

Serious games for home telemonitoring: links to cognition and rsEEG in aging and Alzheimer's disease

Roberta Lizio¹ (roberta.lizio@uniroma1.it), C. Del Percio¹, M. Carpi¹, M. De Bartolo¹, G. Noce², S. Lopez¹, V. Henao Isaza¹, B. Bolukbas¹, P. Barone^{2,3}, Arianna Cappiello³, Angelo Antonini⁴, Eleonora Fiorenzato⁴, Simone Cauzzo⁴, Fabrizio Stocchi⁵, Chiara Coletti⁵, Giacomo Maria Russo⁶, Andrea Rosati⁷, Franco Giubilei⁸, Claudio Babiloni¹

¹ Dep. of Physiology and Pharmacology "V Ersamer", Sapienza University of Rome, Rome, Italy; ² IRCCS Synlab SDN, Naples, Italy; ³ Center for Neurodegenerative Diseases-CEMAND, UNISA, Salerno, Italy; ⁴ Department of Neuroscience, University of Padua, Padua, Italy; ⁵ IRCCS San Raffaele Rome, Rome, Italy; ⁶ Sentech S.r.L., Rome, Italy; ⁷ Sogetel S.r.L., Rome, Italy; ⁸ Dep. of Neuroscience, Mental Health, and Sensory Organs, Sapienza University of Rome, Rome, Italy.

#13088

Background: Unsupervised serious video games delivered through the SmartMe&You-TELEMAIA home telemonitoring platform (<https://smartme.cloud.garr.it/>) may provide a practical approach to track cognitive fluctuations in older adults with or without impairment. This study evaluated their validity in cognitively unimpaired individuals (Healthy) and in patients with mild cognitive impairment and mild-to-moderate Alzheimer's disease-related dementia (ADCD).

Methods: Clinical, demographic, and resting-state eyes-closed EEG (rsEEG) data were collected from 34 Healthy participants and 62 ADCD patients. Seven unsupervised cognitive tasks, which involved the quick evaluation of visual stimuli in a grid and finger motor responses were administered via a commercial tablet (*Figure 1*). The rsEEG data were processed using the EEGLAB toolbox. rsEEG cortical source activity in the individual delta, theta, and alpha frequency bands was estimated using eLORETA. Game performance was compared with Mini-Mental State Examination (MMSE) scores and rsEEG activity, that is typically abnormal in patients experiencing this neurodegenerative condition. Statistical analyses were performed using the freeware tool jamovi version 2.3.

Results: Game performance metrics (*Table 1*) discriminated Healthy participants from ADCD patients, achieving an overall accuracy above 90%. Across the entire cohort, performance showed a strong positive association with MMSE scores (*Figure 2*). Conversely, it was negatively associated with global and regional rsEEG source activity in the delta and theta bands. (GLMs, $p < 0.01$; *Figure 3*).

Conclusions: Serious games implemented on the SmartMe&You-TELEMAIA platform are feasible and informative in older adults across the cognitive spectrum. They may represent a low-cost, sustainable, and unsupervised tool for assessing cognitive status in home telemonitoring, supporting both primary prevention in at-risk individuals and tertiary prevention aimed at slowing disease progression in ADCD.

