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ABSTRACT

Deficits involving metamemory (knowledge about memory) were investigated for elderly individuals in unfamiliar laboratory tasks. In Experiment I, 23 college age subjects and 23 active, community dwelling elderly subjects, roughly matched on socioeconomic status, were given a picture span estimation task, a test of actual span, and then a recall readiness task. In the recall readiness phase, each subject was given subspan (span minus 2), span, and supraspan (span plus 2) lists of pictures and told to take as much time as needed to insure accurate serial recall. The community dwelling elderly individuals were found to recall span and supraspan length lists more poorly than young subjects. The elderly also took considerably less time for study (in the supraspan condition, 30 seconds as opposed to 59 seconds for the young subjects). In Experiment II, prompting a chunking-rehearsal strategy led to somewhat improved performance in the elderly, but merely requiring the elderly to take sufficient time for study led to virtually perfect recall. The data suggest that the older adults were not strategy deficient, but rather may have failed to monitor their readiness to recall so that they did not know how long to study. Since metamemory deficits do appear in laboratory-type tasks, such deficits may, at least in part, account for the frequent poor performance of the elderly in such situations. (Author/JMB)

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# Metamemory in the Aged

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## Abstract

Deficits involving metamemory, knowledge about memory, may appear in the performance of elderly individuals in unfamiliar laboratory tasks even though such deficits are not found in interviews covering more naturalistic situations. In Experiment 1, with unlimited study time on individually established list lengths, community dwelling elderly individuals were found to recall span and supraspan length lists more poorly than young subjects. The elderly also took considerably less time for study (in the supraspan condition, 30 vs. 59 sec for the young subjects). In Experiment 2 prompting a chunking-rehearsal strategy led to somewhat improved performance in the elderly, but merely requiring the elderly to take sufficient time for study led to virtually perfect recall. The data suggest that the older adults were not strategy deficient, but rather may have failed to monitor their readiness to recall so that they did not know how long to study. Since metamemory deficits do appear in laboratory-type tasks, such deficits may, at least part, account for the frequent poor performance of the elderly in such situations.

# Metamemory in the Aged

In a wide variety of situations the elderly have been found to remember more poorly than young adults. While deficits seem small or nonexistent on tasks requiring only primary memory abilities (Craik, 1977), the aged do relatively poorly on almost all laboratory tasks involving secondary memory. Deficiencies have been hypothesized to involve memory storage (e.g., Drachman & Leavitt, 1972) and retrieval (e.g., Anders, Fozard, & Lillyquist, 1972; Reese, 1976). However, it seems increasingly clear that a sharp division between storage and retrieval may not be possible since the processes underlying storage and retrieval probably interact in important ways. Organized storage may make information much more retrievable; on the other hand, with the right retrieval cues, even poorly stored material may be accessible.

Rather than hypothesizing specific storage or retrieval deficits in the aged, more recent theorists (e.g., Reese, 1976) have argued for a general deficit involving the use of memory strategies. It is argued that the aged, like the developmentally young (Brown, 1974, 1975; Flavell, 1970), either fail to produce strategies which could aid remembering, or produce strategies but execute them inefficiently. Support for the strategy deficit notion is provided by Hulicka and Grossman (1967), who found the elderly to report the use of mediators about half as frequently as young adults. In several studies cuing or instructing on the use of mediators has led to improved memory performance in the elderly. For instance, Hultsch (1975) gave older adults sorting instructions and found a large increase in recall accuracy for categorized lists. Thus, the elderly often appear deficient in producing appropriate and effective memory strategies when asked to remember, even though these strategies are helpful if the elderly are induced to use them.

A recent hypothesis to explain similar production deficiencies in children involves the notion of an underlying deficit in metamemory (Flavell & Wellman, 1977; Kreutzer, Leonard, & Flavell, 1975), or what people know about their memory. Available strategies may not be produced or, if produced, then executed inefficiently because of a lack of knowledge about memory capacity limitations, task demands and requirements, memory strategies, or some combination of the three. Memory tasks are thus viewed as problem solving situations involving the whole cognitive system rather than memory alone. The efficient memorizer is seen as analyzing the task in light of his or her abilities and then selecting an appropriate strategy, if one is needed, to optimize performance.

While a good deal of productive research on a wide variety of metamemorial activities has been conducted with children, it has been argued that such research is not fruitful with the elderly. Reese (1976) states that the memory problem of the elderly "...is not in metamemorial processes but in efficient strategies. They have the intention to remember but not all the relevant mnemonic strategies that are required to implement this intention" (p. 196). We would argue, on the other hand, that metamemory involves a great deal more than simply the intention to remember and that the existence of possible metamemory deficits is an empirical issue that cannot be resolved in an a priori way.

