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A Developmental Study of Attribute Encoding in Free Recall[1]

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In two studies, subjects from second-grade, sixth-grade, and college were presented lists of unrelated words for single-trial free recall. Embedded in the list were critical items that were either semantically or phonemically related or else were completely unrelated. The sets of related items were either massed or distributed in the longer list. For second-graders, recall of Phonemic words was better than recall of Semantic words while the reverse was true for sixth-graders. Recall of Semantic distributed words by second-graders and of Phonemic distributed words by sixth-graders did not differ from recall of unrelated words. College students recalled Phonemic and Semantic words equally well and all related words better than unrelated words. Developmental trends were seen in the salience of particular attributes and in the utilization of low salient attributes.

Recent research in memory for verbal materials has found several important developmental differences. At the level of information abstraction, there are age differences in the salience of cues (Odom & Guzman, 1972). There are also differences, no doubt partially the result of these attentional dispositions, in the information that gets encoded (Bach & Underwood, 1970; Freund & Johnson, 1972). In addition, there are age differences in the kinds of skills that are concerned with the efficient utilization of one's own memory, e.g., in elaboration techniques (Rohwer, in press), in rehearsal strategies (Liberty & Ornstein, 1973), and in clustering and organization (cf., Cole, Frankel & Sharp, 1971).

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The present experiments are a further attempt to study the encoding, rehearsing, and organizing skills of children of different ages. A single-trial free-recall task was presented to second-graders and sixth-graders in the first study and to college students in the second. Embedded in a long list of unrelated words was a set of four critical words that were either semantically or phonemically related or else were completely unrelated. The words were presented for study one at a time and the critical items were either massed, so that they followed each other in immediate succession or, distributed throughout the list. One would expect a salient attribute to be used as an organizational device in recall. Thus, the second-graders whose associative repertoire is limited but for whom sound is a significant attribute might be expected to show high levels of recall for phonemically related words. This should occur whether the presence of these words is easily detectable, as in the massed condition, or not, as in the distributed condition. Sixth-graders, on the other hand, have a much richer vocabulary and thus might well be expected to use the meaningful relations embedded in the list and to be able to detect this attribute whether the words are massed or distributed. Such a pattern of results would be anticipated on the basis of our knowledge of the encoding dispositions of these children (Bach & Underwood, 1970; Felzen & Anisfeld, 1970).

A question of further interest is whether there are developmental differences in the ability of children to detect the existence of a low salient attribute when its presence in the list is not immediately apparent. This will be seen for second-graders when semantically similar words are distributed in the list, and for sixth-graders when phonemically similar words are distributed in the list. It was within this context that the performance of college students became of interest. They are sensitive to attributes of low salience; alphabetical cues (Tulving, 1962), and sensory impressions (Wood & Underwood, 1967) will under some conditions facilitate recall. While children may be unable to detect low salient attributes if they are not immediately apparent to them, adults may well be more successful.

A free-recall task was chosen for these experiments for several reasons. First, it allows us to observe the dimensions along which children will encode verbal materials. Second, the task also allows for the observation of developmental differences in rehearsing and organizing skills. Thus, clustering measures, the occurrence of systematic strategies in the order of recall, and serial-position effects were of interest in these experiments. Finally this free-recall task, which includes the variable of presentation position of related items, was of special interest because such a design has been used in the adult memory literature (Bruce & Crowley, 1970; Schwartz, 1973) to evaluate the kind of processing that can occur in the short-term memory (STM). Items which are massed on presentation can occupy the STM simultaneously, while those which are distributed cannot. Thus relations among massed items can be processed, or encoded, in the STM while those among distributed items can be processed only by the long-term memory. Such a position produces predictions about levels of recall that contradict the present ones and will be considered later.

