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ABSTRACT

Forty-eight grade-three children and 48 grade-eight children were presented respectively with six- and eight-letter sequences for written free recall. The older children, as had adult subjects in previous studies, showed a greater tendency to recall serially with a four-letters-per-second presentation rate than with a half- or one-letter-per-second rate. Grade-three children, however, showed evidence of serialness in their recall with all three presentation rates. The results are consistent with the hypothesis that there is an auditory-specific store enduring for perhaps 15 to 20 seconds which holds relatively unprocessed material according to the initial temporal organization. Operation of this store would be most evident when the opportunity or ability to rehearse and recode are minimal, that is, in older children's and adults' recall with a fast presentation rate and in young children's recall with all rates. (Author)

RATE-DEPENDENT CHARACTERISTICS OF CHILDREN'S IMMEDIATE RECALL FOLLOWING AN AUDITORY PRESENTATION

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Very little research has been done examining children's immediate recall of sequentially presented information. One previous study (Murray and Roberts, 1967; Gounard, 1968) has investigated the effects of varying presentation mode and presentation rate on children's ordered recall of digit sequences. With a visual presentation, children seven to ten years of age showed an increase in the amount of their overall recall as presentation rate decreased, and this difference occurred primarily on the recent serial positions. With an auditory presentation, however, the children showed no differences in either the amount of overall recall or in the shapes of their serial position curves as a function of presentation rate.

The discrepancy between the above results obtained with auditory and visual presentations suggested at the time that the children were not adapting their recall strategies to the rate variations when the presentation mode was auditory. With the visual presentation, the improvement in performance at the slower rates could be easily attributed to the increased opportunity to read, rehearse, recode, etc. (It is interesting to note that the amount of recall was inferior from the visual presentation even though this presentation allowed more opportunity for rehearsal and recoding than did the auditory presentation.)

Subsequent research with adult subjects (Gounard, 1971) has suggested that adults adapt their recall strategies to variations in presentation rate in particular ways. It was found that strategies favoring serial recall were adopted at fast presentation rates although not at slow rates whenever such a variation was possible. With free recall instructions, especially, more initial items were recalled and were recorded in their correct serial positions (i.e., primacy was greater) at a fast presentation rate relative to slower rates. Again, however, subjects were generally

not handicapped in terms of amount of overall recall by an increase in presentation rate.

In the present study, children of two different grade levels were tested for their free recall of material presented auditorially at three different rates. The variables were chosen with the following possibilities in mind:

1. If a lack of opportunity or ability for rehearsal and recoding leads to the adoption of serial recall, then young children, who are at best inefficient rehearsers, should show a tendency to recall serially at all presentation rates. Older children, however, should show serialness only at a fast presentation rate since ability to rehearse and recode at slower rates presumably increases with age.

2. If, on the other hand, recall characteristics evident at a fast presentation rate reflect something unique about the storage of rapidly presented items (thinking here of an echoic type of store), then serialness should be evident only at a fast presentation rate, regardless of age.

Method

General Design

Since different list lengths were used for the Grade 3 and Grade 8 children, the experiment was actually designed as two factorial experiments. For Grade 3, the design was a 3 x 2 x 6 factorial, and for Grade 8, a 3 x 2 x 8 factorial. In both instances, two variables were manipulated between subjects; these were presentation rate (½, 1, and 4 letters per second) and list order (order I and order II). The within subjects variable was serial position (six items for Grade 3 and eight items for Grade 8).

In order that tentative comparisons could be made between the results for the two grades, the Grade 3 and Grade 8 subjects were tested randomly. This permitted an overall analysis of the data as a 2 x 3 x 2 x 2 factorial. In this case, the between subjects variables were grade, presentation rate and list order. The within subjects variable was "half", with the performance on the first half of the lists (i.e., the first three or four serial positions) being compared to performance on the second half.

The experimental conditions were randomly ordered within eight replications, each condition being represented once in a replication. This ensured that the experimental conditions were more evenly distributed across schools.

