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ABSTRACT

Previous studies of the effect of age and modality on digit span task performance have yielded inconsistent results. To eliminate some of the methodological difficulties in prior research, 18 college students and 18 older adults were given the digit span task by means of three different modalities: (1) visual successive; (2) visual simultaneous; and (3) controlled auditory. A memory drum and a cassette tape recorder were used. Three different sets of digit series pairs, ranging in length from 3 to 12, were randomly generated for use in all three modalities. Results indicated a significant main effect of modality, with the visual simultaneous condition yielding the highest scores. A significant age by modality interaction revealed that age differences were significant for the visual successive and the auditory conditions, but not for the visual simultaneous condition. The findings suggest that much of the previous confusion may be due to an inconsistent methodology. (Author/JAC)

The Effects of Age and Modality on Digit Span Performance

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Abstract

Previous studies of the effect of age and modality on digit span task performance have yielded inconsistent results. In this study, 18 young and 18 old subjects were given the digit span task by means of three different modalities: visual successive, visual simultaneous, and controlled auditory. There was a significant main effect of modality, with the visual simultaneous condition yielding the highest scores. A significant age by modality interaction revealed that age differences were significant for the visual successive and the auditory conditions, but not for the visual simultaneous condition. It is suggested that much of the previous confusion may be due to an inconsistent methodology in digit span research.

The Effects of Age and Modality on Digit Span Performance

It is generally assumed that performance on a digit span task is primarily a function of primary memory, but includes a secondary memory component. To the extent that memory span reflects secondary memory ability, there should be a small decrement with age (Craik, 1977). It has recently been suggested that digit span performance may simply reflect ability to retain information about the order of a sequence rather than the capacity of memory stores (Martin, 1978), or that the memory span reflects a general storage ability (Parkinson, Lindholm, & Inman, 1982). The results of studies which have examined age differences in memory span have been quite mixed, with some researchers reporting significant age differences (McGhie, Chapman, & Lawson, 1965; Parkinson, Lindholm, & Inman, 1982; Taub, 1975), but others reporting very slight or no differences (Botwinick & Storandt, 1974; Bromley, 1958; Craik, 1968; Gilbert, 1941; Talland, 1968).

The digit span task may be presented either visually or auditorily. Although generally the research indicates that an auditory presentation provides for a larger memory span than a visual presentation, several studies (Botwinick & Storandt, 1974; Gilbert, 1941) have reported that subjects perform better when there is a visual presentation of digits. Some studies (Arenberg, 1968; McGhie et al., 1965; Taub, 1972) have found an interaction between age and modality such that the older subjects benefited disproportionately from an auditory presentation. Other researchers have been unable to find such an interaction (Botwinick & Storandt, 1974; Craik, 1968; Talland, 1968; Taub, 1975).

Part of the reason for the confusion in this research area may be due to a lack of experimental control. In most studies involving an auditory presentation condition, the digits have been read aloud by the experimenter.

Taub (1972) made use of previously tape recorded digits in one part of his study. He found that scores on the controlled auditory presentation were not the same as the scores on the traditional forward span verbal presentation for the younger subjects, although there was no difference among the older subjects. This discrepancy between the two manners of presenting the auditory digit span task may help to explain why an interaction between age and modality is found in some studies but not in others. When Taub controlled the auditory presentation by means of a tape recorder, he was unable to find an age by modality interaction, although in the same series of experiments he had previously found an interaction when the auditory condition consisted of the experimenter reading the digits out loud.

The often cited study by Botwinick and Storandt (1974) not only used an uncontrolled auditory condition, but also made use of a very unusual method of presenting the visual information. Instead of presenting the digits sequentially, as on a memory drum, Botwinick and Storandt presented each series of digits simultaneously, on a card. This procedure does not appear to be equivalent to the usual successive presentation.

It was the purpose of the present study to try to eliminate some of the methodological difficulties found in prior studies of the effect of age and modality on digit span task performance. In addition to a controlled auditory presentation and the traditional visual presentation via a memory drum, a third condition was used. In this condition, digits were presented on a memory drum, but they appeared all at the same time. This is roughly equivalent to the method used by Botwinick and Storandt (1974), and was included in order to test the hypothesis that a sequential and a simultaneous visual presentation are not really equivalent.

Method

Subjects

The younger group consisted of 18 students between the ages of 18 and 30 who were enrolled at a regional campus of a large midwestern university. The mean age was 19.6 and the mean education level was 12.9 years. The older group was composed of eighteen 61 to 75 year olds who were participating in an Elderhostel program. For this group, the mean age was 67.7, and the mean education level was 14.8 years. All research participants were volunteers.

