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A system for motor and cognitive activities for people with mild or moderate cognitive impairment

M. Magrini [1], S. Coscetti [1], U. Barcaro [1], C. Dolciotti [2]
[1] *Istituto di Scienza e Tecnologie dell'Informazione, C.N.R., Pisa, Italy*
[2] *Istituto di Fisiologia Clinica, C.N.R., Pisa, Italy*

INTRODUCTION

A hardware-software system is described for the administration of motor and cognitive exercises to people affected by mild or moderate cognitive impairment. This system was built in the framework of the "Intesa" project, funded by the region of Tuscany. The objective of this project has been the implementation of services based on non-invasive ICT technologies aimed at the improvement of the life quality of elderly non-disabled people in a condition of "fragility".

METHODS

The hardware part of the system included: 1) The portable Interaxon "Muse" EEG headset for the acquisition of four EEG traces; 2) the Microsoft "Kinect" V2 infrared-based sensor for the characterization of gestures and movements; 3) a PC connected to the integrated database of the "Intesa" project. Three categories of software applications were implemented: 1) applications providing cognitive and motor exercises, aiming to improve the conditions of the subjects; 2) applications providing tests, aiming to measure this conditions: 3) application allowing quantitative measures to be performed. Motor exercises generally consisted in asking the subject to mimic the movements proposed by means of an avatar projected on a large screen. A number of simple tasks, such as connect-the-dots and select-the-tile, were simultaneously motor and cognitive. A simplified version of the classic "ANT" (Attention Network Task) [1] was implemented: the subject was asked to lift the right or left arm according to the direction of the central arrow of a pattern projected on a computer screen: in the pattern the central arrow was surrounded by flankers with either neutral or congruent or opposite directions. The procedures for quantitative measures concerned the reaction times, the number of errors, and the basic features of the recorded EEG traces. As regards the EEG traces, signal powers were calculated for five band activities (delta, theta, alpha, beta, and gamma); the power values were compared between the test epochs (or the exercise epochs) and the resting-state epochs, thus measuring the subject's capability to pay attention during the tests or exercises (among the vast relevant literature in the last two decades, see, e.g., [2] and [3]).

RESULTS

Initial application of the system to eight elderly people (ages in the range 65 – 75 years) affected by mild or moderate cognitive impairment did not require particular efforts on the part of the subjects. Reaction times and number of errors during the ANT test and the other tests and exercises were measured: these measures provided an easy and effective way of assessing the impairment degree of the subjects. All of the subjects presented a decrease in theta and alpha power during the tests and exercises with respect to the resting-state epochs. Specifically for the ANT test, comparisons were also made between the band powers before, during, and after the visualization of the pattern: so far, perhaps because of the small number of subjects, we have not observed statistically significant general trends or variations connected to the impairment degree. From the point of view of the general purposes of the "Intesa" project, aiming at improving the subjects' conditions, it has been interesting to observe that the administration of the Attentive matrices Test [4] both before and after the ANT test generally implied better results for the Attentive matrices Test administered after the ANT test.

DISCUSSION

The system is characterized by simplicity: it consists of portable, light (and low-cost) devices; the exercises and tests are easy and friendly and appropriate for people affected by mild or moderate cognitive impairment. A property of most of the tests and exercises is that they combine cognitive and motor aspects: we feel that this combination can be fruitful for an actual improvement of the subjects' condition. The implemented measures allow to subjects' condition to be quickly assessed and comparisons to be made among different sessions of a subject and among the various subjects.

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MCO International Group S.r.l.
Via Luigi Carlo Farini, 11 – 50121 Firenze
Tel. + 39 055 2639073
Mob. + 39 353 3601321
alessandra.grossi@mcointernationalgroup.com
www.mcointernationalgroup.com