Subjects

The subjects were 48 Grade 3 girls and 48 Grade 8 girls who were enrolled in elementary schools in Waterloo County (Ontario). One additional subject was tested and her data discarded since she failed to follow the instructions. Only children who had neither failed nor "skipped" a grade in school were included in the study. The Grade 3 girls ranged in age from 8 years 4 months to 9 years 3 months, with a mean age of 8 years 9 months; the Grade 8 girls ranged from 13 years 4 months to 14 years 6 months, with a mean age of 13 years 10 months.

Material

Thirteen lists of six or eight letters each were used, for Grades 3 and 8

respectively. Their original random ordering (order I) was randomly rearranged to make order II. The first two lists within each order were considered practice lists. The lists for each grade were made up of randomly selected letters of the alphabet with the following constraints:

1. No forward alphabetic sequences were included.
2. There were no repetitions within a list.
3. No letter appeared more than once in each serial position.
4. Each letter of the alphabet appeared four times.

The lists were recorded in a female voice and played on a Sony cassette tape recorder. A warning "Ready" preceded the start of each list by four seconds, and approximately 32 to 33 seconds were allowed for recall. The speaker attempted to keep the duration of each letter constant, at approximately one-quarter of a second.

Procedure

Individual testing was carried out in a small room (usually a school nurse's room). The subject was seated at a desk across from the experimenter, and supplied with a pencil and booklet. Each page of the booklet was printed with a grid of the appropriate number of squares in which the subject was to record her answers. The subjects were given taped instructions to recall the items "in any order" they could remember them (i.e., free recall), and guessing was encouraged.

Results

Three different scoring procedures were used on the data: (a) order scoring which counts the number of items correct in their correct serial positions, (b) item scoring which counts the number of items correct from each of the presentation order serial positions, regardless of the order of recall, and (c) position scoring which considers order scores as a function of item scores rather than of total possible recall. Since position scores are expressed as percentages, the order and item scores were dealt with in the same fashion, and arcsin transformations were used on all of the data before the analyses were carried out.

Analyses of variance were computed on the data for each grade obtained with each type of scoring. In addition, the performance of the two grades was compared in analyses of variance on the scores for the first and second halves of the sequences.

Analyses based on order scores best reflect any evidence of serialness in recall. In the present experiment, the older children showed considerable variation in their order scores as a function of presentation rate (F (14,294) = 5.58, $p < .005$), with very much more primacy being obtained at the 4 items per second rate than at the slower rates. The younger children, however, showed marked primacy at all presentation rates (see Figure 1).

Insert Figure 1 About Here

Unlike the Gounard (1968) results, the serial position curves did vary somewhat for the younger children as a function of presentation rate (F (10,210) = 2.12, $p < .025$). Recall was slightly better on serial positions 1 and 6, than on the midlist positions at the 4 items per second rate when compared to the other two rates.

The two groups of children showed similar variations in amount of overall recall (Grade 3: $F(2,42) = 5.41$, $p < .01$; Grade 8: $F(2,42) = 3.29$, $p < .05$). For both, recall of order information was greater from the 4 items per second rate than from the slower rates. Recall from the slower rates did not differ significantly.

Although the order scoring results differed considerably for the two grades, the results with item scoring were unexpectedly similar. In Figure 2, it is apparent that the children of both grades recalled more of the initially presented

Insert Figure 2 About Here

items from the fast presentation rate than from the other two rates. Comparing performance with the slower rates on the initial positions, it can be seen that the ½ per second rate was somewhat superior to the 1 per second rate. The recent positions showed very little variation as a function of presentation rate. For each grade, the Serial Position X Rate interaction was highly significant (Grade 3: $F(10,210) = 2.69$, $p < .005$; Grade 8: $F(14,294) = 2.14$, $p < .025$).

The item analyses differed for the two grades regarding the overall effect of varying the rate of presentation. The younger children showed no significant difference in recall as a function of presentation rate ($F(2,42) = 1.64$) whereas the older children did ($F(2,42) = 3.98$, $p < .05$). In the latter case, the slowest and fastest rates produced equal amounts of recall, and were superior to the 1 per second rate ($1 < ½ = 4$, Neuman-Keuls, $p < .05$).

