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# Development of children's word recall: Hemispheric specialization, strategy, or high-order cognitive process?

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This study tested the assumption that the development of superordinate relationships activated from semantic memory may be related to the degree to which information is lateralized and strategically processed. Two age groups of children were presented stimulus lists that comprised semantically organized, phonemically organized, or unorganized words. The words were presented diotically or dichotically. Dependent measures were serial recall, adjusted ratio of clustering, and adjusted ratio of category organization. Recall increased with age and type of word processing, and developmental differences in recall interacted with mode of ear presentation and type of word processing. Most important, superordinate organization remained independent of the mode of ear presentation, suggesting that both hemispheres share a common information source (i.e., semantic memory). The results suggest that age-related hemispheric variations in lateralization and control processes may be linked to the organizational components of semantic memory.

The present study tested the assumption that age-related differences in lateralization reflect the matching of encoding demands to the availability of resources in semantic memory. In the present study, semantic memory resources reflect the categorical classification or relational schemata children bring to a recall task. The structure and content of children's categorical representations, in turn, are assumed to account for developmental differences in lateralization and strategy use during recall. This hypothesis reflects recent theory that suggests that individual differences in lateralization reflect the number of alternative information-processing routes available for achieving successful performance (e.g., Friedman & Polson, 1981) and supports age-related studies attributing younger children's recall performance to the accessing of resources (organizational relationships among a series of items) from semantic memory (e.g., Swanson & Mullen, 1983).

In a test of the semantic memory hypothesis, two age groups of children were compared on diotic and dichotic listening tasks with semantically organized, phonemically organized, and unorganized word lists. These word lists were chosen because they allow an assessment of categorization and organization in recall. Semantically organized information was assumed to provide a more durable memory trace than superficially organized information, because categorical lists more closely match the superordinate information that is stored in semantic memory (e.g., Bjorklund, 1985; Mandler, 1979).

Based on the notion that the accessing of categorical information from semantic memory influences lateralization and memory processes, it was predicted that age-related differences would be found in the superordinate organization of recalled information. Furthermore, it was expected that, because children vary developmentally in these semantic memory resources, variations of memory strategies (e.g., serial position performance) and lateralization (i.e., ear presentations) would occur.

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## METHOD

### Subjects and Design

The subjects were 24 boys, separated into two age groups. Mean chronological ages and mean reading achievement percentile scores from the Metropolitan Achievement Tests were 11.91 ($SD$ = .94) and 56.5 ($SD$ = 10.72), respectively, for older children, and 8.65 ($SD$ = 1.08) and 56.55 ($SD$ = 10.800), respectively, for younger children. Mean mental age scores from the Otis Lennon Test of Mental Ability, converted to IQ scores, were 107.5 ($SD$ = 7.74) for older children and 105.25 ($SD$ = 6.91) for younger children. No significant difference was found between age groups on achievement or IQ scores ($Fs < 1.5$). Both younger and older children had normal hearing in both ears, with minimum binaural pure-tone thresholds of 15 dB at 250 through 4000 Hz. All subjects were right-handed. Mean laterality quotients, based on the Edinburgh Handedness Inventory, were 98.0 ($SD$ = .080) for younger and 98.0 ($SD$ = .050) for older readers.

Both age groups received all three modes of presentation (diotic, both ears; dichotic, left ear; dichotic, right ear) and types of word encoding (semantic, phonemic, and unrelated word lists). Treatment order for each subject was counterbalanced for both mode of presentation and word list occurrence.

### Materials and Procedure

An audio tape consisted of nine word lists (divided into three semantically organized, three phonemically organized, and three unrelated lists) to be presented diotically or dichotically. Each word list contained 12 monosyllabic words representing semantically related words (e.g., *red, green*), phonemically related words (e.g., *sit, pit*), or unrelated words (e.g., *your, some*). Materials, word lists, and testing procedures were

the same as those used by Swanson and Mullen (1983). During the testing procedure all subjects received the same instructions:

> You will hear someone talking to you through these earphones (i.e., left, right, both). You will also hear a buzzing noise. Don't pay attention to the buzzing noise; just listen to the words the man is saying. When he stops talking, I'll ask you to tell me all the words you remember.

At the end of each word list presentation, children were asked to freely recall words in any order they wanted.