METHOD

Experiment 1

Design

The subjects in this experiment were from two grades, second and sixth. Within each grade there were five independent conditions, four experimental and one control, that differed in the nature and distribution of four critical items that were embedded in a 25-item list composed of otherwise unrelated words. The four experimental conditions represented a 2×2 factorial combination produced by having critical items that were either semantically or phonemically related and were also either massed or distributed throughout the list. The final condition, a control, had unrelated words as critical items. The subjects' task was to recall, immediately after presentation, each of four successive lists. This design is a modification of one that used high-school students as subjects (Bruce & Crowley, 1970). In that study, however, the nature and distribution of critical items were within-subject variables.

Materials

Four sets of four words were selected to be critical items in the acoustic, semantic, and control conditions. These are shown in Table 1.[3] In addition, four sets of 21 contextual items were selected so as to be unrelated to each other and also to the words in the critical sets. The familiar words used in the experiment were selected from several sources: the Thorndike-Lorge count, the Paivio, Yuille and Madigan (1970) norms, the Bach and Underwood (1970) experiment, and from children's books. On the basis of consultation with teachers, the words were assumed to be within the vocabulary of most second-grade children.

[3] An unassessed confound exists between the acoustic and orthographic attributes of these materials. Both attributes have been shown to influence recognition (Freund & Johnson, 1972; Raser, 1972).

TABLE 1
CRITICAL ITEMS

	Set 1	Set 2	Set 3	Set 4
Semantic	Coat	Glass	Dog	Red
	Dress	Cup	Horse	Green
	Shoe	Spoon	Sheep	Yellow
	Hat	Knife	Pig	White
Phonemic	Bear	Gain	Hop	King
	Hair	Pain	Shop	Sing
	Fair	Jane	Top	Ring
	Pair	Rain	Stop	Wing
Control	Office	Body	Boy	Part
	Dirt	Drink	Stone	Flag
	Fool	Age	Vote	Sound
	Kite	Gate	Road	Ice

Critical items were inserted into the longer list in positions 5, 10, 15, and 20 under the distributed condition and in positions 5, 6, 7, and 8 under the massed condition. The same four lists of contextual items were used in each condition in the experiment. In each of the four experimental conditions, 16 lists were derived by crossing the four sets of appropriate critical items, that is, semantic or phonemic, with the four sets of contextual items. Since there were 16 subjects in a condition, each list was used once as the first, second, third, and fourth list learned by a subject. In the control condition, two sets of contextual items were first crossed with two sets of critical items. Then the remaining two sets of contextual and critical items were also crossed. This made a total of eight critical-item, contextual-item list combinations. Each combination was used once with the critical items massed and once with the items distributed, making a total of 16 lists. Each was then used once as the first, second, third, and fourth list in the condition. Position of critical items in control lists was a dummy variable and was not considered in the analysis of results.

Procedure

Each of four lists was presented for immediate free recall. The experimenter exposed 3 × 5 in. cards, each with a word typed in its center, by hand at a rate of one card every 3 sec. The subject was instructed to read each word aloud as it was presented. At the end of each list a blank card appeared as a signal for the subject to recall out loud as many words as possible from the list just presented in whatever order he or she chose. At least 80 sec were allotted for recall. At the end of this time, the subject was asked to try to recall more words and was given an additional 10 sec. Presentation of the next list began immediately after recall was terminated for the preceding list.

There were ten conditions in the experiment, five at each grade level with 16 children in each. At each age level the experimental conditions were Semantic Massed, Semantic Distributed, Phonemic Massed, and Phonemic Distributed. The fifth condition was called Control. All subjects were run individually. Children were taken from the classroom on the basis of a predetermined random sequence which also assigned them to a particular condition. One subject was run in each of the ten conditions before any condition was repeated.

Subjects

Subjects were 160 English-speaking children, 80 each from the second- and sixth-grades, who were enrolled in four Ottawa Separate (Catholic) Schools. Some control over the socio-economic backgrounds of the children was achieved by using schools that served primarily middle-class housing districts. Only children who were in the grade appropriate to their age were used in the experiment. The ages for children in the second- and sixth-grades were 7 and 11 years, respectively. Two second-grade subjects were replaced; one child read extremely poorly while the other failed to follow instructions.