The position scoring results proved to be very interesting for the Grade 3 children. More order information per item was recalled from the 4 items per second rate than from the slower rates ($F(2,42) = 6.43$, $p < .005$; $½ = 1 < 4$, Neuman-Keuls, $p < .01$). And, as is depicted in Figure 3, the superiority of the 4 items per

Insert Figure 3 About Here

second rate was equal across all serial positions. The Serial Position X Rate interaction was not significant in this case ($F(10,210) = 1.18$).

For the Grade 8 children, the position scores showed a considerable increase in the amount of order information per item recalled on the initial positions with the 4 items per second rate, compared to the slower rates ($F(14,294) = 5.68$, $p < .005$).

As is apparent from the fact that the Grade 3 children received 6-item lists and the Grade 8 children 8-item lists, no analyses could be done comparing Grade 3 and Grade 8 if serial position data were included. However, in Figures 1 and 3, one can see that there are obvious differences in the serial position curves for the two grades. If it were possible to analyse the data from the two grades together, the desired interaction would be Rate X Grade X Serial Position. To obtain an approximation to the desired interaction, percentage scores were calculated for the first three or four and last three or four serial positions of the lists. The 2 x 3 x 2 x 2 analyses of variance used to evaluate these scores produced a Rate x Grade x Half interaction which was significant both with order scoring ($F(2,84) = 4.56$, $p < .025$) and position scoring ($F(2,84) = 4.91$, $p < .005$), although not with item scoring ($F(2,84) < 1$). As may be seen in Figure 4, the slopes for all three

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Insert Figure 4 About Here

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rates with order and position scoring were essentially parallel for the Grade 3 children, whereas performance was disproportionately better on the first half with the 4 items per second rate for Grade 8.

Discussion

In accord with expectations, there was evidence of serialness in young children's recall with all rates of presentation, whereas serialness was more evident in the older children's recall at the fast presentation rate than at the slower rates. Hence it appears that serial recall is favored when items are presented auditorially; and there is either minimal opportunity or minimal ability to rehearse and recode the information. Under these conditions, amount of overall recall is not adversely affected.

The above observations lead one to a consideration of the storage of material presented via the auditory mode. Apparently, the rather commonly accepted verbal short-term store cannot account for these results, although it is consistent with the results reported in a multitude of studies involving a visual presentation (cf., Mackworth, 1962a, 1962b, 1962c, 1963). The alternative favored at the present time is that there is an auditory-specific store which operates in conjunction with the verbal store. This auditory-specific store would hold auditorially presented material according to the organization of input (i.e., in order), until or unless further processing (rehearsing and recoding) transfers these items into the verbal store. Hence, the operation of the auditory-specific store would be evident in the recall of relatively unprocessed material.

In a task involving sequential presentation and immediate recall, the recent items are those for which there is the least opportunity for processing. When a comparison is made between entire sequences presented at different rates, the difference in amount of processing would be most pronounced on initial positions since the recent items would be relatively unprocessed at all rates. If there is an auditory-specific store as described above, then a greater difference in recall as a function of presentation rate should occur on initial positions. This difference should occur in favor of enhanced primacy at the faster rates as was actually found with the Grade 8 children in the present study.

Obviously, the type of auditory store being described is more like the auditory store that Murdock (1968) and Margrain (1967) have postulated than like Crowder and Morton's (1969) precategorical acoustic store or Neisser's (1967) echoic store. The duration would have to be quite long, perhaps as long as 15 to 20 seconds.

An examination of the Grade 3 results suggests that these too are consistent with the hypothesis of an auditory-specific store. The younger children showed evidence of serialness in their recall at all presentation rates as would be expected if the auditory store predominates when nontransformational strategies are used.

There is one new consideration introduced by the Grade 3 results. While the amount of order information recalled is clearly greatest at the 4 items per second rate, there is no difference in amount of recall for the two slower rates. If the auditory store retains order information and if this store is subject to decay, recall from the ½ per second rate should be proportionately lower than recall from the 1 per second rate. It is possible that the young children were rehearsing at the slowest rate, and that this rehearsal facilitated recall but did not impose a new organization on the retained material. Two very simple types of rehearsal which might be available to young children are (a) repeating each letter to oneself during the interitem interval and (b) cumulatively rehearsing. Neither of these would alter the organization of a sequence (cf. Palmer and Ornstein, 1971, regarding cumulative rehearsal). A few of the Grade 3 subjects were observed to be rehearsing cumulatively at the slowest presentation rate in a quite exaggerated fashion. Thus the young children may have been more bound by the initial temporal organization of the material. Since rehearsal affects recall primarily of initial items (cf. Bruce and Papay, 1970), such rehearsal might also account for the primacy differences evident with item scoring for the Grade 3 children.