Perlmutter (1978) has investigated metamemory in older and younger adult populations. She found no important age differences in either memory knowledge as assessed by questions about naturalistic memory situations, or in memory monitoring which dealt with prediction of performance and confidence ratings in a free recall task. While Perlmutter's findings do not provide support for a metamemory deficit hypothesis, we might expect that metamemory deficits would be more likely in relatively unfamiliar laboratory tasks than in the naturalistic memory tasks she investigated. Further, since developmental differences in children's metamemory have been shown most clearly in serial recall tasks (Yussen, Note 1), Perlmutter's supraspan free recall task may not have been maximally sensitive to possible differences.

In this paper we report the results of two experiments. The first was aimed at isolating possible metamemory deficits in the elderly by comparing their performance to that of college age participants. In the second experiment elderly adults were trained in an effort to ameliorate the deficits found in the first study.

## Experiment 1

In this experiment we investigated metamemory in the elderly using a serial recall task which has been shown to yield large developmental differences with children (Flavell, Friedrichs, & Hoyt, 1970). Both older and younger adults were asked to estimate their span for a set of line drawings, with each subject then given a span test to allow assessment of estimation accuracy. Next, each participant was given lists of items with unlimited study time. The number of items in each memory list was based on the person's actual memory span, with subspan, span length, and supraspan lists given to all subjects. Of interest here was how well people of different ages know when they are ready to recall information. Both amount of time spent in study and accuracy of recall were important measures.

Method

Subjects. Participants in the study were 23 older and 23 younger adult volunteers. The older adults were active and dwelling in the community, and were recruited from local senior citizen's recreation centers. Most had completed at least high school and the sample would be classified as middle or upper middle class in socioeconomic status. The older adult group was composed of one male and 22 females with an average age of 69.1 years (range 60 to 80). The young adults were recruited from undergraduate psychology classes. There were seven males and 16 females with an average age of 20.2 years (range 17 to 29).

Materials. The stimulus pool was composed of 208 7.5 x 9 cm black and white line drawings of common objects sampled from 11 semantically based categories. Lists of from two to ten items were attached to a cardboard backing for simultaneous presentation. Within-list semantic relations were minimized by constructing each list with items from different categories. The order of categories across lists was counterbalanced.

Four sets of lists were constructed so that within a set no items were repeated and across sets there was very little item repetition. During a single phase of the study, lists were chosen from the same set so that interfering effects of item repetition were minimal. When lists of more than ten items were needed, two shorter lists were combined, again insuring that there was no item repetition within a list and minimal overlap between lists. Different subjects saw the stimulus sets in different phases of the study so that stimulus set was not confounded with any of the experimental conditions.

Procedure. Following a pretraining period, there were three main phases in the study. First, subjects estimated their span and were given an actual span test. Second, lists of three different lengths were presented, with unlimited study time, and subjects were asked to indicate when they were ready to recall each list. Following the recall readiness indication, actual recall was obtained. In the third phase of the study, the span estimation and span test were repeated with different stimulus items to see if experience in the study had influenced span estimation accuracy. All subjects were tested individually.

In pretraining the purpose and procedures of the study were explained to all participants. An effort was made to insure that subjects were comfortable, that they could easily see the stimuli, and that they understood the requirements of the serial memory task.

In span estimation each subject was first shown a two-item list and asked "Could you remember this many?" If the subject answered yes a new list was presented containing three items, followed by a four item list, and so on until the subject said there were too many pictures to remember in a given list. Estimated span was the greatest number of pictures the person said that he or she could remember.

The presentation format for the span test was the same as for span estimation. New lists of two, then three, then four, etc. items were shown for a total time of two sec for each item in the list. Serial recall was requested immediately following presentation. If the subject recalled the items correctly, a new list with one more item was presented. If recall was not perfect, a new list with the same number of items was shown. If the subject was correct on this list, the test went on; when a second error was made on a given list length, actual span was determined to be one item less than the length of the last list shown.

Recall readiness followed the span test. Here subjects were given two lists at each of three difficulty levels. List difficulty was roughly matched across subjects within and between age groups by basing the number of items shown to each subject on that subject's span. Each subject received two subspan lists (span minus two items in length), two span length lists, and two supraspan lists (span plus two items) in a counterbalanced order with the restriction that one list at each difficulty level appeared in the first three and last three trials of recall readiness. Instructions were to take as much study time as necessary to insure high recall accuracy and to signal when ready to recall. Following study the subject attempted to recall the items in serial order.

