Does including Facebook training improve the effectiveness of computerized cognitive training? A randomized controlled trial

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Abstract

Objective: To determine whether implementing a Facebook training program improves the effectiveness of computerized cognitive training (CCT) in older adults.

Design: Randomized, controlled, double single-blind trial with parallel groups.

Setting: Community centers.

Subjects: Eighty-six adults between 60-90 years old.

Interventions: Nine face-to-face 60-minute sessions of CCT with VIRTRAEL for all participants. The experimental group received an additional 30 minutes of Facebook training per session.

Main measures: Attention (d2 Test of Attention); learning and verbal memory (Hopkins Verbal Learning Test-Revised); working memory (Letter-Number Sequencing test), semantic and abstract reasoning (Similarities and Matrix Reasoning tests); and planning (Key Search test).

Results: There was a significant Group*Time interaction in the Hopkins Verbal Learning Test-Revised-Trial 3, Letter-Number sequencing, and Matrix tests. Between groups, post-hoc analyses showed a difference in Matrix reasoning ($p< .001$; $d= 0.893$) at post-intervention in favor of the experimental group. Significant main effects of time were found in the CCT group between baseline and 3-month follow-up for Concentration (F= 26.431, p≤ .001), Letters and Numbers (F= 30.549, $p \leq .001$), Learning (F= 38.678, $p\leq$ .001), Similarities (F= 69.885, $p\leq .001$), Matrix (F= 90.342, $p\leq .001$), and Key Search (F= 7.904, $p= .006$) tests.

Conclusions: The utilization of CCT with VIRTRAEL, a freely accessible tool with broad applicability, resulted in enhanced attention, verbal learning, working memory,

abstract and semantic reasoning, and planning among older adults. These improvements were sustained for at least three months post-training. Additional training in Facebook did not enhance the effectiveness of CCT.

Keywords: Facebook; CCT; computerized cognitive training; VIRTRAEL; older adults.

Introduction

According to the United Nations, the global population of individuals aged 65 and over is 727 million (1), constituting almost 9.3% of the population. Moreover, projections indicate that this percentage will increase to 16% by 2050. Therefore, the number of older individuals suffering from cognitive impairment will also increase exponentially (2), posing significant challenges at the health, social, and economic levels. As a result, there is a pressing need to implement interventions to reduce cognitive impairment, and in this regard, cognitive stimulation activities and social interactions have great potential (3).

The availability of computerized cognitive training (CCT) is growing, driven by several advantages over the traditional face-to-face format. These advantages include the ability to tailor the training to individual user needs (4), adapt to individual skill levels for optimized performance (5), and enhance motivation (6). The user-friendly interface, convenience, and cost-effectiveness make CCT accessible to a wide audience (7). Notably, CCT has demonstrated efficacy in reducing cognitive impairment and improving cognitive functioning, both in healthy individuals and those with MCI and Alzheimer's disease (8,9). Despite these positive outcomes, it is important to note that the effect size of CCT appears to be small in terms of overall cognition (10), memory, working memory, and executive function (11).

Another recent trend in interventions addressing cognitive impairment in older adults emphasizes the role of social interactions. Research indicates that factors such as the size of the support network (12), engagement in social roles (13), and the quality of social relations (12) influence cognitive functioning in older adults. Specifically, studies have found that smaller social networks are associated with fewer social resources, lower perceived support, and decreased commitment to the community, all of which correlate with lower scores on neuropsychological tests (14). The COVID-19 pandemic has further

accentuated the importance of social interactions, as older individuals, forced to adopt measures of social isolation and quarantine periods (15), have experienced adverse effects on the quality of their relationships, emotional well-being (16), and cognitive states (17). Notably, studies focusing on digital social networks during this period have highlighted the positive impact of maintaining social connections, demonstrating benefits for physical health, subjective well-being (18), and cognition (19).

In the field of social interaction through digital networks, Facebook (FB) has become the most widespread among older adults, as it is used by almost 50% of people over 65 years of age (20). However, only two studies have attempted to explore how the use of this platform is associated with cognitive benefits in older adults (21,22) and have methodological limitations due to very small sample sizes and the need for greater control of the study variables.

No studies have combined computerized cognitive training, the efficacy of which is already known (23), with training using digital social networks such as FB. However, given that improvements in social aspects positively affect cognition in older adults, providing additional training in FB to individuals who are not traditional digital media users could improve the effectiveness of CCT. Therefore, this study aimed to explore whether incorporating FB training could enhance the efficacy of a CCT program using the VIRTRAEL platform. VIRTRAEL is an open-access online platform with evidence of efficacy (24,25), incorporating exercises designed to train cognitive skills frequently affected in older adults, including attention, learning, memory, and executive functions.