Another possibility must, however, be considered with regard to the Grade 3 children's performance. If the auditory-specific store is subject only to very slow

decay and/or is unstable only in the presence of other processing, the Grade 3 children's rehearsal may have had an interfering effect on retention at the slow presentation rates. Whatever strategies were used by the young children to maintain order information at the two slower rates may have been equally effective but also equally disruptive to the auditory-specific store. The Gounard (1968) results are possibly consistent with this interpretation. In this previous experiment, there was effectively no interitem interval at any presentation rate (1, 2, or 3 digits per second) since the items were "drawled" to fill the whole interval. The resulting serial position curves were essentially identical in shape, and there was no difference in the amount of overall recall.

Further research is currently in progress in an attempt to delineate the characteristics of the postulated auditory-specific store. Modality comparisons, of course, must be made. For example, a comparison of auditory and visual presentations with adult subjects would be expected to show a modality difference on initial positions as well as on recent items if a fast rate of presentation is used. Questions being examined with child subjects concern whether output interference in the form of spoken rather than written recall affects performance, and also whether delayed recall (affording an opportunity for further rehearsal and/or decay) is detrimental to the Grade 3 subjects' recall when compared with Grade 8 subjects' recall.

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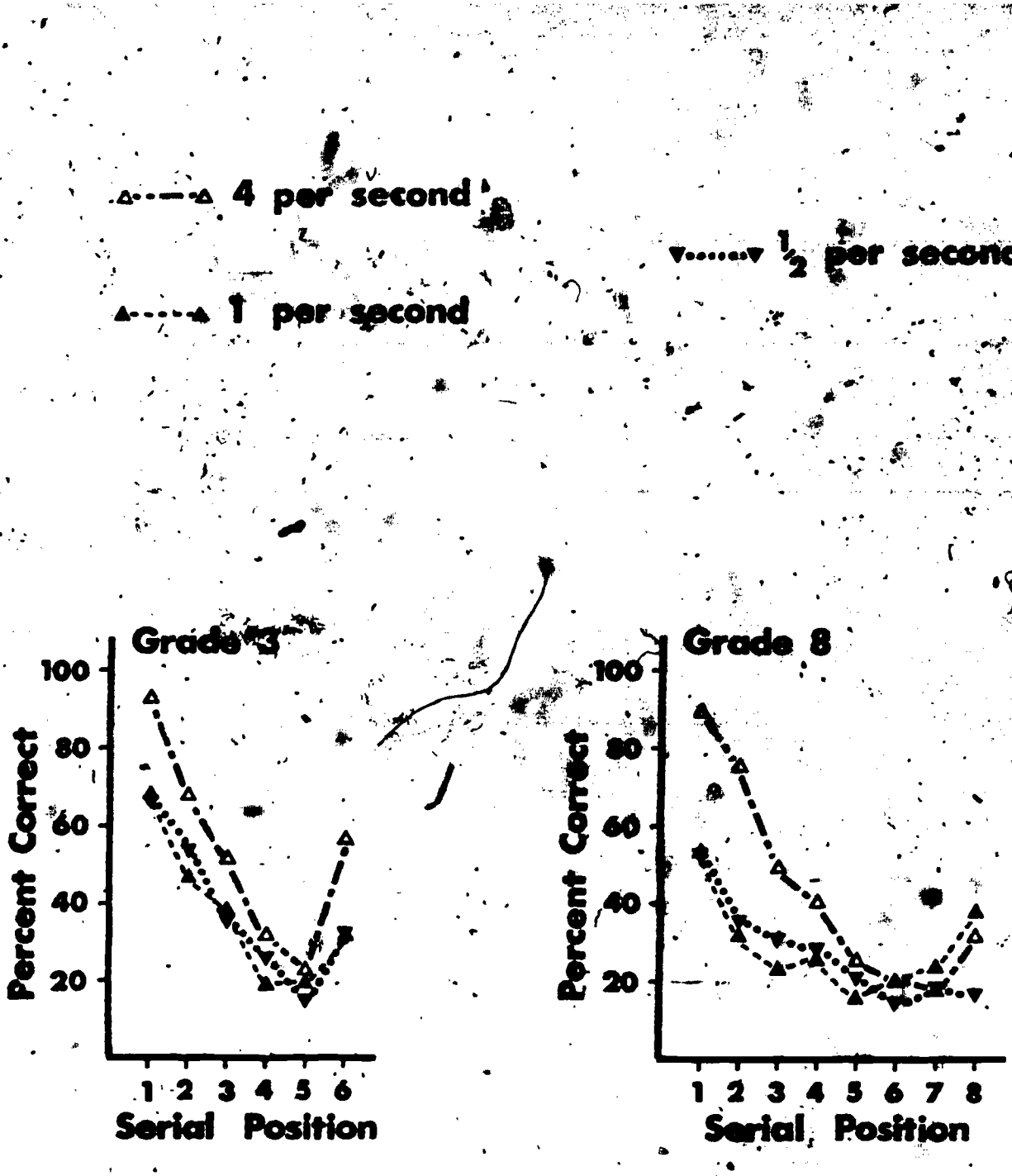
Footnotes

