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ABSTRACT

This study investigated the effects of stimulus presentation rate on primacy-recency effects in children. A modification of the Digit Span task used in the Binet and Wechsler intelligence scales provided the basic memory task administered to 56 male school children in grades kindergarten, second, fourth, and sixth. The specific design required children to verbally recall serial strings of digits presented at various rates of interdigit intervals. It was assumed that effective recall would be a function of general maturation and of the development of cognitive strategies. Age, delay, and age x delay were all significantly related to the number of digits correctly recalled. Results indicated that the traditional interpretation of the primacy effect as reflecting long-term memory store may not be valid. Rather, primacy effects may reflect differential encoding of material as a time-dependent process. (Author)

The Developmental Effects of Stimulus Presentation Time on Primacy-Recenency Recall

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The developmental literature consistently supports the proposition that as children mature they develop the ability to use mediational strategies appropriately and effectively in dealing with memory tasks (Belmont and Butterfield, 1969; Flavell, 1970; Flavell, Friedrichs & Hoyt, 1970; Hagen, 1971; Nermarck, Slotman, & Ulricht, 1971). A mediational strategy (e.g. rehearsal, mnemonic devices) presumably is employed to move information from short-to long-term store.

Generally, developmental memory theorists adhere to the dual memory model or variations thereof (Waugh & Norman, 1965; Atkinson & Schiffrin, 1968, 1971). This model perceives the memory process as being a dichtomy composed of a short- and long-term component; these short- and long-term components are dynamically different from each other, having different encoding and forgetting characteristics.

Primacy-recency recall has traditionally been interpreted in terms of this dual-memory model (Watkins, 1974). Basically, recall from the initial portions of the serial curve (primacy) are thought to reflect long-term memory while recall from the terminal portions of the list (recency) is thought to reflect short-term memory (Glanzer, 1972). Essentially, it is felt that initial items can be rehearsed or encoded into long-term store because of the greater amount of time available. Conversely, the terminal portions of the list are kept in short-term store for immediate recall because of time constraints.

Recently, memory researchers have criticized this dual model interpretation of the primacy-recently effect (Wickelgren, 1973; Murdock, 1972). Shulman (1971) feels that encoding may be a serial process with phonemic features encoded first and semantic features encoded later. While this may be a time dependent process it does not demand a dual memory model. Primacy-recency effects may simply reflect different encoding mechanics rather than dynamically dichtomous short- and long-term operations.

Therefore, developmental primacy-recency effects may not be as validly interpreted as reflecting short- and long-term recall as some investigators believe (Belmont & Butterfield, 1969; Frank & Rabinovitch, 1974; Tulving & Patterson, 1968).

The present study was designed to investigate the relationship of stimulus presentation time on the recall of serially presented digit recall in children (K, 2, 4, 6). In adults the bulk of the evidence suggests, in accordance with dual-memory theory, that recall increases as stimulus presentation times increase (Pollack, 1952; Pollack, Johnson & Knoff, 1959; Pollack & Johnson, 1963; Posner, 1963). However, some evidence suggests recall in adults increases as a function of shorter presentation times (Fraser, 1958; Conrad & Hille, 1958).

Method

Subjects

The subjects were fifty-six male children from the Gainesville Public School system, fourteen each from grades kindergarten, two, four, and sixth. Each subject was screened for learning problems, and each subject had an I.Q. within the normal range of intelligence (mean I.Q. and standard deviations for K, 2, 4, and 6 respectively, 103.4, 4.9; 100.5, 6.9; 101.7; 4.7; and 102.2, 6.36).

Apparatus

In order to minimize distraction the digits were presented via audio tape to both ears through headphones. The source tapes were generated on a reel-to-loop dub mechanism at a constant 70 db, and word length was held constant (250 milliseconds plus-or-minus 15 milliseconds).

