

Impact of executive dysfunctions on episodic memory abilities in patients with ruptured aneurysm of the anterior communicating artery

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Abstract

Executive and memory dysfunctions are among the most frequently reported deficits following a ruptured aneurysm of the anterior communicating artery (ACoA). In order to study the impact of the dysexecutive syndrome on episodic and semantic memory, the data obtained from 59 ACoA patients were examined retrospectively. All patients were assessed on a variety of episodic memory tests (Rey Auditory-Verbal Learning Test, Rey Complex Figure Test, Wechsler Memory Scale), semantic memory (verbal fluency), and standardized tests of executive functions (Trail Making Test, Maze tests, Wisconsin Card Sorting Test). There was a strong positive correlation between executive dysfunction and retrieval difficulties in episodic and semantic memory tasks. Comparisons of subgroups of patients with high and low frontal lobe functioning on delayed recall and recognition revealed a significant group X condition interaction in addition to significant group and condition main effects. ACoA patients with low frontal lobe functioning were particularly deficient in free recall (immediate and delayed) while recognition was equally well preserved in the two subgroups. Neither subgroup presented with an abnormal forgetting over time suggesting a retrieval deficit rather than a true retention impairment.

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1. Introduction

The rupture of a cerebral aneurysm is the most frequent cause of subarachnoid hemorrhage. In 30–40% of the cases, the aneurysm is located in the anterior communicating artery (ACoA) (Beeckmans, Vancoillie, & Michiels, 1998). The two lesion sites most frequently observed after a ruptured aneurysm of the ACoA are the frontal lobes and the basal forebrain (DeLuca, 1993; Parkin & Leng, 1993; Parkin, Yeomans, & Bindschadler, 1994; Van der Linden, Bruyer, Roland, & Schils, 1993). Consequently, memory and executive dysfunctions are the most consistent cognitive deficits encountered after a ruptured aneurysm of the ACoA.

In general, the neuropsychological evaluation of cognitive outcomes after a ruptured aneurysm of the ACoA reveals impairments in planning, set shifting, and verbal fluency. In a maze task, these patients present

difficulties in anticipating dead ends and in completing a planned action. In verbal fluency tasks, their output is often reduced, they have difficulties respecting the rules and they show perseverative tendencies. On the Wisconsin Card Sorting Test (WCST), in addition to an abnormal number of perseverative responses, the patients are easily disturbed by irrelevant stimuli and show poor self-correction of their performance. In a study by Thomas-Anterion et al. (1996) these patients show initial adaptation deficits on tasks of serial reaction time and mirror-reading. These observations suggest the presence of a difficulty initiating a task, which disappears when the task becomes automatic.

At the memory level, retrieval is most consistently affected. On serial learning tasks, such as the Rey Auditory-Verbal Learning Test (RAVLT), free recall rapidly reaches a plateau and both retroactive and proactive interference effects may be observed. Delayed

recall is often poorer than immediate recall but performance is improved by recognition. However, it is unclear if the patients lose information over time. Some studies (DeLuca & Diamond, 1995; Rousseaux, Godfroy, & Cabaret, 1998) reveal a loss of information among ACoA subjects, while others do not (Diamond, DeLuca, & Kelley, 1997). Finally, studies by Van der Linden and Bruyer (1992) and Palmer and McDonald (2000) have revealed a deficit of prospective memory in patients after a ruptured aneurysm of the ACoA.

This brief review of neuropsychological sequelae after a ruptured aneurysm of the ACoA highlights the fact that most of the memory impairment exhibited by these patients may be a consequence of their dysexecutive syndrome. They showed an information retrieval deficit, interference effects, poor verbal fluency, initial adaptation difficulties on a procedural memory task, and a prospective memory deficit, which may all be linked to executive dysfunctions such as planning, intention, or inhibition impairments. Their ability to adequately retain the information over time remains debatable. The objective of the present study was to directly assess the role of the dysexecutive syndrome often observed following ACoA aneurysm, on various aspects of memory functions, such as encoding, retention over time, and retrieval. To this end, the neuropsychological tests performances of 59 patients with a ruptured aneurysm of the ACoA were retrospectively examined.

2. Method

2.1. Participants

The sample consisted in 59 patients (41 men and 18 women) who had undergone surgical repair of a ruptured aneurysm of the ACoA and received a detailed post-operative neuropsychological evaluation. The average age of the patients was 46 years (range 24–65 years) and the average delay between the surgery and the neuropsychological evaluation was 12.75 months (range 0.5–58 months). Detailed neurological and neuroradiological (MRI, arteriography) evaluations were performed pre- and post-operatively in each patient.

2.2. Material

All patients were administered a 2–3-h long extensive neuropsychological test battery. Although the tests used in the assessment of executive and memory functions have slightly changed over the years, the evaluations were sufficiently alike to perform a group study. Serial verbal learning was assessed with the RAVLT or the California Verbal Learning Test (CVLT). Immediate and delayed recall of the WMS logical memory subtest and of the Rey Complex Figure Test (RCFT) were also

performed to assess long-term episodic memory functions. Letter and category fluency were used as measures of semantic retrieval. The integrity of frontal lobe functions was assessed with the WCST, the Maze Test from the WISC, and the Trail Making Test. In addition, most subjects were administered a seven-subtests short form of the WAIS-R (Ward & Ryan, 1996) which included the Information, Digit Span, Arithmetic, Similarities, Picture Completion, Block Design, and Digit Symbol Subtests.

3. Results

In order to get an overall picture of the deficits presented by our patients, the scores obtained by each subject were first examined as a function of the available norms, taking age and education into account whenever possible. As expected, an important proportion of subjects showed marked deficits (less than 2 standard deviations) in tests of executive (WCST [less than 3 categories: 24%], Trail B [total time: 35.4%], Mazes [more than 3 errors: 34%], Category Fluency [total number: 19%]) and episodic memory functions (RAVLT or CVLT total learning and delayed recall, etc.). These results are consistent with those usually reported in the literature (DeLuca & Diamond, 1995).

An analysis using Pearson's correlation coefficients was performed to examine the relationship between executive and memory functions deficits. There was a strong negative correlation between the total number of word recalled over five trials (RAVLT and CVLT) and time to complete Trail B ($r = -.572, p < .001$), number of shifting errors on Trail B ($r = -.397, p < .005$), number of perseverative errors on the WCST ($r = -.630, p < .001$), and number of planning errors on the Maze Test ($r = -.456, p < .001$).

In addition, there was a strong correlation between retrieval from semantic memory (category fluency) and retrieval from episodic memory (immediate story recall: $r = .619, p < .001$, delayed story recall: $r = .550, p < .001$; total words recalled on RAVLT or CVLT: $r = .656, p < .001$) suggesting a sharing of a common basic mechanism. As expected, performance on category fluency was correlated with many measures of executive functions (WCST, number of categories: $r = .484, p < .01$; perseverative errors: $r = -.509, p < .01$; Trail B, total time: $r = -.550, p < .001$; number of errors: $r = -.334, p < .05$). A similar pattern was observed with letter fluency, both oral and written.

There was a strong negative correlation between the copy of the Rey Complex Figure and time to complete ($r = -.572, p < .001$) and number of errors on the Maze Test ($r = -.548, p < .001$). As expected, scores obtained on the copy condition of the Rey Complex Figure was correlated with scores obtained on the Block Design

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