A Rehabilitation Protocol for Empowering Spatial Orientation in MCI. A Pilot Study.

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Abstract. Spatial navigation is among the first cognitive functions to be impaired in Alzheimer’s disease [1] and deficit in this domain is detectable earlier in patients with Mild Cognitive Impairment [2]. Since efficacy of cognitive training in persons with MCI was successfully assessed [3], we developed a multitasking training protocol using virtual environments for stimulating attention, perception and visuo-spatial cognition in order to empower spatial orientation in MCI. Two healthy elders were exposed to the training over a period of four weeks and both showed improved performances in attention and orientation after the end of the intervention.

Keywords. Mild Cognitive Impairment, Visuo-spatial Cognition, Spatial Orientation, Virtual Reality

Introduction

Mild Cognitive Impairment (MCI) is a syndrome that is currently thought of as a transition phase between cognitive ageing and dementia [4]. Cognitive performance in individuals diagnosed with MCI is deficient relative to that of age- and education-matched control subjects [5], but it does not meet the criteria for dementia yet. 20-50\% of patients with MCI will develop dementia over a period of 2-3 years, but whether or not a case converts to AD, MCI in and of itself may be a cause of disability in frail elders and thus may be an important target for screening and possible intervention [6].

Previous research suggests that plasticity still exists in patients with MCI [7] and that they can improve their performance (for example on episodic memory and/or attention) when provided with cognitive training [3]. Spatial navigation has shown to be early impaired in MCI, potentially leading to limitation in independent living. Nonetheless, there is no record of any program of intervention addressing spatial orientation in MCI.

1. Methods

We designed a training protocol aimed to stimulate and improve attention, perception and visuo-spatial cognition in persons diagnosed with MCI. The program is highly individualized and is divided into two main units, each one composed by six one-hour-

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sessions. It covers a period of eight weeks. Six different virtual environments were adapted for the protocol, using the open-source software NeuroVR. Every session takes place in an environment close to the everyday experience of the patient, such as a flat, a supermarket, an office or a park, the city-centre. The subject is required to walk and execute several tasks on the base of a narrative plot.

The protocol includes over 80 different exercises referred to following cognitive functions: spread and divided attention (through visual and/or acoustic cues and distractors), visuo-spatial perception (location of points in the space, appreciation of dimensions, orientation or distance of an object, etc), spatial cognition (recognition of shapes, mental rotation, etc), navigation (way-finding and cognitive mapping). Each cognitive function is stimulated by a specific group of exercises.

Neuropsychological performance and psychological status are assessed for each patient at baseline, at the end of the first unit, at the end of the whole program and after two months. The test battery includes among others MMSE, GDS, Trail Making Test part A and B, Stroop Effect Test, Standardized Money Road-Map-Test. Furthermore, attention and orientation are evaluated at the beginning and at the end of every single session.

The training is individualized by varying the levels of difficulty in visuo-spatial attention and/or spatial orientation tasks. Entry level of each patient is determined by the neuropsychological results at the baseline and may change during the training according to the performance in the visuo-spatial attention and orientation tasks of every session.

2. Results

A pilot trial of the protocol was conducted on two healthy elders (F, 65 and 73) over a period of four weeks. Their performance was assessed at the beginning (T0) and at the end of the training time (T2). Both individuals have obtained improved achievement in attention and especially in orientation. As far as attention is concerned, mean scores improved of 10 percent at Stroop Effect Test and at TMT part A, and of 5 percent at TMT part B. Referred to orientation, the performance at the Standardized Money Road-Map-Test improved for both subjects with a 50 percent decrease of errors (see Table 1).

This trend is similar to the one we observed inside the virtual environments, where visuo-spatial attention and orientation were measured. In order to assess the performance, several different parameters were considered: number of errors and/or omissions committed across the virtual environment, efficiency with which the subject fulfilled the intended purpose, time required to execute all the tasks foreseen for the session, number of times the subject asked the researcher for help (in case of confusion, disorientation or trouble). Orientation was the function showing the biggest improvement (see Figure 1).

| Table 1. Performances of the 2 subjects (mean scores): baseline vs end of training program. |
|---------------------------------|-------------|-------------|
| Test                           | T0          | T2          |
| TMT-A (sec)                    | 84,0        | 75,5        |
| TMT-B (sec)                    | 202,0       | 189,5       |
| STROOP (sec)                   | 128,0       | 111,0       |
| ROAD MAP (errors)             | 10,0        | 5,0         |
Figure 1. Evolution of the performance produced by the two subjects inside the virtual environments (scores at orientation tasks, sessions 1 to 12). ▲ = subject 1 (F, 65) ● = subject 2 (F, 73).

3. Conclusion

The pilot study suggests that the training protocol was able to produce improvement in targeted areas (orientation and attention) in two healthy elders. Our aim is to exploit the protocol on a sample of individuals diagnosed with MCI and early Alzheimer’s disease during the second semester of 2009.

References