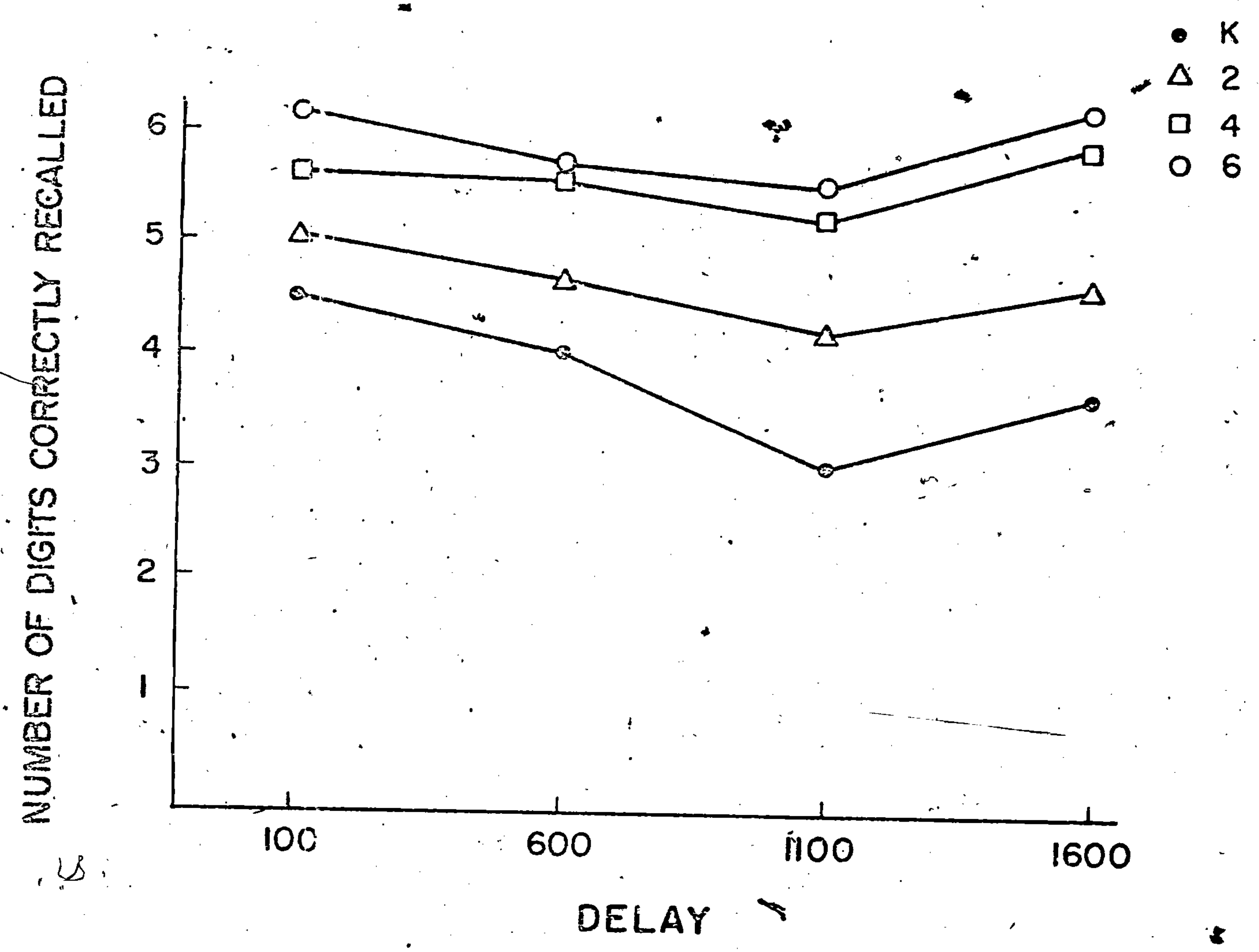
Procedure

Prior to each treatment presentation a standard pure tone hearing test was administered to each subject to insure against possible transitory decrements in hearing. The test conditions ranged from 20 to 40 dbs over 125 to 8000 cps. (Beltone Audiometer, model #10-C)

There were four treatment conditions reflecting four variations of inter-digit delay (100, 600, 1100, and 1600 milli-seconds). Each subject received a random presentation of treatment conditions. The digits were administered as in the Wechsler with the number correct reflecting the highest number remembered in order up to two consecutive failures on the same trial. The serial lists were consecutive sets of one to nine digits. Each subject received all nine trials regardless of where he failed. In order to minimize possible practice and/or carryover effects the subjects received three of the treatments at 24 hour intervals, and the last treatment 48 hours after the previous three due to scheduling problems with the school. Inspection of the data revealed that this distribution of times did not adversely affect the outcome.