Finally, after recall readiness, the span estimation and span test were repeated using the same procedure as in the beginning of the experiment.

Results and Discussion

For all analyses the alpha level for statistical significance was set at .05. The span and recall readiness data were analyzed separately. The factors in the span analysis were age group (young vs. old), span type (estimated vs. actual), and test phase (before or after recall readiness), with repeated measures on the last two variables. There were main effects in the analysis of variance for age, $F(1,44) = 67.51$, $MS_e = 3.62$, and phase, $F(1,44) = 23.50$, $MS_e = .95$, along with the Age x Phase interaction, $F(1,44) = 5.88$, $MS_e = .95$. The interaction showed a tendency for increases in span with practice, but a greater increase for young (Phase 1 = 6.8, Phase 2 = 7.9) than elderly (Phase 1 = 4.9, Phase 2 = 5.2) adults.

The more interesting data involve span type which interacted strongly with age, $\underline{F}(1,44) = 12.46$, $\underline{MS}_e = 1.90$. The overall accuracy of span estimation was found to be the same for young and old subjects, although, the direction of error was different for the two groups. In general the young adults tended to underestimate their spans (estimated = 7.0, actual = 7.7), while the elderly overestimated (estimated = 5.4, actual = 4.7). This overestimation is somewhat surprising in light of the cautiousness usually attributed to the elderly (Botwinick, 1978).

It should be noted that the average signed difference scores are not ideal for comparing group differences in estimation accuracy since with this measure large overestimates by one subject in a group might compensate for large underestimates by another subject in that group. Therefore an analysis of the unsigned (absolute) differences between estimated and actual spans was conducted. Consistent with the above findings, no age differences were obtained in estimation accuracy, with elderly subjects having an average error of 1.6 items and young an average error of 1.4 items, $\underline{F} < 1.0$. Of course direction of error could not be assessed with this measure.

While estimation accuracy was similar for old and young adults, there was a large difference in actual picture span. Young adults recalled 7.7 items while older adults averaged only about 4.7. These picture span data contrast sharply with the usual failure to find age differences in the standard digit span task.

In the recall readiness phase of the study the two main dependent measures were proportion of items correctly recalled in order and time spent in studying the lists. Since subjects were given two trials on each of the three difficulty levels, an estimate of the effects due to practice was obtained by comparing performance on the first trial at each difficulty level with the second replication at each level. Along with the replication factor the other independent variables in the analysis were age and difficulty level. Age was the only between subject factor.

With the proportion correct data, significant effects were obtained for age, $F(1,44) = 20.44$, $MS_e = .04$, difficulty level, $F(2,88) = 12.43$, $MS_e = .03$, and the Age x Difficulty Level interaction, $F(2,88) = 8.23$, $MS_e = .03$. As shown in Figure 1, there was no difference between age groups for subspan lists, an 11% difference at span, and a 21% difference with the most difficult supraspan lists. Even though the difficulty levels of the task were based on each person's span, large and significant age differences appeared as the task became more difficult.

The other significant effect in the analysis was the interaction of Age and Replication, $F(1,44) = 4.89$, $MS_e = .01$. Accuracy did not change with practice for the young subjects (Replication 1 = 97.4%, Replication 2 = 96.7%), but it did increase for the elderly (Replication 1 = 83.8%, Replication 2 = 88.3%). Thus while the elderly showed some evidence of improvement with practice, they were cl rly less accurate than young subjects in the span and supraspan conditions.

The results of the study time analysis are relevant to an explanation of the age differences found in recall. Significant effects were found for age, $F(1,44) = 33.43$, $MS_e = 797$, difficulty level, $F(2,88) = 183.42$, $MS_e = 158$, replication, $F(1,44) = 5.52$, $MS_e = 45.0$ (study time decreased by two sec per list from the first to the second replication), and the Age x Difficulty Level interaction, $F(2,88) = 14.43$, $MS_e = 158$.

Both young and elderly adults increased their study time in response to increasing length of the study list. Surprisingly, however, as shown in Table 1 older subjects spent less time in study than did young subjects, and more importantly, they increased their study time less in response to increasing task difficulty than did the younger subjects. The study time difference between young and old was less than ten sec for subspan lists; it was almost half a minute for supraspan lists. Thus the young subjects not only studied longer than did the elderly, they were also better at adjusting their study times in accord with problem difficulty.

