare the effect of sorting instructions with standard free recall instructions to practice items to be recalled. Since young children typically do not effectively organize their study time during free rehearsal periods (Moely, Olson,

Halwes, & Flavell, 1969), the organization and recall scores of these younger children should be lower relative to their sorting cohorts. The difference between sorting and rehearsing subjects should decrease with age, as older rehearsing subjects impose an organizational structure on materials to be learned in the absence of specific instructions to do so.

METHOD

Subjects

Subjects were 120 children, 40 each from Grades 3, 5, and 7 from a predominantly white middle-class population. Each subject was selected and assigned to a condition randomly, except that an equal number of boys and girls were assigned to each condition. Mean ages and standard deviations for Grades 3, 5, and 7 were 9.10 ± .374, 11.08 ± .400, and 13.09 ± .349, respectively.

Material

The word list included nouns representing two levels of associative relationships. Half of the list consisted of high-associate word pairs from the associative norms for fourth-grade children (Palermo & Jenkins, 1964), with both words in each pair also belonging to the same conceptual category. The other half of the list consisted of "unrelated" words not listed by Palermo and Jenkins as associates of each other. Word lists were selected to insure equal mean Thorndike-Lorge (1944) frequencies for high- (18.78) and low-associate (19.07) words. Pilot testing indicated that all of the words were familiar to young children. List length varied with age of subject in order to avoid floor and ceiling effects when performance was compared across age levels.

Stimulus words were printed individually on 3 x 5 in. cards in capital letters 5/8 in. high. Latin squares of the word lists were employed to minimize the contiguous arrangement of high-associate noun pairs in each order. Every word appeared an equal number of times in each quarter of the list, and no word was preceded or followed by the same word more than once. Each subject received a subset of the orders in a unique random sequence.

Design

The experimental design was a five-way factorial: 3 (age) by 2 (sex) by 4 (conditions) by 3 (trials) by 2 (associative strength), with trials and associative strength as within-subjects variables.

Procedure

Each experimental session was conducted individually and lasted approximately 25 min. Words in the first presentation set were placed before the subject, who initially pronounced each word while the experimenter corrected any pronunciation errors. Subjects in the sorting conditions were instructed to organize the set by putting together the words "that belong together" so that "you could group the words the same way again." Each subject was directed to remember the words for a later recall test. No restrictions were placed on the number of groups that could be constructed.

Typically, the subject sorted the stimulus materials by selecting a word and then any other words that went with it. When one group was completed, the subject began on a second group, and so on, until all words had been grouped or until the subject indicated the rest of the words did not belong in groups. Stimulus cards were then removed and re-presented in a new order. The procedure was repeated until the subject had attained a criterion of two successive identical sorts, or the item set had been sorted through five times. The second item set was then presented following identical procedures. After attaining criteria on the second item set, each subject was tested orally for recall of both presentation sets and recall was tape-recorded and later verified by the experimenter. The retention interval was terminated when a subject failed to recall a word in a 45-sec interval.

On both the second and third recall trials, each subject sorted through both item sets once using the same sequence of presentation sets as that employed during original sorting trials. Recall was tested orally, with the same criterion for termination as during the first retention test. After the final recall test, each subject was presented with the groupings he had constructed on the sorting criterion trial and asked to give his reasons for these groupings.

Of the four conditions, two procedures were identical but differed in the order in which item sets were presented. In the first unmixed-list condition, subjects first sorted the high-associate list and then the unrelated word list; in the second unmixed-list condition, subjects sorted the word sets in the opposite order. The other two conditions involved the presentation of two mixed lists of items and differed in that subjects were instructed to organize or rehearse items to be remembered. In the mixed sorting condition, procedures differed from those employed in the unmixed-list conditions only in that each presentation set consisted of both high-associate and unrelated words in equal numbers (except for counterbalanced 8-6 splits of the 14 word sets used for fifth graders).

Subjects in the mixed rehearsal condition pronounced all items and were instructed to "practice" items for a later recall test. They were not permitted to rearrange the items to be remembered. Lists and counterbalancing procedures were identical to those employed in the mixed sorting condition. The length of the first practice period and intertrial interval for each mixed rehearsal condition subject was yoked to the length of time spent by a comparable subject in sorting during the same interval. After the third recall trial, mixed rehearsal condition subjects were probed for organization they had used in practice by inquiring if they had grouped any of the words together during practice and if they thought any of the words "belonged together."