Results

The digit recall data were subjected to a Split Plot Factoral Analysis of Variance (Kirk, 1969) with repeated measures on the delay factor (Grade:



NUMBER OF DIGITS CORRECTLY RECALLED
6
5
4
3
2
1
100
600
1100
1600
DELAY
K
2
4
6

$F = 24.09$, $df = 3/52$, $p < .01$; Delay: $F = 10.04$, $df = 3/156$, $p < .01$; Grade x Delay: $F = 2.05$, $df = 9/156$, $p < .05$).

The significant Grade x Delay interaction is displayed graphically in Figure 1. In addition to reflecting the superior recall of subjects at

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Insert Figure 1 about here

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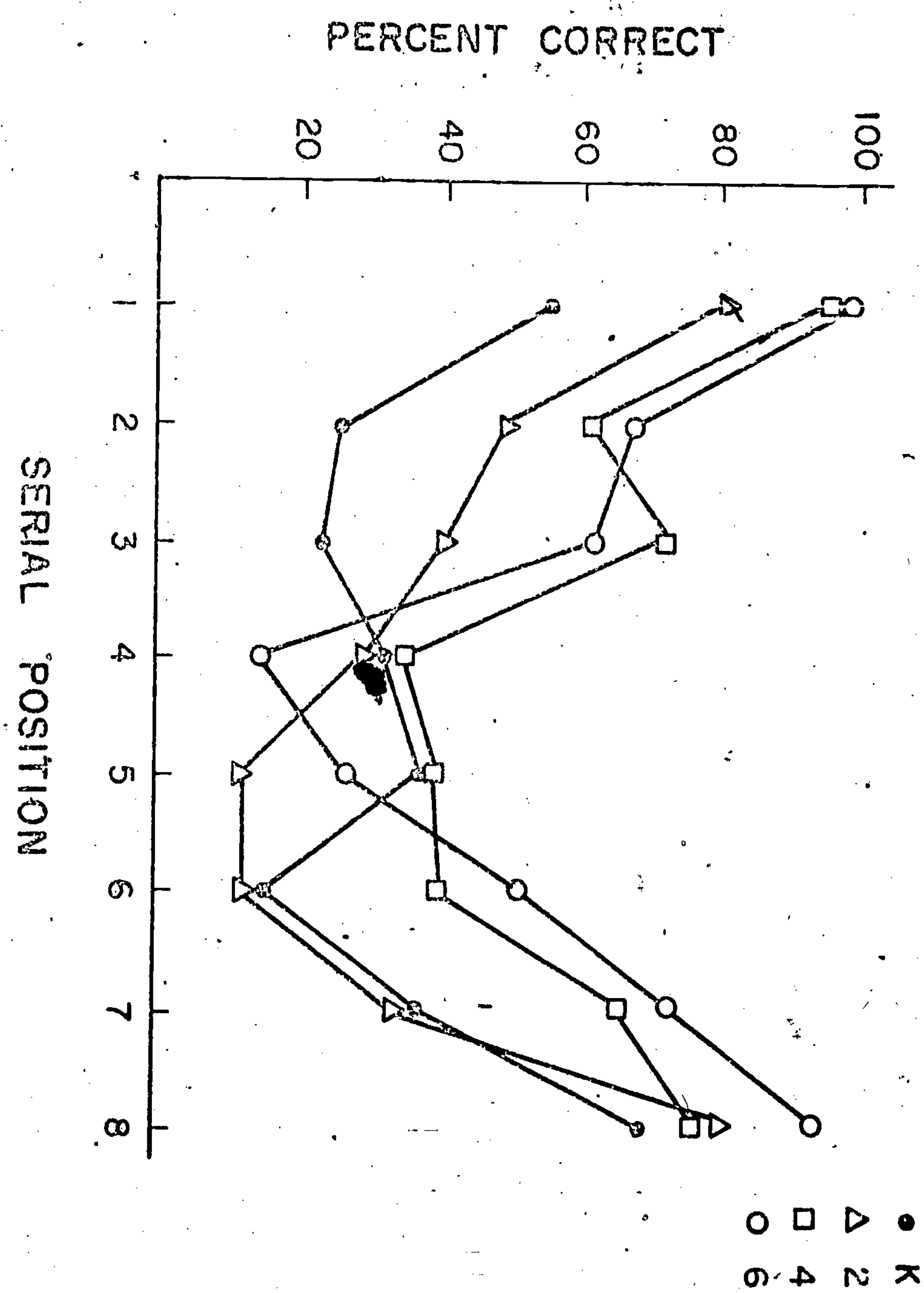
higher grade levels (4 and 6), the graph also demonstrates the poorer recall of younger children (K and 2) as intervals increased. That is, the older children (4 and 6 grade) were able to recall as much at the fastest as compared to the slowest conditions while the younger childrens' recall declined slightly.

