Acceptability and usability of home telemonitoring SmartMe&You videogames to monitor cognitive functions in Alzheimer's and Parkinson's disease patients

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Objective

The SmartMe&You program is part of a smart home telemonitoring environment (https://smartme.cloud.garr.it/) designed to monitor cognitive and motor functions, general stress levels, and sleep-wake cycle for one week in older adults at risk of cognitive impairment or already diagnosed with cognitive disorders. Here, we tested the usability, acceptability, and validity of the SmartMe&You serious video-games for testing cognitive status in cognitively unimpaired older adults (Healthy) and patients with mild cognitive deficits or mild dementia due to Alzheimer's (ADCD) and Parkinson's (PDCD) diseases. The validity was assessed using the Mini-Mental State Examination (MMSE) score as the gold standard.

Materials

As a part of the PREDICT-NEURODEGEN (Call "Annual strategic program of Italian Ministry of Health"; PNRR-MAD-2022-12376415), ROME TECHNOPOLE (Call "PNRR Mission 4, Component 2, Investment 1.5 – NextGenerationEU of Italian Ministry of University and Research"; PNRR-MAD-2022-12376415), and TELEMAIA (Call "Regione Lazio for competitive repurposing for research-development-innovation 2023") projects, clinical and demographic data were collected from 40 Healthy people, 58 ADCD patients, and 54 PDCD (*Table 1*). All participants were involved in the SmartMe&You program. SmartMe&You's serious video games included 7 unsupervised cognitive tasks (including Posner's and Go-NoGo tests), implying the quick evaluation of visual stimuli in a grid and finger motor responses on a commercial tablet monitor**.**

Table 1. Demographic and clinical data

	Healthy	ADCD	PDCD	Statistical analyses
N	40	58	54	-
Age (years)	67.7 ± 1.0 SE	76.6 ± 0.8 SE	74.1 ± 0.9 SE	ANOVA: F = 21.8, p < 0.0001 (Healthy > PDCD, ADCD)
Sex (M/F)	19/21, 47.5%	35/23, 60.3%	39/15, 72.2%	Chi-Square Test: Chi-Square = 6.1, p < 0.05
Education (years)	14.9 ± 3.5 SE	10.3 ± 0.6 SE	11.2 ± 0.6 SE	ANOVA: F = 14.9, p < 0.0001 (Healthy > PDCD, ADCD)
MMSE score	29.4 ± 0.1 SE	23.1 ± 0.7 SE	26.6 ± 0.4 SE	Kruskal-Wallis ANOVA: H = 66.9, p < 0.0001 (Healthy > PDCD > ADCD)

Abbreviations: M/F = males/females; MMSE = Mini-Mental State Evaluation; SE = standard error of the mean

Methods

The MMSE score and performance (i.e., accuracy and reaction time) of the serious video games were acquired. Statistical analyses were performed using the freeware tool jamovi version 2.3.

Results

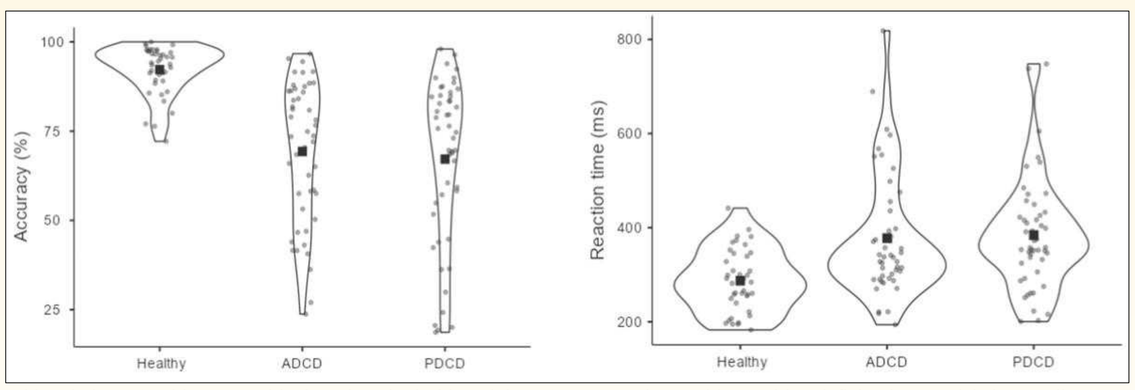
All participants accepted the SmartMe&You serious videogames. All Healthy people (100%), 81% (N = 47) of ADCD patients, and 91% (N = 49) of PDCD patients were able to complete the SmartMe&You task battery. The ADCD and PDCD patients showed significantly lower accuracy and slower reaction time in the video game performances compared to the Healthy group (Rank transformation ANCOVAs, p < 0.05; *Table 2* and *Figure 1*). Finally, a statistically significant positive association was found between the MMSE score and task performances in the Healthy, ADCD, and PDCD participants as a whole group (GLMs; p < 0.001; *Table 3* and *Figure 2*).