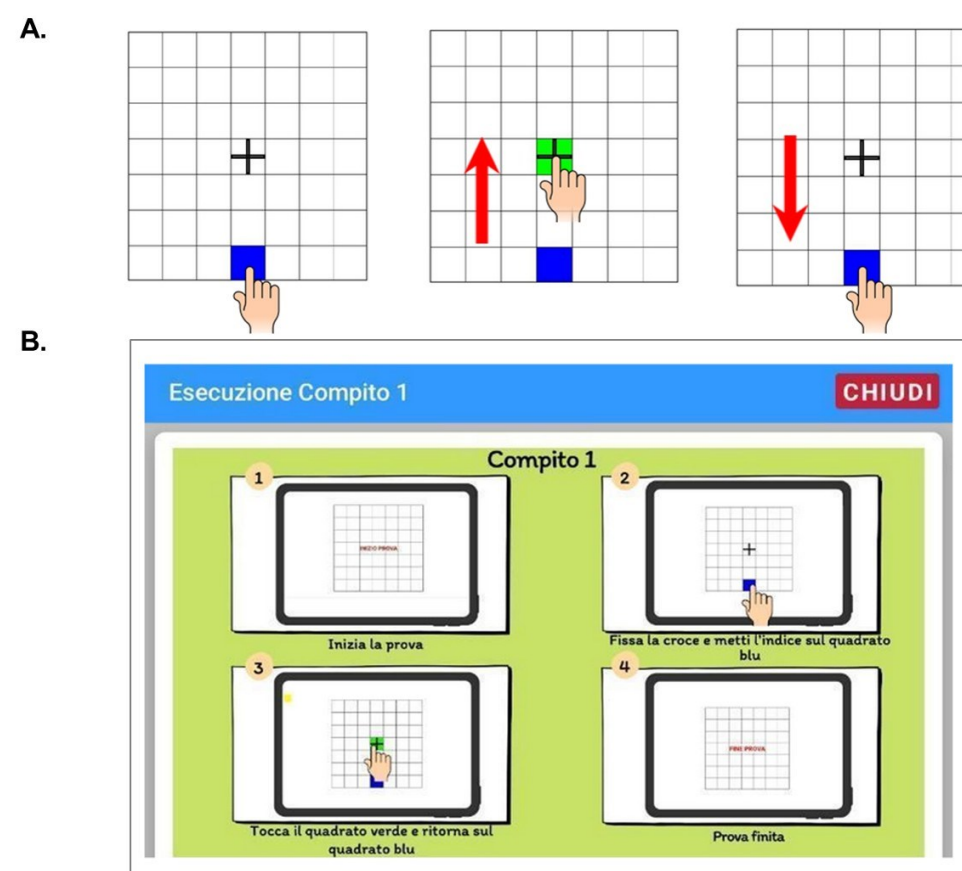


Figure 1. SmartMe&You serious videogame interface and response procedure. (A) Schematic representation of the task layout, showing the 7×7 visual grid, central fixation cue, starting position, and touch response to the green target followed by return to the starting position. (B) Tablet interface displaying the visual instructions for Task 1 (original Italian version).

Global SmartMe&You-TELEMAIA serious video games performance			
Global SmartMe&You-TELEMAIA performance	Healthy	ADCD	Rank transformation ANCOVA
Accuracy (%)	92.0 $\pm$ 1.2 SE	67.9 $\pm$ 2.9 SE	F = 25.6, $p < 0.00001$
Reaction time (ms)	295 $\pm$ 12 SE	365 $\pm$ 14 SE	F = 4.9, $p < 0.05$

Table 1. Mean values ($\pm$ SE) of the overall ("global") SmartMe&You performance (i.e., accuracy and reaction time), calculated as the average across the seven serious video games, in the Healthy and ADCD groups. The results of the statistical comparisons (Rank transformation ANCOVA; $p < 0.05$) are also included. Age, education, and sex were used as covariates.

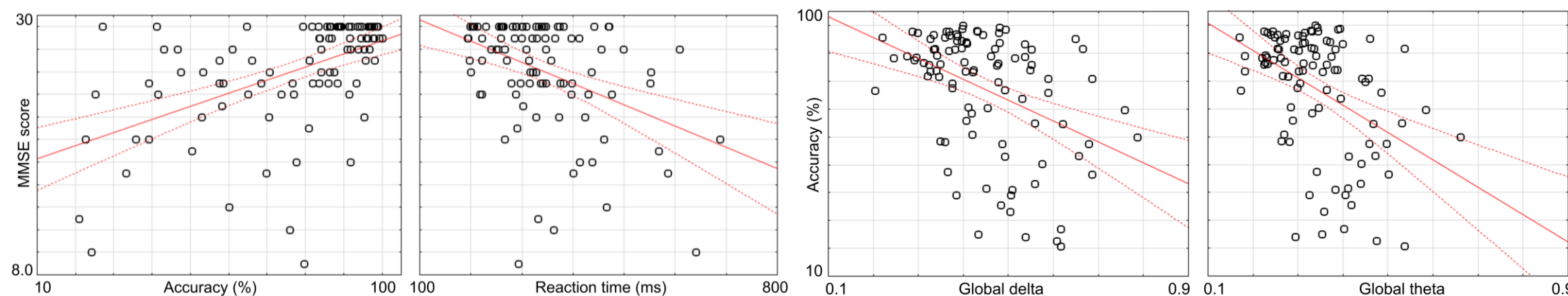


Figure 2. Scatterplots illustrating the association between the global performance (i.e., percent accuracy and reaction time) on the SmartMe&You-TELEMAIA serious video games and the MMSE score, as a measure of the global cognitive status, in the Healthy and ADCD participants as a whole group.

Figure 3. Scatterplots showing the association between the global rsEEG source activities in slow frequency bands (i.e., eLORETA current densities; log 10 transformed) and the global percent accuracy on the SmartMe&You-TELEMAIA serious video games in the Healthy and ADCD participants as a whole group.