The finding of less study time and poorer recall in the elderly are clearly related, but might be due to one of several causal mechanisms, as will be discussed in Experiment 2. It is clear in Experiment 1 that the elderly performed more poorly than young subjects in two ways. First, their actual spans were considerably less than younger adults' spans, although accuracy of span estimation was not different in the two groups. Second, while no metamemory differences were found in span estimation accuracy, there did seem to be a metamemory deficit in recall readiness. Older subjects chose to study for less time, and clearly recalled more poorly. Further, in both study time used for recall readiness and span estimation the elderly appear less cautious than do younger adults. In Experiment 2 a training approach was adopted to get at the locus of the age differences in recall readiness.

## Experiment 2

There are several possibilities which might explain the age differences in recall readiness. Each was addressed by a different group in Experiment 2. First, the older, but not the younger adults, may have misunderstood our instructions emphasizing accuracy so that they may have tried to study the pictures too quickly. To test the possibility that the elderly may have misunderstood the instructions on the speed-accuracy trade off, a group of older adults was given modified instructions greatly emphasizing accuracy. It was very carefully explained that as much time as needed should be taken so as to insure high levels of accuracy.

A second possible explanation for the lower study time and accuracy of the elderly in Experiment 1 entails a memory strategy deficit. Accuracy in the elderly may have been poor, not because of a failure to understand the instructions, but because the elderly did not have effective memory strategies available or because they failed to systematically use effective memory strategies. If this strategy deficiency notion were correct, lower study time would be expected, as without appropriate strategies extra study would have little utility. To test the strategy deficit notion, a group of subjects was instructed to systematically use an efficient serial memory strategy, chunking and rehearsal.

The final possibility investigated was that the elderly neither misunderstood the instructions nor failed in the use of strategies. Instead, it is possible that they simply failed to take the time needed in study, possibly because of some type of metamemory failure. If the metamemory deficiency notion is correct, simply requiring a group of older adults to take sufficient time in study should lead them to perform accurately.

In this study then, an instructional-training approach was used with elderly subjects to investigate the locus of the age differences found in Experiment 1.

Method

Subjects. The elderly participants in this study were recruited in the same manner as in Experiment 1 and were similar in SES and educational background. There were 36 subjects in the study, 12 in each of three groups. The four male volunteers were assigned so that there was at least one male in each group. The 32 females were assigned to groups randomly. The mean age of the sample was 68.9 years (range 60 to 85 years) and the average ages of subjects in the three groups were very similar (ranging from 68.8 years to 69.6 years).

Materials. The stimuli were the same as those used in Experiment 1.

Procedure. Subjects were given the same pretraining as in Experiment 1 followed by an actual span test. In order to save time for training, subjects were not asked to estimate their spans.

The three groups differed in the instructions received prior to the recall readiness task. Subjects in the instruction control group were told to try to remember all of the items in order, with an emphasis on taking as much time as needed to do so. A clear priority was placed on accuracy. The subjects were then given two span length practice trials followed by the recall readiness task.

Subjects in the strategy training group were given the same instructions emphasizing accuracy and were also told that a particular strategy, chunking and rehearsal, should greatly help in remembering the pictures. The strategy of chunking list items into contiguous groups of three and then rehearsing items in the same group together was carefully explained and two practice trials were administered. Following the second practice trial, the subject was asked to explain the strategy. All subjects were able to do so and were then reminded to use the strategy during the recall readiness task.

Subjects in the forced time group were also given the expanded accuracy instructions and in addition were told that a certain minimum amount of study time was needed for the task and that the experimenter would indicate when they had studied for that amount of time. The subjects were then told to signal when ready to recall. Minimum study times were chosen to be the same as the average times taken by young subjects in Experiment 1 for the corresponding difficulty level condition. For subspan, span, and supraspan conditions subjects thus studied for at least 14, 32, and 59 sec, respectively.

The recall readiness task was the same as that used in Experiment 1 except that there were three replications at each difficulty level. Again difficulty was roughly equated across subjects by calibrating the number of items in the memory lists to each individual's actual span.