Table 2. Performance of the overall SmartMe&You serious video games

	Healthy	ADCD	PDCD	Rank transformation ANCOVA
Percentage of participants able to perform at least four of the seven tasks	100% (N =40)	81% (N =47)	91% (N =49)	-
Accuracy (%)	92.2 ± 1.1 SE	69.3 ± 2.9 SE	67.2 ± 3.3 SE	F = 18.4, p < 0.0001 (Healthy > ADCD, PDCD)
Response time (ms)	287 ± 10 SE	378 ± 19 SE	384 ± 17 SE	F = 7.8, p < 0.0005 (Healthy < ADCD, PDCD)

Abbreviations: Healthy = cognitively unimpaired older adults; ADCD = patients with cognitive deficits due to Alzheimer's disease; PDCD = patients with cognitive deficits due to Parkinson's disease; SE = standard error of the mean

Figure 1. Performance of the overall SmartMe&You serious video games



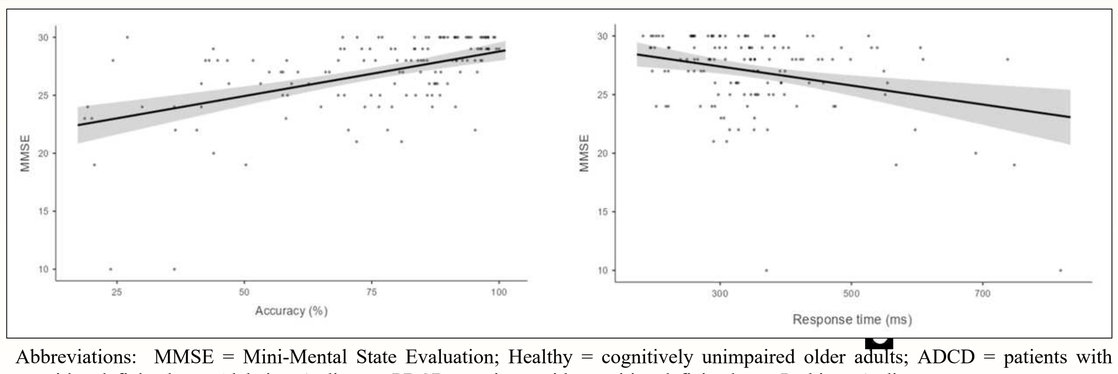
Abbreviations: Healthy = cognitively unimpaired older adults; ADCD = patients with cognitive deficits due to Alzheimer's disease; PDCD = patients with cognitive deficits due to Parkinson's disease

Table 3. Association between the overall SmartMe&You performance and the MMSE

Predictor: Overall ("global") SmartMe&You performance	Dependent variable: Global cognitive status	β standardized	t	p
Accuracy (%)	MMSE score	0.48	5.9	**< 0.00001**
Response time (ms)		-0.28	-3.3	**< 0.001**

Abbreviations: MMSE = Mini-Mental State Evaluation; Healthy = cognitively unimpaired older adults; ADCD = patients with cognitive deficits due to Alzheimer's disease; PDCD = patients with cognitive deficits due to Parkinson's disease

Figure 2. Association between the overall SmartMe&You serious video games performance and the MMSE



Abbreviations: MMSE = Mini-Mental State Evaluation; Healthy = cognitively unimpaired older adults; ADCD = patients with cognitive deficits due to Alzheimer's disease; PDCD = patients with cognitive deficits due to Parkinson's disease.

Discussion

The SmartMe&You unsupervised serious video games were usable and sensitive to global cognitive deficits in both AD and PD patients with cognitive impairment.

Conclusions

The SmartMe&You serious video games demonstrate potential as a useful, practical, free, "green", and unsupervised tool for evaluating cognitive status and decline in older people with and without cognitive deficits in home telemonitoring. This potential opens up exciting possibilities for future applications in prevention, care, and telemedicine in AD and PD patients.