We hypothesize that incorporating FB training into CCT will improve attention, learning, memory, and executive functions among older adults who do not typically engage with social media technology.

Methods

We conducted a double-blind, randomized, controlled trial. The evaluator and statistical researcher were blinded to treatment allocation. Before starting data collection, a researcher not involved in participant evaluation, training, or data analysis conducted concealed randomization of the groups. Only the individual responsible for administering the training, who remained blinded to the baseline assessment, performed the treatment according to the group assignment. The study was conducted following CONSORT guidelines (26) and approved by the Ethics Committee of the University of Granada (Ref. 364/2010). Participants were recruited from community centers in the province of Granada, where they were invited to explanatory meetings about the study.

Sample size estimation was based on the smallest effect size of the observed changes (d = 0.32) found in three studies sharing a similar design, type, and cognitive training parameters (27–29). Utilizing this data and considering the statistical method (Repeated-measures ANOVA between and within subjects), the number of groups (g = 2), the number of evaluations (m = 3), and assuming an alpha of .05 and a power of .85, the calculated sample size was 74 participants using the G-Power v3.0 program. The sample size was increased by 20% (95 participants) to account for potential dropouts.

The inclusion criteria were: a) being ≥ 60 years old; b) obtaining a score of ≥ 21 in the MiniMental State Examination (30); c) absence of depression or medical conditions associated with cognitive impairment (e.g., Parkinson's disease or multiple sclerosis); d) having basic reading and writing skills in Spanish; e) not having an employee or being retired, because work has a positive effect on cognitive abilities (31); and f) not having an account-profile in any digital social network and not possessing the knowledge to use one.

Ninety-five individuals meeting these criteria agreed to participate, providing informed consent. The sample was randomly divided into two parallel groups (1:1) (Supplemental File 1). Randomization by minimization was performed using Minimizer® to avoid gender imbalances between groups (32). Nine participants withdrew during the pre-intervention assessment, resulting in a final sample of 86 participants: 43 participants in the CCT group with VIRTRAEL and 43 in the CCT with VIRTRAEL plus FB training group. All participants who started the training completed it.

Sociodemographic variables, cognitive status, and mood were measured using the *Mini-Mental State Examination* (30), the *Cognitive Reserve Questionnaire* (33), and the *Geriatric Depression Scale-30* (34). Student's t-tests and Chi-square analyses revealed that people who dropped out did not differ from those who completed the study in terms of age, gender, education, mood, or MMSE score.

A blinded evaluator conducted individual neuropsychological pencil-and-paper assessments, each lasting approximately 90 minutes. The pre-intervention assessment took place within two weeks before training; the post-intervention assessment took place in the week immediately following the training, and the follow-up assessment occurred three months later. The primary measures were as follows:

(I) *d2 Test of Attention* (35): A concentration index (d2-Concentration) was obtained by subtracting the number of commission errors from the total number of correct answers.

(II) *Hopkins Verbal Learning Test-Revised* (36): Forms A, B, and C were used, one at each point in the assessment. The indexes included in this study were learning on Trial 3, delayed free recall, and the number of target words correctly recognized.

(III) *Letter-Number Sequencing, Similarities, and Matrix Reasoning* (Wechsler Adult Intelligence Scale) (37,38). These tests were applied to measure working memory and semantic and abstract reasoning. The overall raw scores were used.

(IV) *Key Search* (Behavioral Assessment of the Dysexecutive Syndrome tests battery) (39): This ecological test was designed to assess planning ability as part of executive functions. The overall raw score was used.

Additionally, participants in the CCC+FB group were asked about their FB usage during the three months following completion of the training.

Training consisted of nine sessions conducted twice a week, with a two-day gap between sessions, spanning five weeks. Each session lasted approximately 45-60 minutes (depending on the participants' speed) for CCT in both groups, with an additional 30 minutes for FB training in the CCT+FB group (along with a 10-minute break between both types of training). All sessions were conducted in person at community centers by a researcher not involved in the assessment and data analysis. Each participant had access to an individual computer at the center. The researcher led the sessions and offered individual support whenever participants required additional assistance or clarification.