Results

The actual spans for subjects in the instructional control (4.6), strategy training (4.8), and forced time (4.9) groups did not differ significantly from each other or from the elderly group's mean in Experiment 1. The data of most interest involve recall accuracy for the three groups. Factors in the analysis of variance were training group, difficulty level, and replication with repeated measures on the latter two variables. The significant effects were due to training group, $F(2,33) = 10.70$, $MS_e = .03$, difficulty level, $F(2,66) = 28.25$, $MS_e = .02$, and the Training Group x Difficulty Level interaction, $F(4,66) = 3.90$, $MS_e = .02$. Post hoc Newman

Keuls tests showed that the strategy trained group (91.7%) recalled at a higher level than the instructional control group (86.7%). Somewhat surprisingly, the forced time group (97.5%) was significantly more accurate than the strategy training group.

Several aspects of the Training Group x Difficulty Level interaction, shown in Figure 2, are worth noting. First, the means for the instructional control group are virtually identical to those for the older subjects in Experiment 1. We have no indication, then, that the relatively poor recall of the elderly in the first study was due to their misunderstanding the instructions. Second, the interaction clearly shows the difference among groups to increase with increasing difficulty level. There were no group differences with the subspan list lengths; with span length lists the forced time vs. control difference was about 11%; and with supra-span lists this difference was about 19%. Forced time and strategy training helped most on the most difficult list lengths. Finally, performance of the forced time elderly subjects in Experiment 2 can be compared to that of the young subjects in Experiment 1. Accuracy for the two groups was very similar and, if anything, the elderly group's means were slightly (but nonsignificantly) higher than those of the young adults. Therefore, when task difficulty is equated for younger and older adults by basing list length on span, differences in recall readiness accuracy can be eliminated, simply by insuring that the elderly take enough time in studying the items.

The actual study times for the three groups are shown in Table 1. The patterns of times for the forced time and instructional control groups are similar to those of the younger and older adults in Experiment 1, respectively.

Study times did appear slightly longer in the second experiment, especially for the forced time group with supraspan list. For all three difficulty levels the study times of the strategy trained subjects fell in between those of the other two groups.

## General Discussion

In Experiment 1 clear age differences in recall readiness were found between older and younger adults, especially on the more difficult supraspan and span length lists. In Experiment 2, while very careful instructions on speed-accuracy trade offs did not improve accuracy in the elderly, simply requiring them to take at least as much time in study as did the young adults led to virtually perfect performance. Even training on the task relevant strategy of chunking and rehearsal was less effective than the forced time manipulation. It appears, then, that the elderly did understand the instructions and that they can access appropriate strategies to deal with the task if they take the time to do so.

The failure to allocate sufficient time in study could be due to one of several factors. One possible explanation might be that the elderly are less motivated in this somewhat artificial task than are young adults. The motivation argument does not seem persuasive, however. First, a good deal of time was spent in generating good rapport with the elderly adults. As a result, from all appearances at least, they appeared to be highly motivated. Also, several aspects of the data do not fit with a motivation explanation. If low motivation led to inattention to the stimuli on some trials, performance should have been poorer for the elderly in all task conditions, not just those involving longer lists. Further, if the elderly were not motivated, requiring them to study longer in the forced time condition might well have led them to treat the last part of the study period as a retention interval. Poorer rather than better performance would then have resulted from this manipulation.

A more likely explanation for the failure to study for a long enough period involves a specific aspect of metamemory, memory monitoring. Brown and Barclay (1976) and Flavell (1977) have hypothesized that a deficit in monitoring may underly some of the developmental differences in memory for both normal and retarded children. Similarly if the elderly were not monitoring the state of their own memories (possibly by self testing) in our recall readiness task, they wouldn't know when they could recall accurately. Tentatively, we would hypothesize that a major difference between older and younger adults may have involved monitoring readiness to recall.

While direct training on monitoring would be useful given our findings, it was not attempted in Experiment 2 because of a concern that direct instructions on monitoring might also serve to cue memory strategies such as rehearsal. In that experiment we wanted separate tests of the strategy deficiency and memory monitoring hypotheses. In any case monitoring the state of information in one's memory is clearly important in recall readiness performance and likely in many other situations as well.

One explanation which cannot account for the obtained memory deficit in the elderly is the notion that they are more cautious than young adults (cf. Botwinick, 1978). In recall readiness the older adults were willing to risk recall after studying for less time than young adults. In span estimation it was the college students who were more conservative with the elderly overestimating their spans. While we would not want to argue that cautiousness does not often characterize the performance of the elderly, it does seem that cautiousness is, at least to some degree, situation specific and might not be best viewed as a pervasive and important general trait of the elderly.

