

Implementation of a Brain Training Pilot Study For People With Mild Cognitive Impairment



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ABSTRACT

Objective

A pilot study to determine the feasibility of recruiting patients with MCI to test for cognitive interventions.

Method

Thirty patients with amnesic MCI were to be divided into two intervention arms and one control group. Participants went to local sites and completed brain training for one hour three times per week for nine weeks. Outcome measures were: recruitment, computer abilities, compliance, task performance, neuropsychological tests, and electroencephalography.

Results

After six months, only 20 participants had been recruited. Seventeen were allocated to one of the two intervention groups. Compliance was good and computer skills were not an obstacle. Participants improved their abilities in the modules, but there were no statistically significant changes on neuropsychological tests or EEG.

Conclusions

Recruitment of MCI participants for extensive cognitive intervention is challenging, but achievable. This pilot study was not powered to detect clinical changes. Future trials should consider recruitment criteria, intervention duration, scheduling, and study location.

Key words: mild cognitive impairment, brain training, neuropsychological assessment, pilot study

INTRODUCTION

Mild Cognitive Impairment (MCI) is a condition affecting one or more cognitive domains without significant functional impairment.^(1,2,3) Numerous studies, including the Canadian Study on Health and Aging (CSHA), have shown that more than half of persons with MCI will progress to dementia over five years.⁽⁴⁾ While many memory clinics repeat neuropsychological testing annually to determine if there has been disease progression, in the context of an aging population, it is unclear if this is sustainable, assuming no significant influx in new clinical resources.

Recent research suggests that the brain has a lifelong capacity for physical and functional change that enables learning.^(5,6) Intervention studies in healthy older adults have indicated that some computer programs lead to improved cognitive functioning.⁽⁶⁾ Post-hoc analysis of the Advanced Cognitive Training for Independent and Vital Elderly Trial (ACTIVE) showed that participants with lower cognitive scores also demonstrated improvement after computer-based cognitive training.⁽⁵⁾ Only two small prospective pilot studies have been undertaken in the MCI population to date, one showing a trend towards total score improvement on the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) in the MCI group receiving computer-based cognitive training,⁽⁷⁾ and another showing improvement in verbal memory and increased left hippocampal activation.⁽⁸⁾ There is some controversy about the type of control group to use in these studies: passive (e.g., waiting list) or active (e.g., sham cognitive training, psycho-education or pencil-and-paper cognitive training). It has been recommended not to use a control group that involves computers without interaction (i.e., watching stimuli only).⁽⁹⁾ Furthermore, the makers of Lumosity agreed to settle Federal Trade Commission charges alleging that they deceived consumers with unfounded claims,

based in part on the lack of control groups in their reporting of data.⁽¹⁰⁾

This pilot study aimed to determine the feasibility of a cognitive training intervention on MCI patients using neuropsychological and EEG as outcome measures. Previous studies in healthy older adults have had participants complete the computer-based cognitive training modules at home. To ensure compliance, the participants in this study were brought together.

METHODS

Study Design

The study was designed to have two intervention arms, and one control group. The latter were to have a passive computer activity—learning about MCI on-line and playing games with low cognitive demand. Measures were to be taken at baseline and post-intervention (nine weeks). The protocol was approved by the Bruyère and Carleton University Research Ethics Boards.

Setting and Sample

The pilot was to enroll 30 amnesic MCI participants from the Bruyère Memory Clinic at the Elisabeth Bruyère Hospital in Ottawa, Canada. The clinic sees approximately 333 patients per month, with about 15% of them diagnosed with MCI. Participants were identified via clinic chart review. Following baseline testing, three of the co-authors (MB, LS, FK) confirmed the diagnosis. Exclusion criteria were: significant visual or hearing impairment, inability to provide consent, inability to communicate in English, or taking a cholinesterase inhibitor.

Intervention Description

Participants in the first intervention arm used the BrainHQ brain training program online (Figure 1), while the second intervention arm performed word and number tasks designed by some of the authors (BW, FK, RG; Figure 2).⁽¹¹⁾ The focus of the current report is not to compare the interventions, but to explore whether MCI participants could learn to use them, and whether their performance could be monitored over time. The intervention took 1 hour, three times per week for nine weeks in four distributed locations in the city, starting in May 2014.