RESULTS

Overall performance differences were evaluated by analyses of variance on time and trials to sorting criterion, recall, and organization in recall.

Sorting Measures

Third graders spent less time per sorting trial than did fifth and seventh graders, but required more attempts to reach criterion. Thus, the number of trials needed to reach the criterion of two successive identical sorts decreased significantly with age $[F(2,72) = 7.4, p < .01]$ and there were no age-related changes in the time before criterion attainment $[F(2,72) = 1.32]$. Only two third-grade subjects failed to reach the sorting criterion. Subjects who received high-associate and unrelated words in separate lists constructed fewer groupings of unrelated words $[F(1,48) = 16.42, p < .001]$, and there was no change with age in the number of such groupings formed.

As determined by postrecall questioning, the way subjects sorted both high associates and unrelated words reflected semantic properties of words rather than orthographic or other properties. Eighty-five percent of third-grade, 91% of fifth-grade, and 96% of seventh-grade sorting groups were semantically based. The remainder of the groupings at each age level were nonsemantically based or were not labeled by the subject. In the mixed sorting condition, third-graders' groupings also involved twice as many instances combining low with high associates (26%) as did those of fifth (11%) or seventh graders (12%) $[F(2,25) = 4.1, p < .05]$.

Table 1
Age-Related Changes in Recall and Organization

	Grade 3	Grade 5	Grade 7
Proportion of items recalled*	.597	.665	.683
Clustering	.492	.463	.532
Subjective organization*	.300	.376	.411
Correspondence between subject-identified groups and recall order*	.344	.406	.511
Correspondence between presentation order and recall order	.019	.035	.044

*Denotes a significant difference across ages

Recall and Organization

Since list length was varied with age, all recall analyses were performed on the number of items recalled divided by the length of the list. Analyses were performed on four separate organization measures, all based on Pellegrino's (1971) ARC′ measures of internal sequential consistency in recall order. All measures of organization are independent of list length (Pellegrino, 1975). The order of presentation for each trial was compared with recall order for that trial to assess subjects' use of the presentation order to organize recall. Subjective organization was measured by comparing recall on consecutive trial pairs to provide an assessment of clustering. Sort-recall correspondence was assessed by comparing recall order with the groupings subjects actually constructed for both high-associate and unrelated words. Additionally, the list of high-associate words was compared directly with subjects' sorting groups to measure the use of associate relationships in organization.

Although the Pellegrino (1971) organizational measures allow assessment of units of varying size and internal sequential consistency, all organizational measurements revealed relatively high levels of pairwise organization, while organization at unit sizes larger than two was essentially at floor level. In light of the above, the analyses reported below include only organization of pairs.

Age Differences in Recall and Organization

There was an increase with age in the proportion of list items recalled [F(2,96) = 4.6, p < .025] but no interaction of Ages by Conditions (Table 1). As shown in Table 1, clustering of high-associate words showed no significant age increase, nor was there an increase in correspondence between high-associate pairs and subjects' sorting groups. However, Table 1 shows age-related increases in recall organization according to sorting groups [F(2,96) = 10.2, p < .001], as well as in subjective organization [F(2,96) = 5.8, p < .01].

Condition Differences in Recall and Organization

Recall was similar in all three sorting conditions and significantly superior to the mixed rehearsal condition [F(3,96) = 9.7, p < .001]. Orthogonal comparisons of recall in the sorting conditions with the mixed rehearsal condition were statistically significant [F(1,92) = 4.6, p < .05] (Table 2). As shown in Table 2, subjects in the three sorting conditions showed higher levels of subjective organization, clustering, and correspondence between subject-identified groups and the high-associate pairs than the levels shown by subjects in the mixed rehearsal condition [all Fs(3,96) ≥ 13.0, p < .001]. Presentation of high-associate before unrelated words resulted in significantly greater clustering than did presentation in the opposite order [F(1,48) = 6.2, p < .05]. The use of presentation order to order recall was significantly greater than chance only in the mixed rehearsal condition, and it was significantly higher than in the mixed sorting condition [F(3,96) = 11.7, p < .001].