Two questions are left unanswered in our research. First, while the forced time manipulation led older adults to perform at the same level as young adults in recall readiness, a dramatic improvement, the younger and older adults still differed in span length. While differences as large as three items are not found on standard forward digit span tasks, Taub (1972) has found larger age differences in digit span with visual than auditory presentation. In agreement with Taub (1972) we suspect the deficit involves at least in part the processes of decoding the visual stimulus items and generating their names. Explicating the nature of the span difference was not a focus of this research, and we can provide no definite answers here.

The second unanswered question involves the reason for improvement in the strategy training group in Experiment 2. The obvious explanation is that the elderly may have been to some degree strategy inefficient so that training led to more systematic strategy execution. However, as well as following the instructions to execute the chunking-rehearsal strategy, the trained subjects also studied longer than control subjects. It is possible that the strategy instructions subtly induced the elderly to study longer and the extra time interacting with the stimulus materials, independent of strategy, may have led to the improvement in performance.

Overall, with a serial recall task we demonstrated a metamemory deficit in the elderly. The hypothesized deficit in memory monitoring could contribute importantly to other memory deficits in the elderly, both in laboratory tasks and possibly in nonlaboratory situations as well. Further work might profitably (a) directly train monitoring skills in the elderly (as opposed to our rather indirect forced time procedure), and (b) investigate other possible metamemory deficits in a wide variety of tasks, including for instance, recall for prose as well as the more standard laboratory tasks. As Perlmutter's (1978) data have shown, we should not expect universal metamemory deficits in the elderly, as such deficits did not appear in her supraspan free recall results. Similarly we found no age differences in accuracy of span estimation. Nevertheless, the important contribution of metamemory was clearly demonstrated here, and may well be found in other situations.

## Reference Note

1. Yussen, S. R. How much can I remember?: A review of available developmental studies. Paper presented at the Biennial Meeting of the Society for Research in Child Development, San Francisco, March 1979.

## References

Anders, T. R., Fozard, J. L., & Lillyquist, T. D. The effects of age upon retrieval from short-term memory. Developmental Psychology, 1972, 6, 214-217.

Botwinick, J. Aging and behavior (2nd ed.). New York: Springer, 1978.

Brown, A. L. The role of strategic behavior in retardate memory. In N. R. Ellis (Ed.), International review of research in mental retardation (Vol. 7). New York: Academic Press, 1974.

Brown, A. L. The development of memory: Knowing, knowing about knowing, and knowing how to know. In H. W. Reese (Ed.), Advances in child development and behavior (Vol. 10). New York: Academic Press, 1975.

Brown, A. L., & Barclay, C. R. The effects of training specific mnemonics on the metamnemonic efficiency of retarded children. Child Development, 1976, 47, 71-80.

Craik, F. I. M. Age differences in human memory. In J. E. Birren & K. W. Schaie (Eds.), Handbook of the psychology of aging. New York: Van Nostrand Reinhold, 1977.

Drachman, D., & Leavitt, J. Memory impairment in the aged: Storage versus retrieval deficit. Journal of Experimental Psychology, 1972, 93, 302-308.

Flavell, J. H. Developmental studies of mediated memory. In H. W. Reese & L. P. Lipsitt (Eds.), Advances in child development and behavior (Vol. 5). New York: Academic Press, 1970.

Flavell, J. H. Cognitive development. Englewood Cliffs, N. J.: Prentice Hall, 1977.

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

Flavell, J. H., & Wellman, H. M. Metamemory. In R. V. Kail, Jr. & J. W. Hagen (Eds.), Perspectives on the development of memory and cognition. Hillsdale, N. J.: Lawrence Erlbaum Associates, 1977.

Hulicka, I. M., & Grossman, J. D. Age-group comparisons for the use of mediators in paired-associate learning. Journal of Gerontology, 1967, 22, 46-51.

Hultsch, D. F. Adult age differences in retrieval: Trace-dependent and cue-dependent forgetting. Developmental Psychology, 1975, 11, 197-201.

Kreutzer, M. A., Leonard, C., & Flavell, J. H. An interview study of children's knowledge about memory. Monographs of the Society for Research in Child Development, 1975, 40 (1, Serial No. 159).

Perlmutter, M. What is memory aging the aging of? Developmental Psychology, 1978, 14, 330-345.

Reese, H. W. The development of memory: Life-span perspectives. In H. W. Reese (Ed.), Advances in child development and behavior (Vol. 11). New York: Academic Press, 1976.

Taub, H. A. A comparison of young adult and old groups on various digit span tasks. Developmental Psychology, 1972, 6, 60-65.