Measures

Six outcome variables were chosen: 1) ability to recruit persons with MCI for cognitive training, 2) participant technical computer ability, 3) level of compliance to the protocol, 4) changes in task performance, and feasibility of measuring impact of brain training using: 5) neuropsychological testing, and 6) electroencephalography.



FIGURE 1. Example of a task performed in BrainHQ



FIGURE 2. Screen shot of Carleton word search task

Cognitive tests were performed at baseline and post-intervention. These included the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS),⁽¹²⁾ Trail Making Test A & B,^(13,14) and the Montreal Cognitive Assessment (MoCA).⁽¹⁵⁾

Event-Related Potentials (ERPs) are extracted from electroencephalograms (EEG) and provide a measure of cortical activity with a high level of temporal resolution. The participant is exposed to visual or auditory stimuli, and average brain response to these stimuli is calculated. There is emerging evidence of changes in ERP in persons with cognitive decline.^(16,17)

For the ERP portion of the study, participants wore EEG sensor caps while performing cognitive tasks at baseline and post-intervention. These tasks included three n-back paradigms, a go-no-go paradigm, and a verbal recognition paradigm. The measures for the ERP included reaction time, accuracy, and numerous ERP components. Further details are available in Lopez Zunini et al.^(18,19) and Wallace et al.⁽²⁰⁾

Measures for the Carleton puzzles included level of difficulty, number of puzzles attempted and solved, number of correct entries, number of error hints, and duration spent on tasks. Measures for the BrainHQ modules included days trained, time spent on tasks, “stars” earned, levels completed, as well as improvements in attention, brain speed, and memory domains.

Analysis

In addition to having the six descriptive outcome variables identified above, for completeness, a number of statistical analyses were performed. These included descriptive statistics, paired sample *t*-tests comparing baseline to post-intervention scores, as well as independent sample *t*-tests to examine whether there were differences in results depending on the intervention arm.

RESULTS

Recruitment Results

Recruitment was anticipated to take three months, but after six months, there were only 20 participants. This represented an approximate recruitment rate of 1 in 5. Issues identified by potential recruits from highest to lowest frequency included: frequency of interventions, duration of the trial, and travel requirements. Seventeen took part in the pilot study and were randomized to one of the two interventions, and the control arm was dropped. Few MCI patients were purely amnesic, prompting a revision to the participant definition to include “amnesic plus one,” allowing the inclusion of one additional affected cognitive domain (Table 1).

Computer Technical Abilities

The participants enjoyed the interventions and tolerated the schedule. Some MCI patients had difficulties with mouse use, visual sweep, or needed prompting during the intervention. However, none of these difficulties led to discontinuation.

Compliance to Protocol

Of the 17 participants who took part in the trial, only one participant dropped out during the intervention period. The average attendance was 24/27 sessions. There were no significant differences in intervention attendance between the BrainHQ and Carleton puzzle groups. Reasons for missed sessions included family visiting, vacations, and illnesses (both research assistant and participant). No participant felt that the neuropsychological test battery or EEG testing was too long, and no one dropped out of the ERP arm of the study.

Task Results

Task performance improved for both the BrainHQ and Carleton puzzles.^(20,21) Table 2 demonstrates that for the BrainHQ arm, the scores on the three domains utilized in this study (attention, brain speed, and memory) were significantly improved ($p < .01$).

TABLE 1.

Baseline characteristics of MCI participants

<i>Characteristic</i>	<i>Intervention: BrainHQ n=9</i>	<i>Intervention: Carleton Puzzles n=8</i>
Age, mean (range)	78.89 (71-89)	73.86 (66-82)
Sex, n (%)		
Male	6 (66.7)	3 (37.5)
Female	3 (33.3)	5 (62.5)
Education in years, mean (range)	14.89 (12-18)	15.00 (12-20)
Research Diagnosis, n (%)		
Amnesic MCI (aMCI)	5 (55.6)	6 (75.0)
aMCI + visuospatial	0 (0.0)	1 (12.5)
aMCI + language	1 (11.1)	1 (12.5)
aMCI + executive functioning	3 (33.3)	0 (0.0)
Intervention Location, n (%)		
Central Ottawa	5 (55.6)	0 (0.0)
South Ottawa	0 (0.0)	3 (37.5)
West Ottawa	2 (22.2)	0 (0.0)
East Ottawa	2 (22.2)	5 (62.5)
ERP protocol, n (%)	6 (66.7)	8 (100.0)
Baseline MoCA, mean (SD)	22 (1.32)	23.14 (3.48)
Trails A, mean in seconds (SD)	69.33 (27.64)	44.14 (11.04)
Trails B, mean in seconds (SD)	190.11 (80.40)	151.43 (53.92)
RBANS, mean (SD)	83.89 (12.40)	81.14 (10.46)