CCT utilized the VIRTRAEL platform, a freely accessible online program designed for mass application to enhance attention, learning and verbal memory, working memory, reasoning, and planning (http://www.everyware.es/webs/virtrael/#home) *(24,25,40)*. Comprising nine sessions, each lasting approximately one hour, the program includes a combination of three to five exercises from 11 training exercises. The difficulty of these exercises is adjusted according to the individual's progress in performance. The exercises included List of Errands (learning and verbal memory), Balloons (attention and working

memory), Messy Objects (attention), Bag of Objects (working memory), Image Classification (working memory), What's Different? (abstract reasoning), Semantic Analogies (semantic reasoning), Puzzle Pieces (abstract reasoning), Semantic Series (semantic reasoning), Logical Series (abstract reasoning), and Gift Purchase (planning). A detailed description of the exercises and sessions is provided in Supplemental File 2, and a demo of VIRTRAEL can be accessed via the following link: https://virtrael-demo.web.app/exercises.

FB training in the CCT+FB group occurred after completion of the CCT and. It consisted of two phases (Supplemental File 3). Phase 1 (training) was aimed at training, during the first five sessions, how to use the Facebook social network following a guideline for beginners (41). An initial explanation in group format was given of the essential aspects (what, why, how, etc.) of each of the contents programmed for each session. At the same time, visual support was provided in real-time through a screen and digital projector, which were connected to the instructor's computer. The contents addressed in each session were as follows: (I) *Privacy of data and publications* (Chapters 17, 18 and 19); (II) *Search for friends and friend requests* (Chapters 2 and 3); (III) *Sharing information* (photos, texts, videos, etc.) (Chapters 5 and 6); (IV) *Commenting or reacting to the publications that others share* (Chapters 11 and 16); and (V) *Use of private messages* (Chapter 9). In Phase 2, the aim was making a full use of the basic utilities of Facebook. During four sessions, the competencies acquired sequentially in Phase 1 were then practiced jointly. Each person individually managing their personal profile to carry out all the activities learned and to practice their basic use of the network. Participants were asked to freely practice everything they had learned, navigate their profile, and ask for help to solve any doubts and problems that arose.

Student's t / Chi-square tests were conducted to determine the equality of the groups on all sociodemographic and dependent variables at pre-intervention. To accomplish this objective, mixed 2 (Groups) X 3 (Time; pre/post/follow-up) ANOVAs were conducted to compare the effectiveness of the interventions in each cognitive measure. An intention-to-treat analysis was planned, however, because the nine older adults who dropped out after randomization did not attend the pre-intervention assessment, a per-protocol analysis was chosen. When an interaction effect was significant, *d* Cohen's effect size between independent groups was calculated for the post and follow-up times. Effect sizes were interpreted according to the generally accepted standards of Cohen (1992): 0.2 for a small individual change, 0.5 for a moderate individual change, and 0.8 for a large individual change. Version 28 of the SPSS statistical package was used to conduct all statistical analyzes.

Results

There were no significant differences regarding the sociodemographic variables of age, gender, years of education and cognitive reserve, cognitive status (measured with the MiniMental State Examination), and mood (see data in Table 1). Additionally, no significant differences were observed in neuropsychological test scores at the pre-intervention assessment (see data in Table 2).

The ANOVA results revealed a significant Group * Time interaction for three variables: learning (Hopkins Verbal Learning Test-Revised, Trial 3), working memory (Letters and Numbers), and abstract reasoning (Matrix) (see Table 2).

At post-intervention, the CCT+FB group obtained higher scores on the abovementioned variables, with the difference reaching significance for abstract reasoning (Matrix; $p < .001$). However, no between-group differences were observed at

follow-up. During the 3-month follow-up period, 37.2% of participants continued to use FB. An analysis was conducted to determine the relationship between FB use during follow-up and loss of benefits in the Matrix score relative to the CCT group. The between-group difference analysis was repeated, focusing on the 16 participants who continued to use the social network. Pairwise comparisons at follow-up revealed no significant differences (Matrix, $p = .729$).

Regarding the effect size for the Matrix score, the large value ($d = 0.89$) at post-intervention in favor of the CCT+FB group was not sustained at follow-up.

Finally, although not part of our objective, we report the main effect of time to highlight the long-term efficacy of CCT with VIRTRAEL. The main effect of time was significant and the post hoc analyses of the differences between the pre and the follow-up times were also significant for the following variables: Concentration ($F = 26.431$, $p \leq .001$), Letters and Numbers ($F = 30.549$, $p \leq .001$), Learning ($F = 38.678$, $p \leq .001$), Similarities ($F = 69.885$, $p \leq .001$), Matrix ($F = 90.342$, $p \leq .001$), and Key Search ($F = 7.904$, $p = .006$).