## Footnote

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Table 1

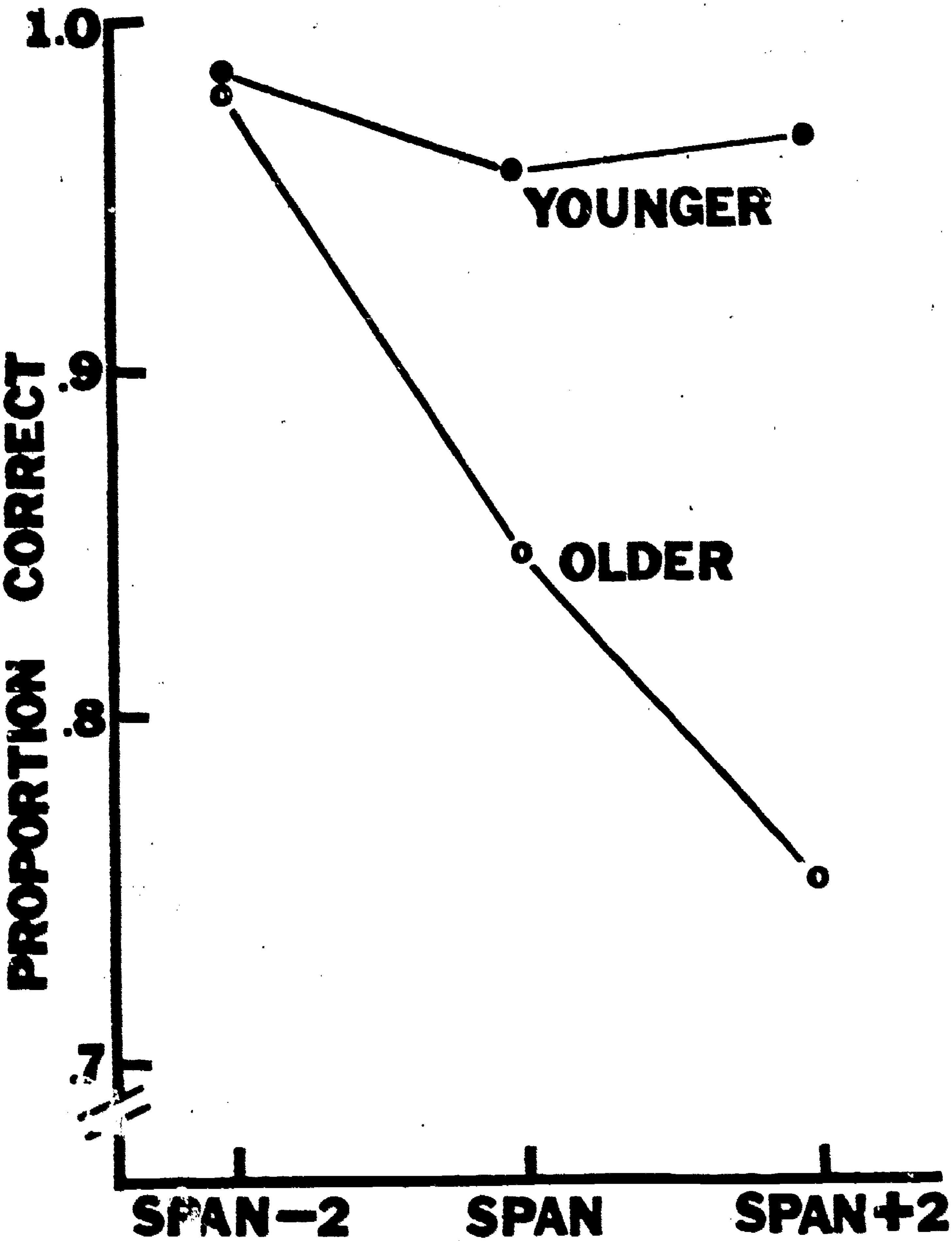
Study Time (in sec) in Experiment 1 and Experiment 2 as a Function of Group and Difficulty Level

| | Recall Readiness Difficulty Level | | |
|---|---|---|---|
| **Experiment 1** | | | |
| Age Group | Span - 2 | Span | Span + 2 |
| Young Adult | 14.4 | 32.0 | 59.2 |
| Older Adult | 4.9 | 11.8 | 30.0 |
| **Experiment 2** | | | |
| Training Group | | | |
| Forced Time | 16.6 | 39.2 | 73.9 |
| Strategy Trained | 8.3 | 23.4 | 45.0 |
| Instructional Control | 6.5 | 14.8 | 34.0 |

## Figure Captions

Figure 1. Recall readiness accuracy for older and younger adults as a function of difficulty level in Experiment 1.