Experiment II

The second experiment was a replication of the first. The subjects were Carleton University undergraduates who received extra credit in Introductory Psychology for their participation. The single change was in procedure, with the subject rather than the experimenter exposing the stimulus cards. Subjects paced themselves by matching clicks played over a tape recorder. Although the data from the two studies will be presented together, the studies were analyzed separately because they were run independently.

RESULTS

Critical-Item Recall

Table 2 presents the mean number of critical items recalled on a trial.[4]

[4] Because critical items occupied different positions under massed than under distributed conditions, any differences in recall shown under the two conditions may be a product of list-position effects rather than of the distribution of items. Some control over this confound can be gained by referring to Figure 1 which shows position effects for subjects in Control conditions. The probability of recalling items in positions 5–8 is slightly lower than is the probability of recalling items in positions 5, 10, 15, and 20.

Performance of the grade-school children will be considered first. For each grade, a Dunnett's test was performed that compared recall under each of the four experimental conditions with the recall of the control condition. At the second-grade level, three conditions showed recall superior to the unrelated control, Semantic Massed, Phonemic Massed, and Phonemic Distributed, all $ts(5,75) \geqslant 3.84$, $p < .01$. However, recall of Semantic Distributed items did not differ from that of unrelated words, $t = 1.00$. At the sixth-grade level, again three conditions showed recall superior to the Control, Semantic Massed, Semantic Distributed, and Phonemic Massed, all $ts(5,75) \geqslant 3.22$, $p < .01$. Here, however, recall of Phonemic Distributed items did not differ from that of unrelated words, $t = 1.01$.

An overall analysis of variance was then performed on critical-item recall for the experimental conditions only. The plan of the analysis was first to compare the two grades and second to look at the two-way interactions between item type and distribution at each grade level separately. The difference in performance between second- and sixth-grade children was significant, $F(1,120) = 28.37$, $p < .01$. For second graders there was a main effect of item type, $F(1,60) = 10.63$, $p < .01$, with phonemic words being better recalled than semantic. While there was no main effect for the distribution of items, the interaction between the item-type and distribution variables was significant, $F(1,60) = 4.33$, $p < .05$. Thus semantically related words show a facilitation in recall if they are massed on presentation as compared to distributed, while phonemically related words are well recalled whether massed or distributed on presentation.

At the sixth-grade level, the picture is quite different. There is again

TABLE 2

Mean Number of Words Recalled Per Trial

	Critical words recalled				
	Phonemic		Semantic		
Grade	Massed	Distrib.	Massed	Distrib.	Control
2	1.41	1.48	1.23	.66	.45
6	2.00	1.16	2.31	1.59	.95
College	2.89	2.08	2.80	2.27	1.42
	Total words recalled				
2	6.25	5.80	5.17	4.81	5.17
6	8.56	7.55	8.38	8.20	7.94
College	11.81	11.70	12.36	11.64	10.94

a main effect of item type, but at this age superior recall was shown for semantic rather than for phonemic items, $F(1,60) = 10.63$, $p < .01$. Another difference from second-grade performance was a significant main effect for item distribution, with massed presentation superior to distributed, $F(1,60) = 29.04$, $p < .01$. The interaction was not significant, $F < 1$.

