



**BRAZILIAN JOURNAL**  
OF MEDICAL AND BIOLOGICAL RESEARCH

www.bjournal.com.br

ISSN 0100-879X  
Volume 42 (10) 870-992 October 2009

BIOMEDICAL SCIENCES  
AND  
CLINICAL INVESTIGATION

Braz J Med Biol Res, October 2009, Volume 42(10) 988-992

## Cognitive performance of young and elderly subjects on the free word recall memory test: effect of presentation order on recall order

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The Brazilian Journal of Medical and Biological Research is partially financed by



Ministério  
da Ciência e Tecnologia



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# Cognitive performance of young and elderly subjects on the free word recall memory test: effect of presentation order on recall order

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## Abstract

The influence of aging on memory has been extensively studied, but the importance of short-term memory and recall sequence has not. The objective of the current study was to examine the recall order of words presented on lists and to determine if age affects recall sequence. Physically and psychologically healthy male subjects were divided into two groups according to age, i.e., 23 young subjects (20 to 30 years) and 50 elderly subjects (60 to 70 years) submitted to the Wechsler Adult Intelligence Scale-Revised and the free word recall test. The order of word presentation significantly affected the 3rd and 4th words recalled ( $P < 0.01$ ;  $F = 14.6$ ). In addition, there was interaction between the presentation order and the type of list presented ( $P < 0.05$ ;  $F = 9.7$ ). Also, both groups recalled the last words presented from each list (words 13-15) significantly more times 3rd and 4th than words presented in all remaining positions ( $P < 0.01$ ). The order of word presentation also significantly affected the 5th and 6th words recalled ( $P = 0.05$ ;  $F = 7.5$ ) and there was a significant interaction between the order of presentation and the type of list presented ( $P < 0.01$ ;  $F = 20.8$ ). The more developed the cognitive functions, resulting mainly from formal education, the greater the cognitive reserve, helping to minimize the effects of aging on the long-term memory (episodic declarative).

Key words: Recall order; Aging; Memory; Presentation order

## Introduction

The influence of age on cognitive performance has been described (1,2). Although there is general agreement that cognitive deficits are commonly found in the aged (3), the rate of cognitive decline is not uniform for different cognitive abilities (2,3). Some functions appear to be more resistant to the aging process, while others decline more quickly (3). Memory dysfunction predominates among the more common complaints of cognitive decline in the aged (1,4).

The influence of aging on memory has been extensively studied and the role of short-term memory in stimulus recall sequence has been thoroughly examined, although its importance has not been emphasized (2,4).

Some studies have indicated the occurrence of episodic memory deficit in the aged and some have speculated as to the possible cause (5-8). For example, some studies have sought to relate episodic memory deficit to defective semantic processing, and others have examined whether altered working memory may be a factor that disrupts epi-

sodic memory (9,10). One factor that may be responsible for working memory deficit is reduced speed of information processing (11).

In the present study, we sought to identify the recall order of words presented on lists, and to determine if age affects sequence recall.

## Subjects and Methods

### Subjects

Male subjects were divided into two groups according to age. The young group consisted of 23 subjects aged 20 to 30 years and the elderly group consisted of 50 subjects aged 60 to 70 years. Within groups, subjects were classified according to years of education. All subjects were physically and psychologically healthy, as determined by physical examination and a minimum score of 24 on the Mini Mental State Exam (MMSE; Table 1) (12). The study was

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Research supported by Associação Fundo de Incentivo à Psicofarmacologia (AFIP).

Received September 12, 2008. Accepted July 31, 2009. Available online September 28, 2009.

approved by the Medical Ethics Committee of São Paulo Hospital, Federal University of São Paulo, and all subjects gave written informed consent to participate.

### Neuropsychological tests

The Wechsler Adult Intelligence Scale - Revised (WAIS-R; Psychological Corporation, San Antonio, TX, USA), which eliminates the age influence factor, was used to measure the IQ of each subject (Table 1) (13,14).

### Free Word Recall Test

This test evaluates episodic declarative memory and provides evidence of short- and long-term memory function independent of the central executive processes related to the capacity to integrate information. In this test, 12 lists numbered 1 to 12 containing 15 words each were presented. For the even-numbered lists, positions 7, 8, and 9 contained semantically related words (e.g., fire, firemen). After the examiner slowly presented the list, the individuals wrote as many words as they could remember from it.

The presentation order of stimulus words influences recall, causing an increase or decrease in the probability of recall according to the position of the word on the list. Therefore, a U-shaped curve according to serial position is expected in which the two extremes of the curve represent the primacy effect and recency effect related to short-term memory, respectively. The middle portion of the curve reflects long-term memory. The use of semantically related words in the middle positions of the even-numbered lists alters the shape of the serial position curve, increasing the probability of recalling centrally positioned words (15; test adapted to Portuguese language by O.F.A. Bueno at the Psychology Department, UNIFESP/EPM).