Associative Strength and Improvement With Practice

High-associate words were remembered more frequently than were the unrelated words at all age levels [F(1,96) = 16.6, p < .001]. Items in the second list were recalled better regardless of whether the list included high-associate words only, unrelated words only, or was a mixed list [Fs(1,48) ≥ 53.8, p < .001]. There was improvement across recall trials [F(2,192) = 201.4, p < .001], and recall advantage of second-list items was greatest on the first trial and reduced on Trials 2 and 3 [F(2,96) = 22.5, p < .001].

DISCUSSION

As stated in the introduction, one purpose of this study was to compare the pattern of developmental changes in memory organization for strongly associated and unrelated verbal items that were presented in mixed and unmixed lists. For both list types, the greatest age-related improvement occurred in the organization of unrelated words, and there was little increase in organization of high-associate words from Grades 3 to 7. The present age-related increases in measures (subjective organization and the correspondence of sorting groups with recall order)

Table 2
Condition Differences in ARC′ Scores Across Different Types of Organization

| | Associates | | Mixed | |
	Second	First	Sorting	Rehearsal
Proportion of items recalled*	.706	.690	.661	.538
Clustering*	.478	.628	.523	.353
Correspondence between subject-identified groups and high-associate pairs*	.793	.959	.669	.531
Subjective organization*	.418	.413	.420	.199
Correspondence between subject-identified groups and recall order*	.430	.426	.386	.134

*Denotes a significant difference across conditions

which included unrelated words was in marked contrast with the stable high level of clustering of high associates across ages. Age-level stability in the organization of high associates was also demonstrated by the lack of age differences when experimenter-defined high-associate pairs were compared with the subjects' actual groupings of high associates. These findings are highly compatible with the notion that developmental change involves the increasing use of semantic relationships to organize moderately related or unrelated items.

The sharp differences between these findings and those from standard free recall research is undoubtedly due to the present sorting procedures which constrained children to organize materials to be learned. Not only did children as young as third grade demonstrate very high levels of recall clustering after sorting procedures, they sorted unrelated words into groups as frequently as did older children. But they did not use their sorting groups to aid in the recall of unrelated items as frequently as did older children. Furthermore, young children combined high-associate and unrelated words in groups more often than did older children, suggesting age-related differences in classificatory structures.

There was little evidence that the different orders of presentation affected children's use of semantic organization, since subjects used predominantly semantic organization in all sorting conditions. However, there was significantly less clustering in recall when the high-associate list was presented after unrelated words. This probably reflects a change in the quality rather than the amount of high-associate organization, since the correspondence between subjective groupings and the high-associate pairs was sharply higher when high-associate pairs were presented first and there were no significant differences between the two presentation orders in subjective organization and the use of sorting groups in recall organization. Despite the disruption in the organization of high associates presented after unrelated words, there was no evidence of alteration under the opposite order of presentation, nor were there significant differences in recall between the two conditions.

Items in the second list were recalled more often regardless of whether they were preceded by high associates, unrelated words, or a mixed presentation list. The superior recall of second-list items across sorting conditions can be attributed to the reduced interference and shorter time interval between their presentation and the recall test. Similarly, the reduction in the recall advantage of the second-list items on Trials 2 and 3 can be attributed to the shorter interval between presentation and recall test for both lists on these trials than during original sorting.

When instructed to practice items, the third-, fifth-, and seventh-grade children showed a tendency to use serial memorization strategies, as demonstrated by the higher correspondence of recall order to presentation order in the mixed rehearsal condition. There was no evidence of decreasing age-level differences between sorting and rehearsing subjects in recall, but the present age range was narrower than that in studies where such a trend has been observed (e.g., Lange & Hultsch, 1970).

The present results demonstrate that even when age-level differences in the production of organizational strategies are overcome by instructing children to sort items to be remembered, substantial developmental differences remain in organization and memory. These differences became apparent in the present study when subjects' sorting groups were compared with their recall order. The use of sorting organization to aid in recall was dependent on interitem relatedness in third-grade children but not in seventh graders. Thus, in addition to the focus on children's use of organizational mediators predominant in the recent memory development literature, additional attention needs to be directed to the effects of stimulus attributes on the successful application of such mediators at different developmental levels.

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