For second-graders then, semantically related items distributed throughout a list were no better recalled than were unrelated items. Recall was facilitated by meaningful relations only when such words were massed at presentation. In addition, phonemically related items had an advantage over unrelated items, regardless of their distribution in the list. For sixth-graders, on the other hand, phonemically related words distributed throughout a list were no better recalled than were unrelated words. There was better recall for semantically related words than for phonemically related words, and recall was further facilitated when related items were presented in a block. Within the framework of a dual-process model, and consistent with the Bruce and Crowley (1970) interpretation of their experiment, these data suggest a semantic long-term memory for six-graders (and adults) and an acoustic long-term memory for second-graders. That is, for sixth-graders, when phonemically similar words are distributed in the list and so do not simultaneously occupy the short-term store, they are transferred into the long-term store where phonemic encoding is not available. For second-graders, the same process presumably occurs except now it is semantically related words that are transferred into the long-term store which apparently at this age cannot process semantic information. Given the limited linguistic system of young children, such a developmental discontinuity in memory operation may not seem so radical a proposal. However, the value of such an interpretation of these data becomes unclear in the face of adult performance on this task.

Adult recall of critical items was analyzed first by comparing all experimental conditions with the control. A Dunnett's test showed that all types and distributions of related items were better recalled than were unrelated words, all $ts\ (5,75) \geqslant 3.09$, $ps < .01$. A 2×2 analysis of variance was then performed on the experimental conditions. The only significant effect was for item distribution, with an advantage in recall for massed-as compared to distributed-related items, $F(1,60) = 18.61$, $p < .01$. Recall of phonemic and semantic words did not differ, $F < 1$, and the interaction of item type and distribution was not significant, $F < 1$.

Adult performance suggests that the "long-term memory" can encode phonemic and semantic information. Apart from the issue of dual-process models of memory these data suggest two important developmental trends: first, in the attributes of words that children use, and second, in the ease with which organizational codes provided by an experimenter can be used. Massed presentation of related items facilitated their recall both for college students and for sixth-graders. For second-graders, however, massed presentation facilitated recall only of semantically related items, an otherwise low salient dimension. It did not facilitate recall of words related on the salient dimension, sound.

Total Recall

Total recall for all conditions is shown in Table 2. Dunnett's tests were done separately on the three grade levels, comparing recall shown by each of the four experimental conditions with the control. In only one instance was there any significant difference; for second-graders, recall of lists containing phonemic massed items was superior to recall of lists containing only unrelated items, $t(5,75) = 2.44$, $p < .05$. Thus while a blocked presentation of these salient items did not produce a facilitation in their own recall relative to phonemic distributed items, it did apparently facilitate recall of the rest of the list. Under all other conditions for all other groups of *Ss*, any advantage shown for the recall of related items, relative to the control condition, was apparently compensated for by a reduced recall of the contextual items. Thus the total recall of experimental and control conditions did not differ.

Clustering

Clustering, or the tendency for items sharing some attribute to occur continguously in a subject's recall, is assumed to tap a fundamental organizing skill of the memory. Because chance levels of clustering vary with the number of critical and of contextual items recalled, and because there were recall differences both within and among the age levels in this experiment, no unbiased measure of clustering could be found. With this in mind, two different measures were devised. The first was simply the probability that two or more related items would be recalled together, given that two or more related items were recalled. These scores led to the observation that even for the youngest children in this study there was a high probability of clustering; the range among the four second-grade experimental conditions was .60 to 1.00. The second measure, shown in Table 3, was the average length of a cluster. This score was obtained in the following fashion: On each trial for each subject who recalled two or more critical items, a score of 0 was recorded if no critical items were recalled together, a score of 1 was recorded if two critical items were recalled together, a score of 2 if three were recalled together, and a score of 3 if four were recalled together. At each level of critical-item recall, two, three, and four, these clustering-size scores were tallied and divided by the number of subjects who recalled that number of critical items. The score then is a mean length score where the base considers all subjects who could possibly have produced a cluster. The maximum cluster length was 1.0, 2.0, and 3.0 when two, three, or four critical items, respectively, were recalled. Also shown in Table 3 are the same scores calculated for subjects in the Control conditions. These scores represent a chance cluster size at any given level of critical-item recall.