Furthermore, recall scores were significantly higher for all grades ($p < .01$) in the 1600 as compared to the 1100 msc. conditions. In general, recall scores gradually decreased from the 100 through 1100 msc. conditions then increased between the 1100 and 1600 msc. conditions (means: 100 = 5.31; 600 = 4.9; 1100 = 4.78; 1600 = 5.02).

A Posteriori pairwise comparisons for the main effect of Grade were all significant ($p < .01$), except for the comparison between the fourth and sixth grades. In general, recall scores increased across grade level (means: K = 3.72; 2 = 4.5; 4 = 5.43; 6 = 6.01). Additionalally, A Posteriori pairwise comparisons for the main effect of Delay showed that recall scores in the 100 msc. condition were significantly higher ($p < .05$) than those in the 600, 1100, and 1600 msc. conditions.


PERCENT CORRECT
100
80
60
40
20
SERIAL POSITION
1
2
3
4
5
6
7
8
K
2
4
6

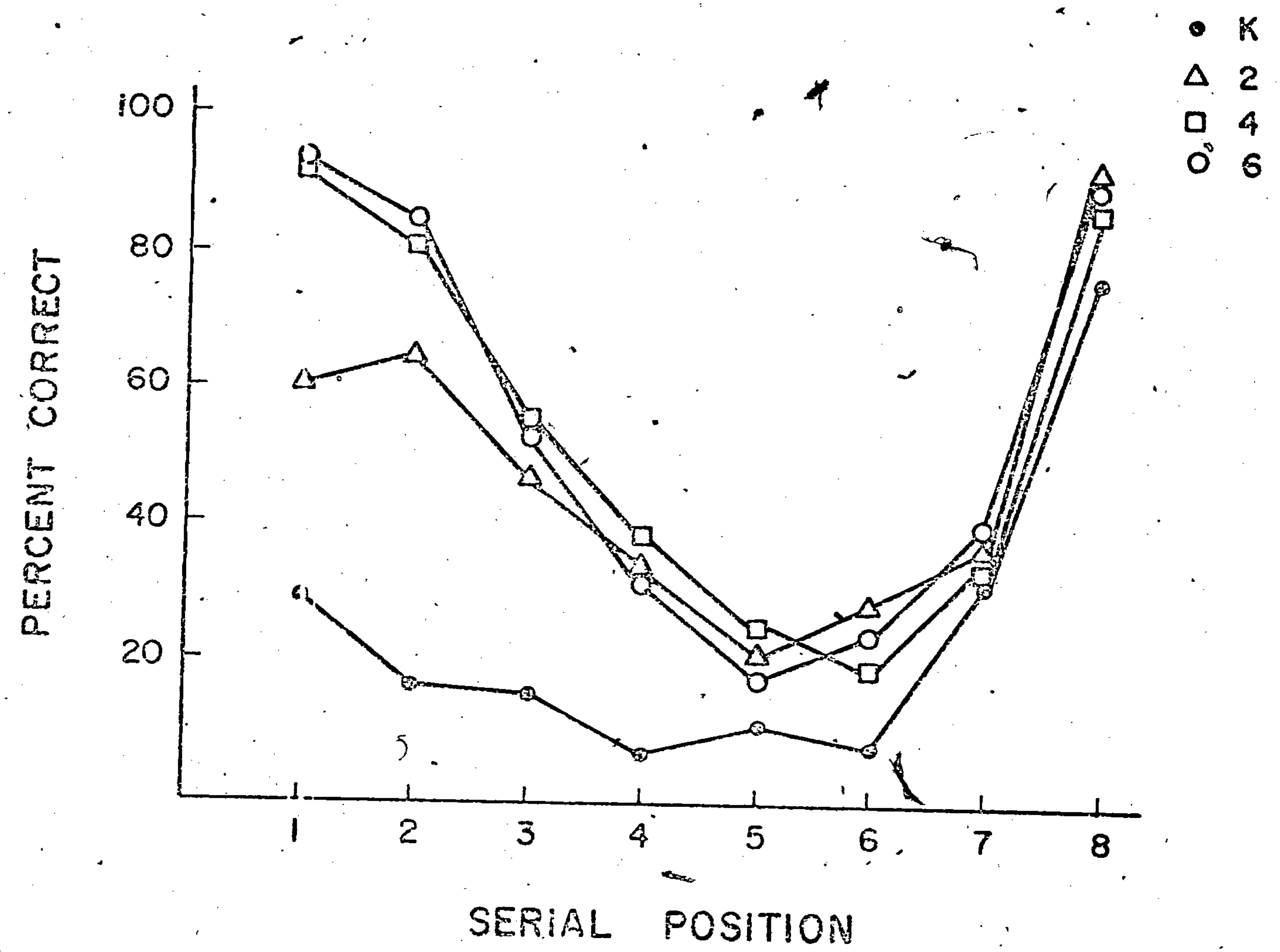
Serial Position Curves for the Recall Data

In order to further investigate the nature of the Grade x Dealy interaction traditional primacy-recency curves were separately constructed for serial digit strings of three through eight digits; the curves constructed for the eight digit strings under the 100 and 1600 msc. conditions were the most representative regarding primacy-recency effects. Figure 2 shows the serial position curves for the 100 msc. conditions for each grade. The primacy-recency effects were not substantially difference from each other at this rate of presentation. Indeed, even at this rapid rate of presentation traditional grade-related primacy-recency effects emerged. In general, upper grade children were superior to lower grade children in both primacy and recency recall. However, increased inter-digit delays (1600 msc.) produced an interesting effect, and is most clearly depicted in Figure 3. While recency effects were very similar across grade levels in the 1600 msc. condition, there was a dramatic difference in the primacy scores. Basically, kindergarten subjects displayed very poor primacy recall followed by second grade subjects, while primacy recall in the fourth and sixth grades was very similar to the recency effect for these latter grades.