[1] Paper presented at the meeting of the Canadian Psychological Association, June 1972. This research represents a portion of the author's doctoral dissertation which was presented to the University of Waterloo under the supervision of P.M. Merikle. This work was supported in part by an Ontario Mental Health Foundation Research Fellowship awarded to the author, and by National Research Council Grant No. APA - 231 awarded to P.M. Merikle.


4 per second
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Grade 3
Grade 8
Percent Correct
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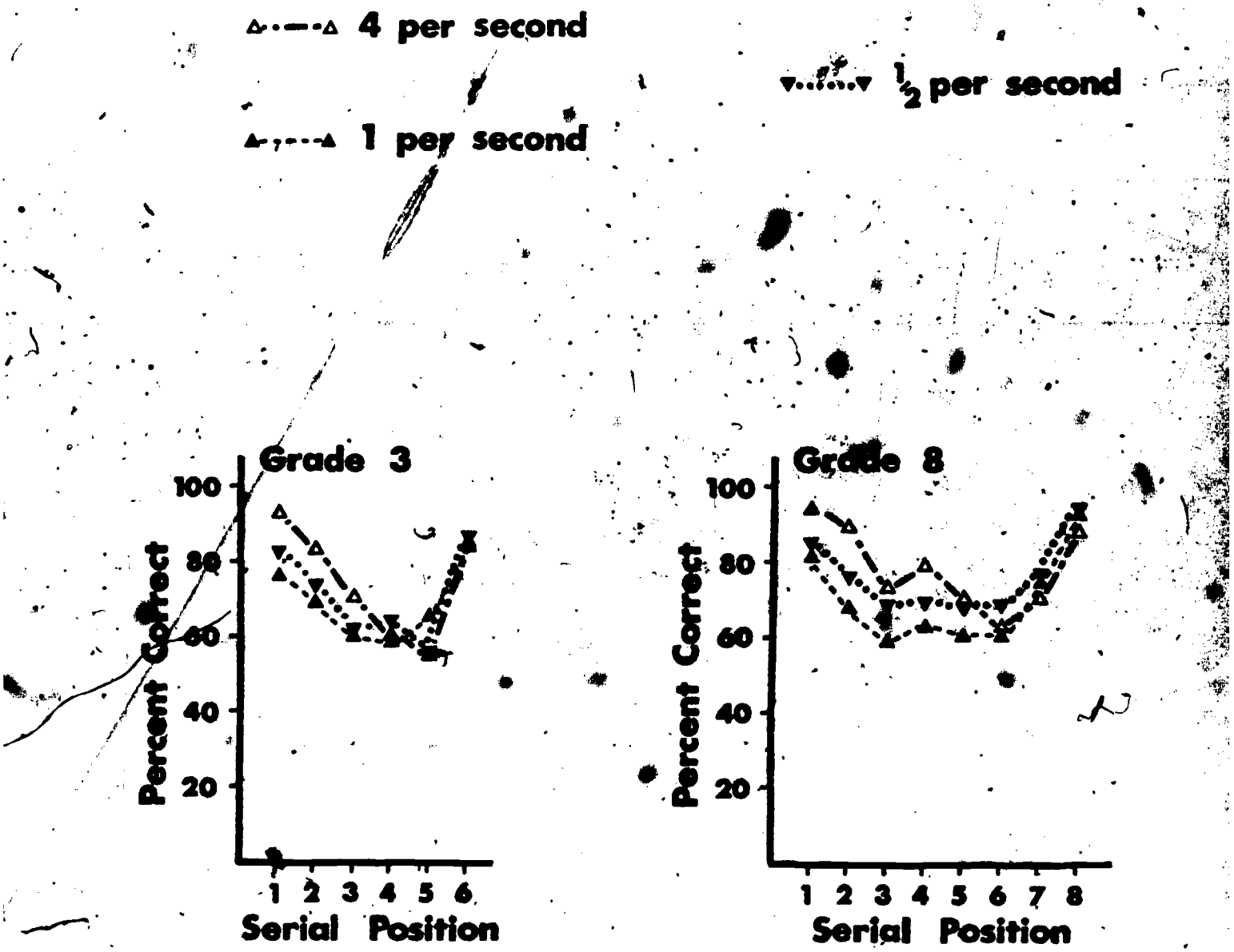
1 2 3 4 5 6 7 8
Serial Position