There are several things to be noted about cluster length. First, note that the size of a cluster tended to be larger under massed rather than under distributed presentation. Second, consider clustering when only two critical items were recalled. For college students, it is the case that if only two critical items were recalled, there was a low probability, that in three out of four instances was at a chance level, of clustering. For second- and sixth-graders, however, high clustering scores are seen in seven out of eight cases. While college students may recall only two out of four critical items, these are treated in recall as unrelated words, i.e., they are not recalled together. They typically cluster larger numbers of items together. For younger children when only two critical items are recalled, these are treated not as unrelated words but, instead, are clustered. Thus while younger children do indeed cluster, the minimum size of a cluster is smaller than it is for adults.

When three or four critical items were recalled, there was no systematic

TABLE 3
MEAN LENGTH OF CLUSTERS

	Phonemic		Semantic		
	Massed	Distrib.	Massed	Distrib.	Control
2 Critical items recalled					
Grade 2	.82	.79	.73	.60	0
Grade 6	.72	.60	.70	.38	.29
College	.23	.23	.92	.27	.24
3 Critical items recalled					
Grade 2	1.46	1.80	1.91	2.00	0
Grade 6	1.30	1.00	1.75	1.40	.67
College	1.75	.88	1.55	1.24	.57
4 Critical items recalled					
Grade 2	2.25	1.50	2.00	0	0
Grade 6	2.25	1.00	2.53	1.50	0
College	2.56	1.50	2.70	2.30	.33

age difference apparent in the mean length of a cluster. When such a high level of recall was attained by children, the size of a cluster did not differ from that shown by an adult. What did differ, given our knowledge of recall scores, is that young children were less likely to recall as many critical items as adults.

Position Effects

The serial-position curve characteristic of single-trial free recall (Murdock, 1962) is a product, at least in part, of the rehearsal processes that occur during the presentation of items in the list (Rundus & Atkinson, 1970). Previous studies in multiple-trial free recall have found age differences in these position curves to be located chiefly in the beginning and middle portions of the curve (e.g., Cole, Frankel & Sharp, 1970) where active rehearsal processes are thought to influence the level of recall (Fischler, Rundus & Atkinson, 1970). The position curves, collapsed across the four lists, for the Control conditions only at each age level are shown in Fig. 1. The values for all but the first and last positions have been smoothed by averaging recall at each position with recall at the two immediately surrounding positions. The college students present us with a familiar curve: recency and primacy effects together with an unstable asymptote. Primacy appears to be some-

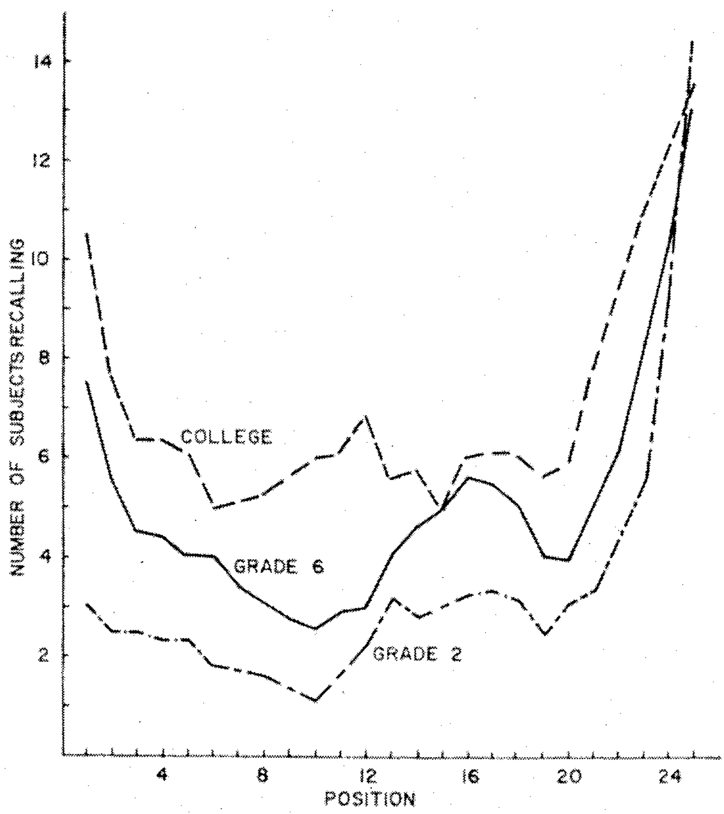

FIG. 1. Serial position curves of second-grade, sixth-grade, and college students.