Figure 2. Recall readiness accuracy for older adults as a function of training and difficulty level in Experiment 2.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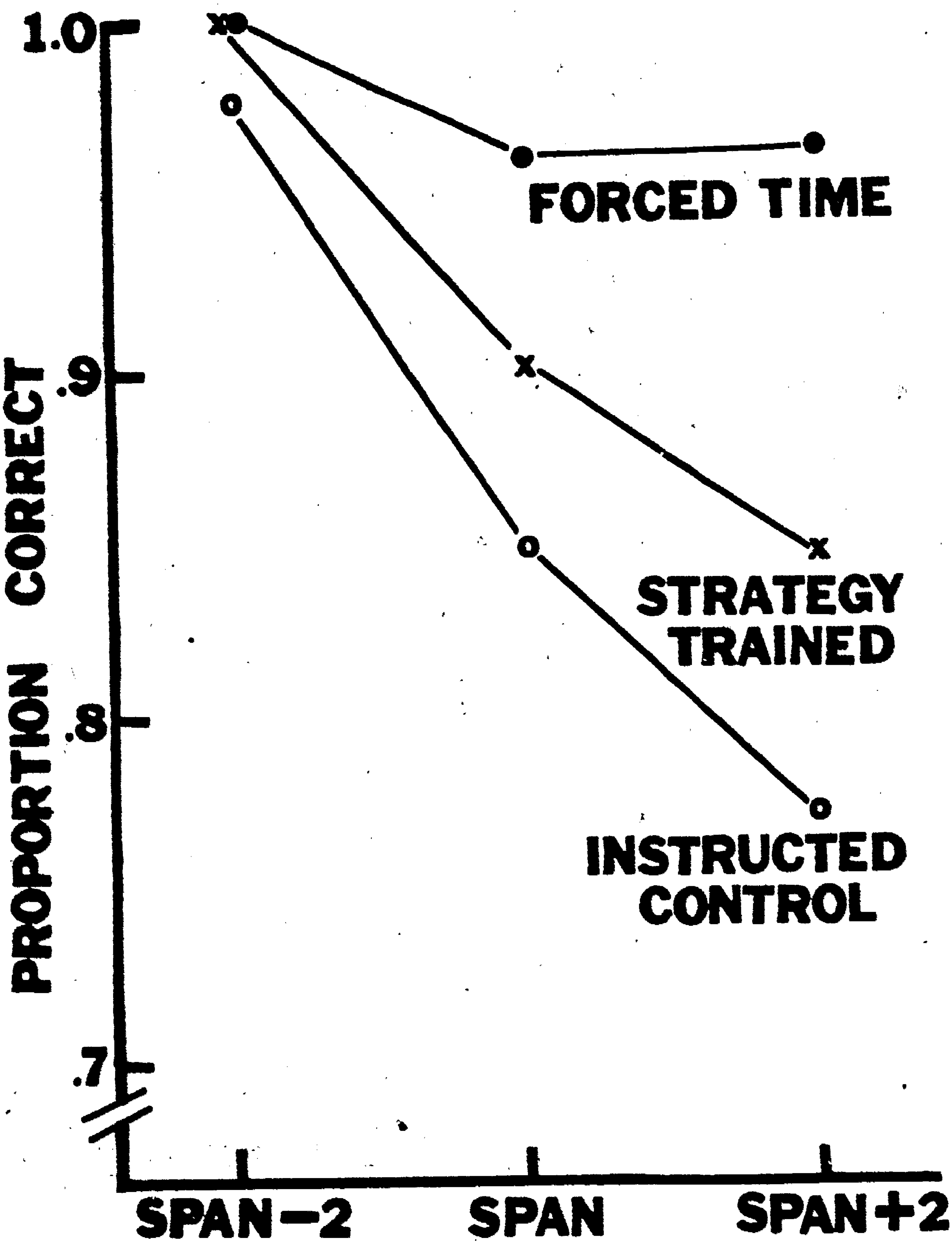
.9
.8
.7
PROPORTION CORRECT
YOUNGER
OLDER
SPAN−2
SPAN
SPAN+2


1.0
.9
.8
.7
PROPORTION CORRECT
FORCED TIME
STRATEGY TRAINED
INSTRUCTED CONTROL
SPAN-2
SPAN
SPAN+2