Insert Figures 2 & 3 about here

Discussion

The present study examined the development of serial digit recall under different inter-digit delay conditions in an effort to acquire information regarding the use of mediational strategies. In general, it was assumed that


PERCENT CORRECT
100
80
60
40
20
SERIAL POSITION
1
2
3
4
5
6
7
8
K
2
4
6

short inter-digit intervals would interfere with the use of mediational strategies and thereby reduce recall efficiency in older children. Conversely, long inter-digit intervals would be presumably more conductive to the utilization of mediational strategies, and would therefore increase the efficiency of digit recall.

Evidence suggestive of possible mediational strategies emerged from the analysis of the serial position data under the 100 to 1600 millisecond conditions. Both conditions depicted the expected or typically obtained superiority of digit recall for the initial and final digits of a series. Additionally, there was increased superiority of digit recall with increased age. However, there was a striking difference between the two treatment conditions as indicated by the marked inferiority of primacy recall under the 1600 millisecond condition for the kindergarten subjects, and to a somewhat lesser extent, for that of the second graders. Although no behavioral evidence was obtained to suggest that mediational strategies were employed, it has been inferred that such age related differences in primacy-recency data reflect the utilization of mediational strategies which somehow enable the subject to retain incoming sensory information for longer periods of time (Ellis, 1969; Belmont and Butterfield, 1969).