what elevated compared to the ideal curve. The subjects in the present study have recalled only four lists while Murdock's subjects recalled many more. Since primacy is known to diminish across successive lists (Keppel & Mallory, 1969) our college subjects might not have had enough experience for the primary effect to have washed out.

The sixth-graders show a position curve similar to the ideal one; the recency effect is greater than the primacy effect. The second-graders show no primacy effect whatsoever. Adults produce just such a position curve when they are instructed to rehearse only the item that is currently presented (Fischler *et al.*, 1970; Raffel, 1936). Second-graders may be using a similar rehearsal technique. It is possible that the greater advantage older children and adults show over younger children in recalling early- and mid-list items lies in differences in the distribution of rehearsals.

The order in which subjects recall items in a list may be a deliberate strategy adopted during the course of the experiment (Hasher, in press). Order of recall is also thought to play a role in determining the level of recall, most notably in reducing recall of those items not recalled first. Output order was analyzed in the following fashion: For each subject on each trial the presentation positions occupied by the first three items in his or her recall was considered. If two of those three came from the first four, last four, or critical positions in the list, the subject was labeled Early, Late, or Critical, respectively. Subjects not fitting into one of the three classifications were called None. These events were tallied for each list and then summed across the four lists learned in each condition. Table 4 shows these values for each condition at each age level.[5] The frequency of systematic retrieval strategies, that is Early, Late or Critical, increases with age. For second-graders systematic strategies occurred in 63% of the opportunities while the frequency of occurrence was 74% for both the older groups. The favored strategy at all age levels was for late items to be recalled first. For second- and sixth-graders and for college students, this strategy occurred in 51, 56, and 58%, respectively, of the opportunities. Such a strategy allows the subject to recall first those items which have the highest probability of being lost over a short retention interval (Postman & Phillips, 1965). The final note-

[5] This measure is biased against assigning subjects to the Late category. Subjects who actually adopt a recency strategy may begin their recall not with positions 22 or 23, which would allow them to be assigned to the Late category, but rather with positions 18 or 19 and then continue recalling to the end of the list. Such a subject would be classified as "Neither" according to the present measure. By such a more lenient scoring, seven additional "Late" events would occur among the college students. There were no additions to be made among the grade-school children.

TABLE 4
FREQUENCY OF EARLY OUTPUT OF EARLY, LATE, AND CRITICAL ITEMS

	Phonemic		Semantic			
	Massed	Distrib.	Massed	Distrib.	Control	Total[a]
Grade 2						
Early	2	4	1	0	3	10
Late	38	27	24	34	32	155
Critical	4	8	14	0	0	26
None	19	22	22	26	25	114
Grade 6						
Early	9	5	7	5	6	32
Late	36	43	34	35	31	179
Critical	6	1	12	6	0	25
None	13	15	11	18	27	84
College						
Early	3	14	4	5	11	37
Late	42	36	40	33	38	189
Critical	4	2	4	6	0	16
None	15	12	16	20	15	78

[a] Because 13 *S*s who recalled only two words were not considered in this analysis, the values seen for the second-graders do not sum to the product of 80 *S*s × 4 lists, or 320.

worthy outcome in these data is with regard to the strategy of recalling critical items first. Second-graders did not recall semantic distributed items better than controls while sixth-graders did not recall phonemic distributed items better than controls. Note that these two conditions together showed only one instance of critical items being recalled early. There was, however, under other presentation conditions a modest frequency of critical items being recalled first.