### Statistical analysis

The Student *t*-test was used to determine significant differences between the young and elderly groups in recall probability on the word recall test. Repeated measure ANOVA was used to analyze difference in order of word

recall relative to the order of word presentation (using groups of three words), followed by the Tukey HSD *post hoc* test when necessary. One-way MANOVA followed by the Duncan test when necessary was used to study the effect of presentation order on recall order. The level of significance was corrected with a Bonferroni's correction according to the number of comparisons. The Pearson correlation test was used to calculate the correlation between presentation order and recall order in each group separately.

## Results

Figure 1 shows the Serial Position Curve for young and elderly subjects in the free word recall test. The young group recalled significantly more words than the elderly group from various positions on both types of lists ( $P < 0.05$ ), except for the 1st and 2nd words of the semantically related lists ( $P > 0.05$ ). Analysis of performance of the two groups regarding the types of lists showed that significantly more words were recalled from lists containing semantically related words ( $P < 0.01$ ). Significantly fewer words from these lists were recalled from the initial position downward (3.52 fewer for the young group and 2.24 fewer for the elderly group;  $P < 0.01$ ). For the semantically related lists, elderly subjects recalled significantly fewer initially presented words than young subjects ( $P < 0.01$ ).

Because there was no significant difference between the 1st and 2nd words recalled or between the 3rd, 4th, 5th, and 6th words recalled, the results of recall order were pooled. For the 1st and 2nd words recalled there was a significant difference in the order of word presentation ( $P < 0.01$ ;  $F = 23.4$ ). There was also a significant interaction between order of presentation and type of list ( $P < 0.01$ ;  $F = 11.1$ ). In addition, the final three words presented (words 13, 14, and 15) were recalled more often than all other words on the list by both groups, reflecting the recency effect ( $P < 0.01$ ).

The order of word presentation significantly affected the 3rd and 4th words recalled ( $P < 0.01$ ;  $F = 14.6$ ). In addition, there was interaction between order of presentation and type of list presented ( $P < 0.05$ ;  $F = 9.7$ ). Also, the last words presented from each list (words 13-15) were recalled significantly more times 3rd and 4th than words presented in all remaining positions by both groups ( $P < 0.01$ ). The order of word presentation also significantly affected the 5th and 6th words recalled ( $P = 0.05$ ;  $F = 7.5$ ), and there was a significant interaction between the presentation order and the type of list presented ( $P < 0.01$ ;  $F = 20.8$ ).

On lists containing semantically related words, elderly subjects recalled the semantically related words significantly more than all other words ( $P < 0.05$ ;  $F = 6.0$ ). In contrast, the 5th and 6th words recalled by young subjects were

**Table 1.** Subject description.

	Young (N = 23)	Elderly (N = 50)
Age (years)	25.6 ± 3.3	65.3 ± 3.2
Years of education	14.1 ± 1.7	13.5 ± 2.1
MMSE score	28.7 ± 1.6	27.2 ± 2.5*
Verbal IQ (WAIS-R) <sup>a</sup>	98.3 ± 12.5	102.1 ± 9.5
Executive IQ (WAIS-R) <sup>a</sup>	92.6 ± 13.6	97.6 ± 16.3
Global IQ (WAIS-R) <sup>a</sup>	91.3 ± 12.8	98.9 ± 11.4

Data are reported as means ± SD. <sup>a</sup>Scores corrected for age. MMSE = Mini Mental State Exam; IQ = Intelligence Quotient; WAIS-R = Wechsler Adult Intelligence Scale - Revised. \* $P < 0.01$ , elderly group compared to young group (Student *t*-test for independent samples).

those in the final positions (words 13-15), again reflecting the recency effect.

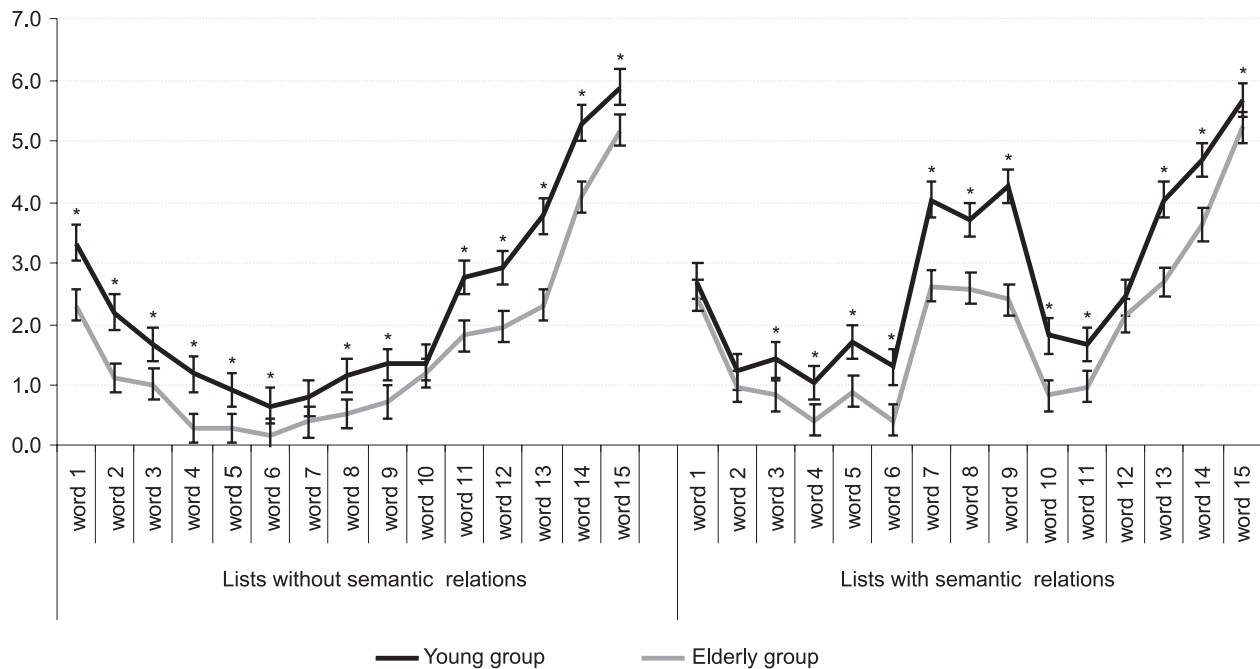
There was a significant interaction between order of presentation, group and type of list for those words recalled 7th and 8th ( $P < 0.05$ ;  $F = 3.2$ ), but recall in this order was only found in a small number of volunteers (10 subjects); therefore, these results are not shown graphically. There was no significant relationship between the 9th and 10th words recalled and group, types of lists or order of presentation ( $P = 0.07$ ;  $F = 3.8$ ).