Since there is evidence to suggest that five and six-year old children do not have mediational strategies (Flavell, 1970; Goulet, 1968; Rossi, 1964; Daeler et al., 1969; Cole, Frankel and Sharp, 1971; Corsini et al., 1968; Moely et al., 1969), or at best use them ineffectively (Kendler, 1963; Luria, 1961; Reese, 1962), it might be reasoned that the poor performance of kindergarten children under the 1600 millisecond condition reflected in inability to retain primacy information because they were unable to employ some mediational device which would facilitate longer retention. Conversely, primacy recall for kindergarten children may have been easier under the 100 millisecond condition because of the shorter temporal interval between primacy elements and recall. That is, digits at the 100 msc. condition were recalled from short-term memory.

Surprisingly, recall was slightly superior under the 100 millisecond inter-digit delay conditions for subjects at all grade levels. This short-term store appears to increase with age between grades K to 6. It is reasonable to assume that the superior performance under the 100 millisecond condition was related to central nervous system maturation.

Unexpectedly, the recall declined from the 100 to the 1100 millisecond conditions. This decline may reflect the interference of these time intervals upon the recoding of the information from short- to long-term memory stores. On the other hand, the increase in recall from the 1100 to 1600 millisecond conditions may reflect the successful ability to recode the information into long-term memory. Older (4, 6 grades) children may have been more sophisticated in their mediational strategies and hence did not decline in recall across conditions as dramatically as grades K and 2. Thus, it appears that children from K-6 grades can use mediational strategies. However, older children use them more effectively.

Of most importance to the present study is the observation of traditional grade-related primacy-recency effects at the 100 msec inter-digit interval presentation rate. It does not seem reasonable to conclude that this grade-related primacy effect reflects long-term store at this rapid presentation rate. It would seem more appropriate to view this grade related primacy-recency effect as reflecting general central nervous system maturation.

Specifically, primacy-recency may be a time dependent process: different encoding mechanics (e.g., phonemic v. semantic) may be employed depending upon the temporal demands of the situation (Shulman, 1971). For example, at rapid rates of stimulus presentation phonemic encoding may be used; at slow rates the more cumbersome semantic encoding may be used. Regardless of what may be the differential encoding factor, the evidence of this study suggests that there are different encoding preferences which share similar recency but not primacy effects. Further, these different encoding preferences apparently are both age-related and dependent upon stimulus presentation rate.

The analysis of primacy-recency effects using a dual-memory model which views primacy as reflecting long-term store exclusively does not appear to be consistent with this data.

References

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

Atkinson, R. C. & Shiffrin, R. M. The control of short-term memory. Scientific American, 1971, 224, 82-90.

Belmont, J. M., & Butterfield, E. C. The relation of short-term memory to development and intelligence. Advances in Child Development and Behavior, 1969, 4, 29-47.

Cattell, R. B., & Cattell, A. K. S. Handbook for the Individual or Group Culture Fair Intelligence Test (A Measure of "g"): Scale One. Institute for Personality and Ability Testing, Champaign, Illinois, 1960.

Cattell, R. B., & Cattell, A. K. S. Handbook for the Individual or Group Culture Fair Intelligence Test (A Measure for "g"): Scale Two. Institute for Personality and Ability Testing, Champaign, Illinois, 1960.

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

Conrad, R., & Hille, B. The decay theory of immediate memory and paced recall. Canadian Journal of Psychology, 1958, 12, 1-6.

Corsini, D. A., Pick, A. D., & Flavell, J. H. Production of nonverbal mediators in young children. Child Development, 1968, 39, 53-58.

Daehler, M. W., Horowitz, A. B., Wynns, F. C., & Flavell, J. H. Verbal and non-verbal rehearsal in children's recall. Child Development, 1969, 40, 443-452.

Ellis, N. R. Evidence for two storage processes in short-term memory. Journal of Experimental Psychology, 1969, 80, 390-391.