DISCUSSION

Is the long-term memory of a second-grader different from that of a sixth-grader? Does the memory of a young child process words phonemically while that of an older child process them semantically? Even disregarding the performance of adults on this task, such a conclusion is unwarranted in light of our knowledge of the developing vocabulary skills of young children and of those same skills in adults (see Stolz & Tiffany, 1972). Second-graders have a limited knowledge of the variety in meaning words can have and so of their interrelations. During gradeschool, both the richness of a child's vocabulary increases and reading instruction based on the sound patterns of words is gradually eliminated from the school program. One would expect a young child to pay particular attention to the sound of a word, because of his limited knowledge of its meaning and/or because of his reading training. Less reliant on sound that younger children and perhaps less flexible in organizational strategies than adults, older children are unlikely to notice words that sound alike. In this, they are much like the high-school students in the Bruce and Crowley (1970) study who failed to recall phonemically related words better than unrelated control words when the former were distributed in the list. The performance of college students in the present study, however, differed substantially from that of Bruce and Crowley's subjects: Phonemically and semantically related words were equally well recalled and all were recalled better than unrelated controls. When performance conditions, in this instance a between-subjects design, allowed for the detection of an otherwise low-salient attribute, college students, but not sixth-graders, could capitalize on this relation to facilitate recall of those particular items.

Thus the recall of critical items in this study points to two conclusions: First, there is a change with age in the salience of particular attributes of words. For second-graders, sound is especially important and meaning less so, while the situation is reversed for sixth-graders. Second, there is a change with age in the ability to use a low-salient attribute. Both second- and sixth-graders treat words with low-salient attributes as unrelated words. College students, however, can make use of an ordinarily low salient attribute, here sound, even when its presence in a list is not immediately apparent.

Apart from developmental differences in the attributes of words that are salient at particular ages and in the use that can be made of a low-salient attribute, there are some major similarities in performance among the different aged groups. The high frequency of second-graders who showed an early recall of late-presented items suggests that systematic retrieval devices, ones that may facilitate adult performance in single-trial free-recall tasks (Tulving & Arbuckle, 1963), occur early in grade school. Young children also showed substantial amounts of clustering. In fact, at every level of critical-item recall, mean cluster length was equivalent for all age groups. Thus, the sophisticated memory strategies used by adults may be seen in early grade-school children.

There are suggestions in the data of a developmental trend in the efficiency with which organizational devices, available by second-grade, are used. While young children do indeed cluster related items, the minimum size of a cluster appears to be smaller for them than for older children. When college students recall only two critical items, they are far less likely to cluster them than are the grade-school children.

Another determinant of efficiency may be based on the serial position curves generated by the different age groups. Second-graders showed no primacy at all and, in fact, only a two-item recency effect. Perhaps it is that young children, as opposed to older children and adults, do not use position cues to organize their recall. That is, on a single presentation of a list, it may be very difficult for even adults to pick out whatever weak associative relations there are that remain among words whose criterion for selection was that they be unrelated. Instead, adults may be able to use nonassociative retrieval cues like the gross position, beginning, middle, or end, that items occupied at the time of presentation to cue their recall. Young children may be lacking in either or both the sequential ordering skill and the self-cuing ability.

To conclude with the theoretical problem addressed by these experiments, we can most easily explain the performance of the different age groups by the linguistic skills a subject brings to the laboratory and by the task demands imposed on him by the experimenter. Sixth-graders have a richer vocabulary than do second-graders but are no more able than the younger children to capitalize on low-salient attributes of verbal materials if these are not immediately apparent. What does change with age between these two grades are the attributes that are salient. Sound is more important for the younger than for the older children while meaning is more important for the latter than for the former. A further developmental trend is observed as we go from sixth-grade to college students; the latter are more able than the former to abstract whatever relations are embedded in a list of words.