We found no significant difference in errors or false recalls (intrusions, repetitions and perseverations) related to presentation order or recall order ( $P = 0.1$ ;  $F = 3.9$ ).

When we determined whether a possible correlation existed between the order of words presented on the lists and recall order, we did find significant correlations.

Specifically, words presented last on the lists (words 13-15) were between the 1st and 4th words recalled by both groups ( $r = 0.54$ ).

Finally, we found that semantically related words in the middle of the word lists caused those words to be recalled significantly more frequently than words in the middle of lists that were not semantically related. Furthermore, elderly subjects recalled the semantically related words more often than younger subjects. Specifically, the 5th and 6th words recalled by the elderly subjects were the semantically related words ( $r = 0.54$ ), whereas among the younger subjects the 5th and 6th words were those from the end of the lists ( $r = 0.72$ ). In other words, young subjects continued to rely on short-term memory while elderly subjects engaged executive functions to recall words that were semantically related (Table 2).



**Figure 1.** Difference in serial position curve. Data are reported as means ± SEM. \* $P < 0.05$  compared to elderly group (Student *t*-test for independent samples).

**Table 2.** Significant correlations between recall order and presentation order.

Presentation order	Recall order											
	Lists without semantic relation						Lists with semantic relation					
	1st and 2nd	3rd and 4th	5th and 6th	7th and 8th	9th and 10th	11th and 12th	1st and 2nd	3rd and 4th	5th and 6th	7th and 8th	9th and 10th	11th and 12th
Young	0.72	0.54	0.56	0.41	0.32	-0.08	0.75	0.77	0.72	-0.09	0	0
Elderly	0.67	0.67	0.12	-0.07	0.0	0.0	0.65	0.58	0.54	0.19	0.40	0.30
Total	0.68	0.60	0.29	0.21	0.22	-0.05	0.69	0.68	0.51	-0.17	0.23	0.20

## Discussion

The question addressed in the present study was whether the order of word presentation affects recall. For both young and elderly groups, the 1st two words recalled corresponded to the words presented in the same position on the list, suggesting a similar search strategy based on short-term memory. Hanson (16) reported similar findings in a study assessing the role of the phonetic code in retaining information in short-term memory.

This search pattern remained the same for the 3rd and 4th words recalled, although on lists with semantically related words in the middle positions recall of semantically related words caused an increase in recall of middle-positioned words. This suggests that when short-term memory reaches a limit, subjects use information about the words in their search strategy, although this was only observed among the elderly subjects (17,18).

In the present study, we observed satisfactory performances in word list recall by subjects in the two age groups and identified differential search strategies between the two age groups during recall. Specifically, we found that, although the two age groups used a similar short-term memory search strategy for the 3rd and 4th words recalled,

differential search strategies were employed for the 5th word to be recalled. For the 5th word recalled, young subjects continued to rely on short-term memory in recall while elderly subject turned to a strategy based on semantically related words, suggesting that elderly subjects utilized central executive functions to integrate information based on word content and not on location on the list (17).

This difference in the order of search of words between young and elderly subjects is based on the strategy used by two groups whose cognitive development occurred during different historical periods. Another possibility is the use of a strategy typically modified by non-pathological aging, in which the executive memory develops strategies to minimize the impact of natural wear on the ability of formation of new memories. This supports the view of Vygotsky (18) that the change in the functional structure of consciousness is what constitutes the central and fundamental content of the entire development process (18-22).

Therefore, memory strategies are modified by aging, i.e., the elderly need to make the content more meaningful. The more developed the cognitive functions, resulting mainly from formal education, the greater the cognitive reserve, helping to minimize the effects of aging on long-term memory.

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