Cognitive Testing and ERP Changes

This pilot was not powered to detect pre/post differences. Indeed, there were no statistically significant differences in total scores on the MoCA, Trails A, Trails B, and RBANS from baseline to post-intervention when intervention arms were grouped together or when the two interventions arms were analyzed separately (Table 3). Results for the analyses performed on the RBANS domains and tasks also did not yield significant results. Similarly, there were no significant changes in ERP elements from baseline to post-intervention.

DISCUSSION

This report demonstrates that studies on the use of computer training modules for persons with MCI are challenging, but feasible, in a structured setting. This study was not powered to determine whether these types of modules can help increase cognitive function in persons with MCI. Recruitment challenges dictated the adjustment of diagnostic criteria and the inclusion of more than the pure amnesic variant.

Technical computer ability of the participants was adequate with respect to the completion of the intervention. There

TABLE 2.

Paired sample *t*-test comparing BrainHQ domain scores at baseline and at outcome for the BrainHQ arm

<i>BrainHQ Domain</i>	<i>Baseline Mean (SD) n=9</i>	<i>Post-Intervention Mean (SD) n=9</i>	<i>t value</i>	<i>p value</i>
Attention	23.22 (7.71)	40.44 (9.80)	10.85	<.01
Brain speed	19.44 (6.62)	48.00 (10.68)	13.71	<.01
Memory	12.33 (9.96)	42.67 (15.39)	8.57	<.01

TABLE 3.

Paired samples *t*-tests comparing total scores at baseline and post-intervention for the MCI participants combined

<i>Test</i>	<i>Baseline Mean (SD) n=16</i>	<i>Post-Intervention Mean (SD) n=16</i>	<i>t value</i>	<i>p value</i>
MoCA	22.50 (2.48)	23.19 (2.90)	1.51	.15
Trails A (s)	58.31 (24.95)	54.81 (17.04)	-0.64	.53
Trails B (s)	173.19 (70.73)	159.06 (104.64)	-0.80	.44
RBANS	82.69 (11.31)	84.56 (13.36)	0.82	.43

was some difficulty with mouse use, easily overcome with the help of the research assistant. The mean education level of the participants in this study was 15 years, typical for Ottawa, Canada—but higher than the Canadian average, limiting generalizability.

Attendance was high, and persons with MCI could perform the tasks featured in both intervention arms. The participants showed improvements across all domains trained in Brain HQ. The improvements in Carleton puzzles were more difficult to measure since they were not designed around specific cognitive domains.

The neuropsychological test battery was well tolerated by participants and proved useful in the classification of MCI sub-types. The ERP portion of the study was also well tolerated.

Future studies would benefit from: 1) consideration of MCI sub-populations, 2) sufficient research assistant support, and 3) appropriate sample size. Recruitment may be easier if the interventions take place where the participants already attend (e.g., seniors' centers, retirement homes). The selection of the appropriate control group for this type of study also needs reflection, as do the outcome measures: computer measure outcomes being least relevant compared to NP tests and functional outcomes (the most significant). Studies including an ERP component may wish to consider selecting a sub-set of EEG leads to reduce the time for this assessment.

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CONFLICT OF INTEREST DISCLOSURES

Frank Knoefel is co-owner of MemoryFitness®, a service company providing recreational brain training in several retirement homes in Ottawa, Canada. Memory Fitness has done collaborative work with DynamicBrain.ca in the last few years. DynamicBrain.ca provided the licenses for the brain training in this study, but had no input into study design, data analysis or writing of this report. All other authors claim no conflicts of interest.

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