REFERENCES

Atkinson, R. C., & Shiffrin, R. M. Human Memory: A proposed system. In K. W. Spence & J. T. Spence (Eds.), *The Psychology of Learning and Motivation*, Vol. 2. New York: Academic Press, 1968.

Bach, M. J., & Underwood, B. J. Developmental changes in memory attributes. *Journal of Educational Psychology*, 1970, **61**, 292–296.

Bruce, D., & Crowley, J. J. Acoustic similarity effects on retrieval from secondary memory. *Journal of Verbal Learning and Verbal Behavior*, 1970, **9**, 190–196.

Cole, M., Frankel, F., & Sharp, D. Development of free recall learning in children. *Developmental Psychology*, 1971, **4**, 109–123.

Felzen, E., & Anisfeld, M. Semantic and phonetic relations in the false recognition of words by third and sixth grade children. *Developmental Psychology*, 1970, **3**, 163–168.

Fischler, I., Rundus, D., & Atkinson, R. C. Effects of overt rehearsal processes on free recall. *Psychonomic Science*, 1970, **19**, 249–250.

Freund, J. S., & Johnson, J. W. Changes in memory attribute dominance as a function of age. *Journal of Educational Psychology*, 1972, **63**, 386–389.

Hasher, L. Position effects in free recall. *American Journal of Psychology*, in press.

Keppel, G., & Mallory, W. A. Presentation rate and instructions to guess in free recall. *Journal of Experimental Psychology*, 1969, **79**, 269–275.

LIBERTY, C., & ORNSTEIN, P. A. Age differences in organization and recall: The effects of training in categorization. *Journal of Experimental Child Psychology*, 1973, **15**, 169–186.

MURDOCK, B. B., JR. The serial position effect in free recall. *Journal of Experimental Psychology*, 1962, **64**, 482–488.

ODOM, R. D., & GUZMAN, R. D. Development of hierarchies of dimensional salience. *Developmental Psychology*, 1972, **6**, 271–287.

PAIVIO, A., YUILLE, J. C., & MADIGAN, S. A. Concreteness, imagery and meaningfulness values for 925 nouns. *Journal of Experimental Psychology Monograph Supplement*, 1968, **76** (1, Pt. 2).

POSTMAN, L., & PHILLIPS, L. W. Short-term temporal change in free recall. *Quarterly Journal of Experimental Psychology*, 1965, **17**, 132–138.

RAFFEL, G. Two determinants of the effect of primacy. *American Journal of Psychology*, 1936, **48**, 654–657.

RASER, G. A. False recognition as a function of encoding dimension and lag. *Journal of Experimental Psychology*, 1972, **93**, 333–337.

ROHWER, W. D., JR. Elaboration and learning in childhood and adolescence. In H. W. Reese (Ed.), *Advances in child development and behavior*. New York: Academic Press, in press.

RUNDUS, D., & ATKINSON, R. C. Rehearsal processes in free recall: A procedure of direct observation. *Journal of Verbal Learning and Verbal Behavior*, 1970, **9**, 99–105.

SCHWARTZ, A. K. An analysis of the recall of sequences of related words. *Journal of Verbal Learning and Verbal Behavior*, 1973, **12**, 32–42.

STOLZ, W. S., & TIFFANY, J. The production of "child-like" word associations by adults to unfamiliar adjectives. *Journal of Verbal Learning and Verbal Behavior*, 1972, **11**, 38–46.

TULVING, E. The effect of alphabetical subjective organization on memorizing unrelated words. *Canadian Journal of Psychology*, 1962, **16**, 185–191.

TULVING, E., & ARBUCKLE, T. Y. Sources of intralist interference in immediate recall of paired associates. *Journal of Verbal Learning and Verbal Behavior*, 1963, **1**, 321–334.

WOOD, W., & UNDERWOOD, B. J. Implicit responses and conceptual similarity. *Journal of Verbal Learning and Verbal Behavior*, 1967, **6**, 1–10.