Flavell, J. H. Developmental studies of mediated memory. Advances in Child Development and Behavior, 1970, 5, 182-209.

Flavell, J. H., Friedrichs, A. G., & Hoyt, J. D. Developmental changes in the memorization process. Cognitive Psychology, 1970, 1, 324-340.

Frank, H. S. & Rabinovitch, M. S. Auditory short-term memory: Developmental changes in rehearsal. Child Development, 1974, 45, 397-407.

Fraser, D. C. Decay of immediate memory with age. Nature, 1958, 182, 1163.

Glanzer, M. Storage mechanisms in recall. In G. H. Bower (Ed.). The Psychology of Learning and Motivation: Advances in Research and Theory. Vol. 5, New York: Academic Press, 1972.

Goulet, L. R. Verbal learning in children: Implications for developmental research. Psychological Bulletin, 1968, 69, 359-376.

Hagen, J. W., & Kingsley, P. R. Labelling effects in short-term memory. Child Development, 1968, 39, 113-121.

Hagen, J. W. Some thoughts on how children learn to remember. Human Development, 1971, 14, 262-271.

Kendler, T. S. Development of mediating responses in children. In J. C. Wright and J. Kagan (Eds.), Basic Cognitive Processes in Children, Monographs of the Society for Research in Child Development, Chicago, 1963, 28 (2) 33-52.

Kirk, R. E. Experimental Design: Procedures for the Behavioral Scientist. Belmont, California: Brooks-Cole Publishing Co., 1969.

McCrary, J. W., & Hunter, W. S. Serial position issues in verbal learning. Science, 1953, 17 (8), 131-134.

Moely, B. E., Olson, F. A., Halwes, T. G., & Flavell, J. H. Production deficiencies in young childrens' clustered recall. Developmental Psychology, 1969, 1, 26-34.

Murdock, B. B. The criterion problem in short-term memory. Journal of Experimental Psychology, 1966, 72, 317-324.

Murdock, B. B. Short-term memory. In G. H. Bower (Ed.) The Psychology of Learning and Motivation: Advances in Research and Theory. Vol. 5. New York: Academic Press, 1972.

Neimarck, E., Slotman, N. S., & Ulricht, T. The development of memorization strategies. Developmental Psychology, 1971, 5, 427-432.

Norman, D. A. Acquisition and retention in short-term memory. Journal of Experimental Psychology, 1966, 72, 369-381.

Pollack, I., Johnson, L. B., & Knaff, D. R. Running memory span. Journal of Experimental Psychology, 1959, 57, 137-146.

Pollack, I., & Johnson, L. B. Continuing memory span for digits. Perceptual and Motor Skills, 1963, 17, 731-734.

Pollack, I. The effect of rate of presentation of information. Report No. 45, 1952, Human Factors Operations Research Laboratories (AD 140).

Posner, M. I. Immediate memory in sequential tasks. Psychological Bulletin, 1963, 60, 333-349.

Reese, H. W. Verbal mediation as a function of age level. Psychological Bulletin, 1962, 59, 502-509.

Rossi, E. Development of classificatory behavior. Child Development, 1964, 35, 137-142.

Schulman, H. G. Similarity effects in short-term memory. Psychological Bulletin, 1971, 75, 399-415.

Tulving, E., & Patterson, R. D. Functional units and retrieval processes in free recall. Journal of Experimental Psychology, 1968, 77, 239-248.

Watkins, M. J. Concept and measurement of primary memory. Psychological Bulletin, 1974, 81, 695-711.

Waugh, N. C. Primary and secondary memory in short-term retention. In K. H. Primbram and D. E. Broadbent (Eds.), The Biology of Memory. New York: Academic Press, 1970, 63-68.

Waugh, N. C. & Norman, D. A. Primary memory. Psychological Review, 1965, 72, 89-104.

Wechsler, D. The Wechsler Intelligence Scale for Children. New York: Psychological Corporation, 1949.

Wickelgren, W. A. The long and short of memory. Psychological Bulletin, 1973, 80, 425-438.