Apparatus

Digits were presented by means of a memory drum and a cassette tape recorder. Three different sets of digit series pairs ranging in length from 3 to 12 were randomly generated for use in all three modalities. The digits never appeared in numerical order and until the digit sequence exceeded ten, no digit was repeated within a sequence.

Procedure

Upon arrival at the laboratory, subjects were questioned as to age, level of education and state of general health. Prior to each experimental condition, instructions were read to the subjects. Each subject was tested in all three modality conditions.

For the visual successive condition, digits were presented at the rate of one per second in the window of the memory drum. After it was ascertained that the subject was able to perceive the stimulus figures, two different series of three digits were presented to the subject. If one or both of the digit strings were correctly recalled, two series of four digits were presented. This procedure was repeated until a series length was reached for which the subject could not recall all digits in correct order for either of the two sequences. The sequence length prior to this last series was

considered to be the subject's memory span.

In the visual simultaneous condition, the procedure was identical except that all of the digits within a given series were presented to the subject at the same time through the window of the memory drum. The digit series remained exposed for one second per digit.

In the auditory condition, the procedure was exactly the same as in the other two conditions except for the fact that the digits were presented verbally, by means of a tape recorder, at the rate of one digit per second.

The order of presentation for each modality condition was completely counterbalanced across subjects. Each of the three different sets of digits was paired with each modality an equal number of times and appeared in each order an equal number of times.

Results

The mean scores on the digit span task for the young group were 6.21 for the visual successive condition, 7.88 for the visual simultaneous condition,and 5.94 for the auditory condition. For the old group, the average scores were 5.56 for the visual successive condition, 8.22 for the visual simultaneous condition, and 5.00 for the auditory condition.

A 2 x 3 repeated measures analysis of variance indicated a significant main effect of modality (F (2, 68) = 91.12, $p < .01$) and a significant age by modality interaction (F (2, 68) = 5.36, $p < .01$), but no significant main effect of age (F (1, 34) = 2.87, $p > .05$). An analysis of simple main effects indicated that age had a significant effect on performance in the visual successive condition (F (1, 34) = 5.80, $p < .05$) and the auditory condition (F (1, 34) = 6.37, $p < .05$), but not in the visual simultaneous condition (F (1, 34) = .79, $p > .05$).

Planned comparisons revealed that the subjects' scores for the visual

simultaneous presentation were significantly different than scores on both the visual successive condition (t (70) = 8.68, $p < .01$) and the auditory condition (t (70) = 8.93, $p < .01$). Scores for the auditory condition were not significantly different from scores for the visual successive condition, however (t (70) = 1.62, $p > .05$).

Discussion

In this study a significant age difference was found when the traditional modes of presenting the digit span task were used (visual successive and auditory conditions). Although an age by modality interaction was found, it did not take the form found previously in that the older people did not benefit disproportionately from the auditory presentation. In fact, neither age group showed an advantage during the auditory presentation condition. Perhaps this was due to the use of a controlled auditory presentation. It is very difficult to read digits out loud at the rate of one per second, and it is possible that some experimenters who have used this technique have actually presented the digits at a rate that was somewhat slower than the rate at which the visual digits were presented. It may even be possible that the rate of presentation was slowed slightly for the older subjects. Continued use of pre-recorded digit presentations may well eliminate the discrepancy in results with regards to the presence or absence of an age by modality interaction.

The most clear-cut finding was that a simultaneous presentation of digits is not equivalent to a successive presentation or to an auditory presentation. The performance on the visual simultaneous task is markedly better than in the other two conditions. Apparently the task of remembering the order of digits becomes much easier if the digits are presented all at once. Although the amount of time the digits were exposed was equated for

all three conditions, it is likely that in the visual simultaneous condition, subjects concentrated on each digit for more that one second, since they were able to see more than one digit at the same time. It is also likely that chunking was easier with this type of presentation. Why the extra rehearsal time and the facilitation of chunking would have eliminated any age differential is a question that will have to be answered by further research.

The means obtained for the visual simultaneous condition were higher than those obtained by Botwinick and Storandt (1974) at least in part because Botwinick and Storandt only presented a maximum of eight digits to their subjects. Several of our subjects were able to retain up to 11 digits in this condition, making for very different results than would have been obtained if a ceiling of eight had been used.

The visual simultaneous condition in this study and in the study by Botwinick and Storandt likely corresponds to the prose condition in Taub's (1975) study. When subjects were required to retain visually and auditorily presented recipes, the visual presentation yielded higher scores. Taub's conclusion that the effect of modality depends on the type of presentation used and the requirements of the task is obviously applicable to the present study. A task as conceptually simple as the digit span test may nonetheless be presented in a variety of ways, some of which may not actually be measuring immediate memory span. Clearly, a further exploration of the effects of age and modality of presentation on digit span performance is necessary.

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