## RESULTS

### Serial Position

Figure 1 presents the percentage of words correctly recalled by older and younger children by type of encoding (semantically organized, phonemically organized, or unrelated word lists) as a function of presentation mode (left ear, right ear, both ears) and serial position. Data from three groups of serial positions (1-4, 5-8, and 9-12) form the three data points presented on each curve. The increase in recall as a function of age was significant [$F(1,22) = 13.38$, $p < .01$], as was serial position [$F(2,44) = 5.27$, $p < .05$]. As shown in Figure 1, older children recalled more words than younger children on the first four serial positions. The main effect of presentation mode and type of encoding was not significant ($Fs < 1.5$), but was obscured by significant age × serial position [$F(2,44) = 4.83$, $p < .05$], age × mode of presentation × type of encoding [$F(4,88) = 3.48$, $p < .05$], and age × mode of presentation × type of encoding × serial position [$F(8,176) = 2.48$, $p < .05$] interactions. No other significant interactions occurred.

The interactions suggest that younger children have difficulty activating a critical number of word features from semantic memory and therefore utilize alternative processes for encoding information. For example, as shown in Figure 1, variations in strategies were found between younger and older children. When information was presented to the right ear, a nonsignificant primacy effect (i.e., performance on serial positions 1-4 was not significantly greater than that on positions 5-8) occurred for younger children. This suggests that younger children used a serial recall strategy, in which the recall of items largely occurs at the middle or end of the word list. In contrast, older children's significant primacy performance reflects a greater tendency to recall initial items. For the left ear presentation, young children yielded a significant primacy performance only for phonemically organized word lists, whereas significant primacy performances occurred across all encoding conditions for older children. Differences in recall were also noted within age groups in terms of ear presentation and type of word list.

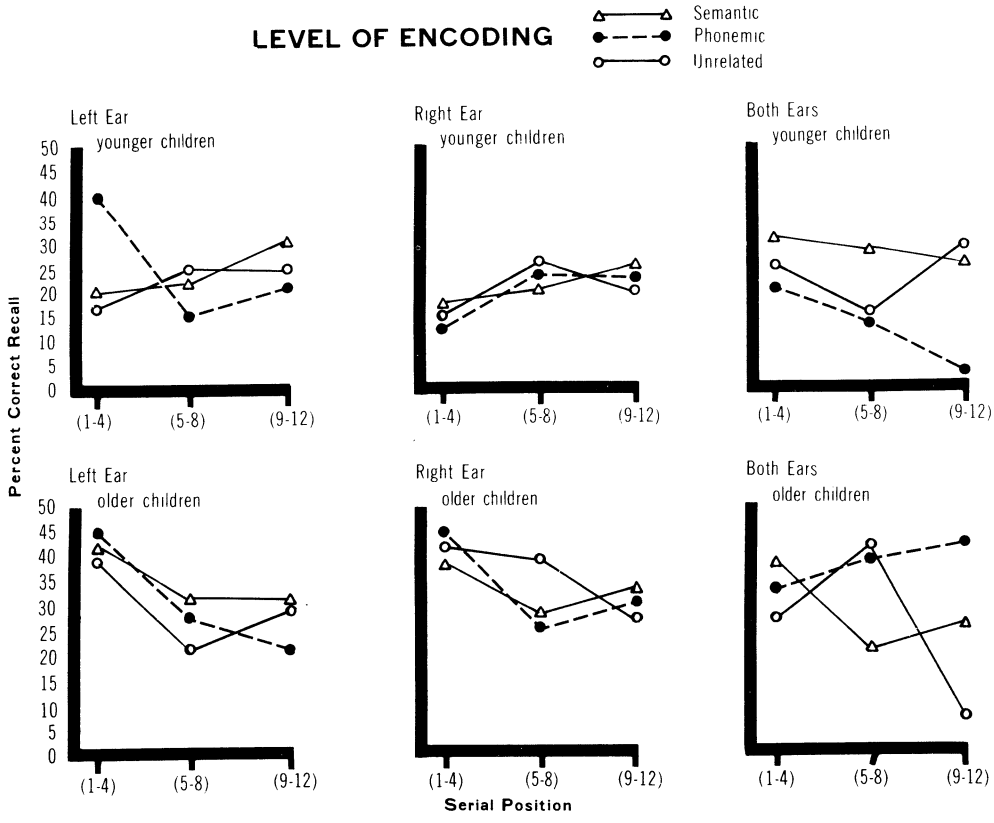


**Figure 1. Mean percent correct recall as a function of age, mode of presentation, level of encoding, and serial position.**

