

## Working Memory Deficits in Alzheimer's Disease

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### Abstract

The phonological loop and central executive components of working memory were examined in patients with Alzheimer's disease (AD patients) and elderly controls. Patients with Alzheimer's disease showed reduced verbal spans, with smaller phonological similarity and word length effects. They also showed a decreased performance in tasks examining processing speed and articulation rate. However, phonological analysis was normal. With regard to the central executive, AD patients showed deficits in an alphabetical span task in which subjects were asked to recall a random series of words in their alphabetical order, while they performed normally on a dual task in which they had to perform simultaneously a digit repetition and a visuo-motor task. These results suggest that Alzheimer's disease may affect several components of working memory but all aspects of the central executive mechanism are not necessarily affected.

### Introduction

Working memory has been found to be impaired in Alzheimer's disease (AD). Most studies reported reduced verbal spans although the different subcomponents of the phonological loop (phonological store and articulatory rehearsal system) appeared to be intact in the disease (Morris, 1984, 1987). As AD patients also exhibited specific impairments in dual tasks (Morris, 1986; Baddeley, 1991), the hypothesis was made that the AD working memory deficit could result from an impairment affecting the central executive (Morris, 1984). However, recent data observed that a specific phonological loop deficit (more precisely of the phonological store) may also exist in AD patients, in addition to a central executive dysfunction (Belleville, Peretz & Malenfant, 1996). Given these contradictory results, the aim of this study was to re-evaluate the functioning of the phonological loop and central executive in a single group of patients.

### Methods

Ten subjects meeting the NINCDS-ADRDA criteria for probable or possible Alzheimer's disease and 11 elderly controls were evaluated on different working memory tasks. The articulatory rehearsal mechanism and phonological store were examined by comparing the span performance for respectively short and long words and for similar and dissimilar words.

Articulation rate was measured by asking subjects to repeat five times two mono-syllabic words as rapidly as possible. We also investigated the capacities of phonological discrimination. The central executive component was examined by means of a dual task (Greene et al. 1996) in which one task was to give continuously sequences of digits at the subject span and the second was to present a trail of boxes which the subjects were required to place a cross in each box, following the trail. Both tasks were firstly executed separately and thereafter simultaneously, during 2 minutes. We also administered the alpha span task (Belleville et al., accepted) evaluating the manipulation capacities of the central executive, in which subjects were asked to recall a random series of words in their alphabetical order. The storage demand was equalized across subjects by adjusting the list length according to individual span. Finally, processing speed was evaluated in both groups. The measure used was correct response time to decide if two presented letters are similar.

### Results

AD patients had inferior results to the control group for processing speed [ $t(18) = 2.29, p < 0.05$ ], digit span [ $t(19) = 3.89, p < 0.05$ ], word span [ $t(19) = 3.89, p < 0.001$ ] and articulation rate [ $t(19) = 3.43, p < 0.005$ ].

However, no differences were observed in phonological discrimination abilities [ $t(16) = 1.41, p = 0.18$ ]. Concerning the phonological similarity effect, a 2 (group) \* 2 (similar/dissimilar words) ANOVA

showed a group effect [ $F(1, 19) = 11.71, p < 0.005$ ], a type of word effect [ $F(1, 19) = 29.72, p < 0.0001$ ] and an interaction between group and type of words [ $F(1, 19) = 11.37, p < 0.005$ ], indicating that AD patients had a smaller phonological similarity effect than controls. The word length effect was evaluated by a 2 (group)\*2 (short/long words) ANOVA which revealed a group effect [ $F(1, 19) = 12.99, p < 0.005$ ], a type of word effect [ $F(1, 19) = 61.65, p < 0.0001$ ] and an interaction between group and type of words [ $F(1, 19) = 5.19, p < 0.05$ ]. With regard to the central executive, the alpha span task showed that AD patients were impaired in manipulating information compared to elderly subjects [ $t(16) = 3.83, p < 0.005$ ]. However, for the dual task, both groups had a similar decreased performance when the performance for the execution of both tasks separately was compared to that of both tasks performed simultaneously [ $t(16) = 1.51, p = 0.15$ ]. No significant correlation was observed in AD patients between span tasks, capacities of central executive, speed processing and articulation rate. However, in control subjects there was a significant correlation between short word span and processing speed ( $r = -0.79, p < 0.01$ ), short word span and articulation rate ( $r = 0.63, p < 0.05$ ), long word span and articulation rate ( $r = 0.63, p < 0.05$ ), digit span and repetition of digit sequences in dual task ( $r = -0.83, p < 0.005$ ), word span and manipulation of information in alpha span task ( $r = 0.81, p < 0.05$ ).

## Discussion

These results suggest that Alzheimer's disease may affect several component of working memory, namely the phonological store, the articulatory rehearsal system and the central executive mechanism. Concerning the central executive, results show that some aspects of functioning may be impaired while other aspects are not affected in the same way and that Alzheimer's disease does not necessarily affect dual task coordination in the early stages of the disease.

## References

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