4 per second
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Grade 3
Grade 8
Percent Correct
100
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1 2 3 4 5 6
1 2 3 4 5 6 7 8
Serial Position

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△----△ 1 per second

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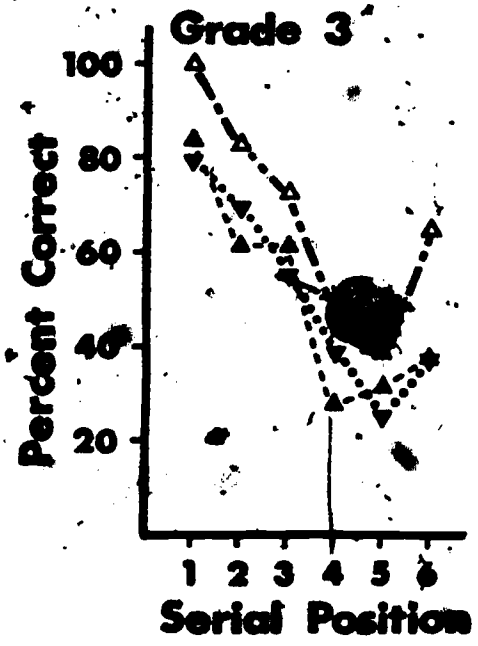

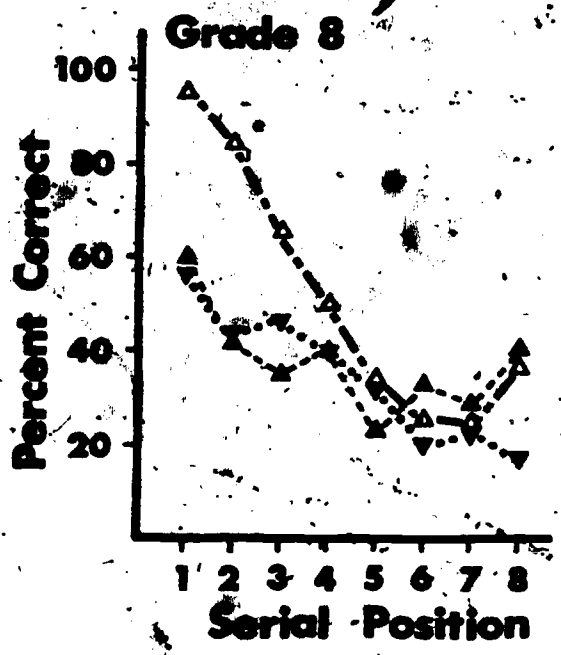

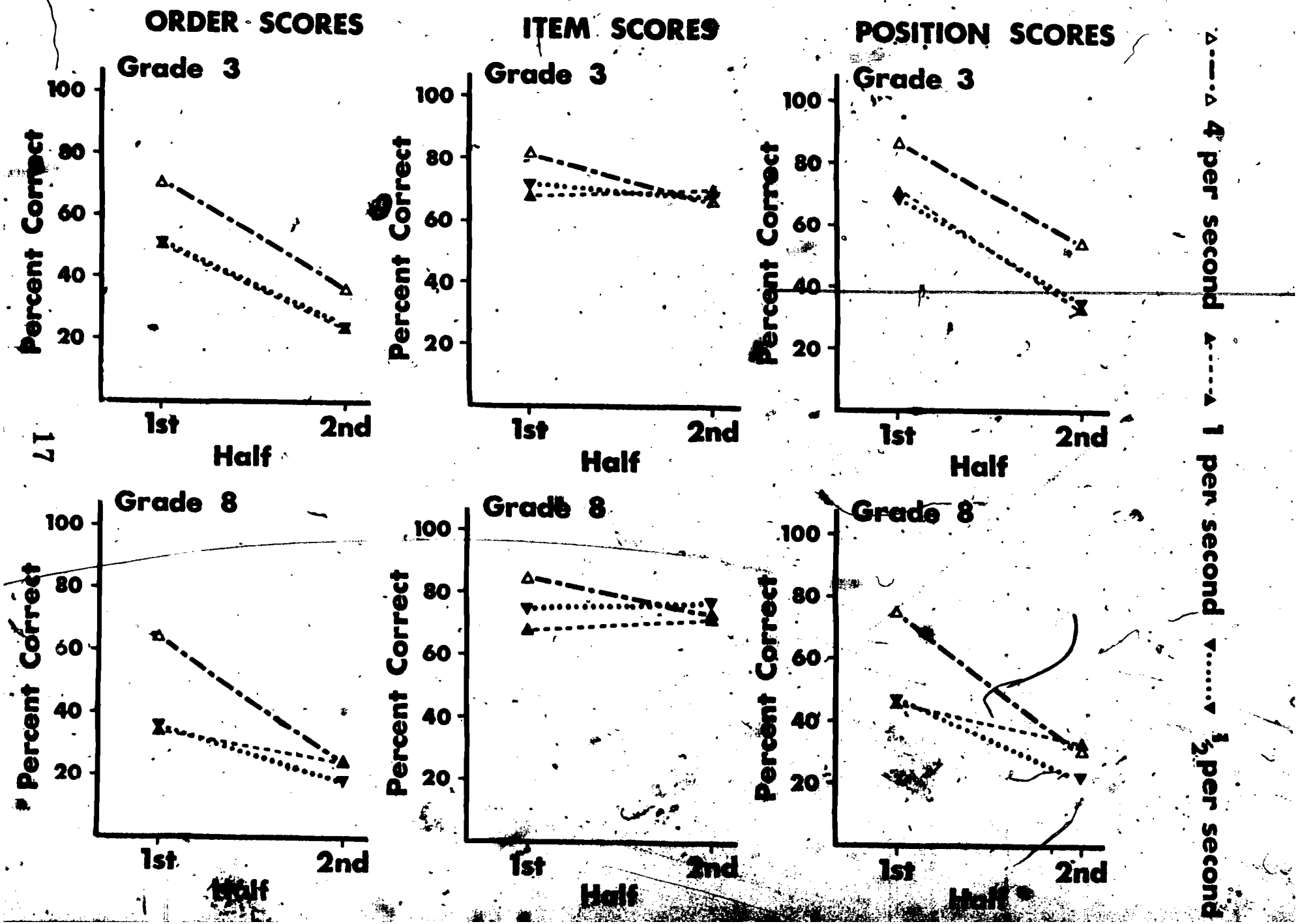
ORDER SCORES
ITEM SCORES
POSITION SCORES
Grade 3
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