**Table 1**
**Means for the Adjusted Ratio of Clustering (ARC) and the Adjusted Ratio of Category Organization (ACAT) by Age, Mode of Presentation, and Type of Word Encoding**

| | Left Ear | Right Ear | Both Ears |
|---|---|---|---|
| | Younger Children | | |
| Semantic | | | |
| ARC | .26 | .17 | .22 |
| ACAT | .53 | .55 | .55 |
| Phonemic | | | |
| ARC | .13 | .13 | .10 |
| ACAT | .57 | .44 | .44 |
| | Older Children | | |
| Semantic | | | |
| ARC | .28 | .30 | .39 |
| ACAT | .82 | .89 | .77 |
| Phonemic | | | |
| ARC | .19 | .16 | .13 |
| ACAT | .60 | .63 | .56 |

## Recall Order

The Adjusted Ratio of Clustering (ARC) was used to measure the subordinate order of recall output (Murphy, 1979). Categorically unrelated words were removed from the analysis. This was done because unrelated word lists produced lower percentile scores than other word lists and were not likely to be sensitive to clustering strategies. Table 1 shows the mean cluster scores (i.e., ARC) by age, mode of presentation, and type of encoding. Main effects were significant for age and list organization, but not for mode of presentation ($F < 1.5$). Interactions were not significant ($F$s $< 1.2$). These results indicate that older children cluster words more than younger children [$F(1,22) = 4.67, p < .05$], and that clustering is more likely to occur for semantically than for phonemically organized lists [$F(1,22) = 46.91, p < .001$]. Since no reliable interactions occurred, it appears that clustering was independent of ear presentation, suggesting that both hemispheres may collaborate or share comparable resources in word organization.

The Adjusted Ratio of Category organization (ACAT) was used to measure the superordinate structure of recall (Murphy, 1979). As shown in Table 1, older children relied more on the superordinate structure of items than did younger children [$F(1,22) = 24.61, p < .001$], and semantically organized lists were more likely to elicit superordinate structure than were phonemic lists [$F(1,22) = 15.69, p < .001$]. An analysis of the age × type of word encoding interaction [$F(1,22) = 5.12, p < .05$] via Duncan's multiple range test indicated significantly ($p < .05$) higher organization scores for older children than for younger children on both semantically and phonemically organized lists. However, mean scores within age groups indicated that older children had better organization scores for semantic than for phonemic lists, whereas younger children's organization scores were not significantly different ($p > .05$) for the two types of encoding.

## DISCUSSION

Consistent with previous studies, this study indicates that younger children are less able than older children to (1) recall words organized according to certain features, (2) utilize comparable strategies on the initial parts of word lists (i.e., rehearsal and/or organization), and (3) organize information for effective retrieval in terms of superordinate and subordinate structures. Since no ear presentation interactions occurred for subordinate and superordinate clustering, the results suggest that both hemispheres may share resources from a common pool (i.e., semantic memory). The results are consistent with those of several studies (e.g., Friedman & Polson, 1981; Swanson & Mullen, 1983) that suggest that word recall may be performed with a variety of resource compositions as well as memory strategies related to both or either hemisphere.

The present study clearly showed that hemispheric (ear preference) and cognitive (serial position, clustering) processing vary by age. Furthermore, the interactions suggest that the present word tasks may not represent hemisphere-specific resources, but rather different resource compositions accessed from semantic memory. The implication is that variations in ear asymmetry and memory process (i.e., interactions) reflect demands placed on the accessing of a limited pool of word information stored in semantic memory. Thus, assuming that children vary in the amount of, as well as in the way that, information is stored in semantic memory, variability in how children retrieve information is to be expected.

## REFERENCES

BJORKLUND, D. F. (1985). The role of conceptual knowledge in the development of organization in children's memory. In C. J. Brainerd & M. Pressley (Eds.), *Basic processes in memory development* (pp. 103-134). New York: Springer-Verlag.

FRIEDMAN, A., & POLSON, M. (1981). Hemispheres as independent resource systems: Limited-capacity processing and cerebral specialization. *Journal of Experimental Psychology: Human Perception & Performance*, **7**, 1031-1058.

MANDLER, J. M. (1979). Categorical and schematic organization in memory. In C. Puff (Ed.), *Memory organization and structure* (pp. 259-296). New York: Academic Press.

MURPHY, M. (1979). Measurement of category clustering in free recall. In C. Puff (Ed.), *Memory organization and structure*. New York: Academic Press.

SWANSON, H. L., & MULLEN, R. C. (1983). Hemispheric specialization in learning disabled readers' recall as a function of age and level of processing. *Journal of Experimental Child Psychology*, **35**, 457-477.

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