Discussion

This study aimed to determine whether Facebook training improves the efficacy of CCT based on the VIRTRAEL program in older adults. The inclusion of FB training produced a specific improvement in the Matrix Reasoning test scores compared to CCT with VIRTRAEL, but this effect was only observed in the short term and was not sustained after a three-month follow-up.

High scores on the Matrix Reasoning test indicate proficient nonverbal abstract reasoning and visuospatial information processing skills (42, p.183). Both skills are relevant in the lives of older individuals. Abstract reasoning as measured by visuospatial

tasks is related to people's performance in familiar contexts, such as the ability to navigate familiar places, one's own home, or to follow habitual routines (43). Functional limitations in everyday visuospatial information processing have been associated with an increased risk of functional disability in activities of daily living among older adults (44). CCT has emerged as a method for improving cognitive functions in healthy older adults, including visuospatial skills, with evidence of statistically significant effects on this cognitive function. A meta-analysis of domain-specific results from 51 studies found positive effects on visuospatial skills immediately after the interventions (7). However, among the eight studies closely examined, which included visuospatial skills, only three conducted a follow-up (45–47), and none reported significant group differences in this skill. In our study, although a larger short-term effect size in abstract reasoning was observed in the FB training group, this effect was not sustained in the long term, as it disappeared after finishing the program. This agrees with previous studies and, contrary to our expectations, FB training did not generate sustainable benefits.

Previous studies (13,48) have indicated that socio-emotional aspects play a crucial role in cognitive improvement. However, our findings differ since the 16 older individuals who continued to use FB lost their improvements in abstract reasoning. This finding suggests that factors beyond social influences should be considered to explain the improvements observed in the group during the combined social network and VIRTRAEL training period. One plausible explanation for these improvements might be the longer training time per session in the CCT+FB group. The duration of training sessions could be a critical factor, as supported by a meta-analysis revealing that the transfer of computer-based cognitive training tasks to cognitive domains and the global cognitive index was more likely when sessions exceeded 30 minutes each (7).

Two previous studies also found short-term cognitive improvements in older adults due to FB training. One study demonstrated enhanced working memory (22), while another indicated improved learning and verbal memory (21). However, it is worth noting that the latter study did not conduct between-group comparisons, and the active control group also showed cognitive improvements, albeit in different components. The control group received computer and Internet browsing training, which can be considered a source of cognitive training leading to positive effects over the five months of training (21). The fact that Facebook training enhanced different skills in these two studies suggests that managing this digital social network requires a wide range of skills, including attention, working memory, and verbal memory. Nonetheless, our research differs substantially from those two previous studies. In our case, both groups followed CCT, producing some of the long-term improvements found in those studies. The VIRTRAEL CCT improved concentration, working memory, verbal learning, semantic and abstract reasoning, and planning. Therefore, CCT with VIRTRAEL (49,50) has emerged as a comprehensive and superior approach compared to Facebook training.

This study has several limitations that warrant consideration. First, we did not include measures to help determine whether Facebook use contributed to participants feeling less lonely or more socially connected. Therefore, we were also unable to ascertain whether the observed improvements in cognitive performance were associated with changes in social aspects and how these aspects developed during the follow-up period. Additionally, we did not measure the extent to which the observed improvements transferred to activities of daily living or impacted the subjective well-being of older adults. Finally, a notable limitation is the unequal duration of training between the groups, with the CCT+FB group receiving an additional 30 minutes, potentially introducing a confounding factor.

In conclusion, integrating Facebook training into CCT does not significantly increase the effectiveness of the latter for older adults. CCT with VIRTRAEL, a freely available tool applicable on a large scale for healthy older adults, produced improvements in concentration, working memory, verbal learning, semantic and abstract reasoning, and planning.

Clinical messages

- CCT with VIRTRAEL effectively improves concentration, working memory, verbal learning, semantic and abstract reasoning, and planning three months after the end of training.
- The addition of 30 minutes of FB training produced a specific improvement in abstract reasoning compared to CCT with VIRTRAEL, but this enhancement only lasted for three months without continued training.
- VIRTRAEL is a freely available tool that can be utilized on a large scale, potentially benefiting many healthy older adults.

Conflict of interest

The authors declared no potential conflicts of interest concerning the research, authorship, or publication of this article.

Author Contributions

Conceptualization, A.C.R., y M.P.G.; methodology, A.C.R., M.P.G. and S.R.P.; software and randomization, C.R.D., y A.C.R.; validation, S.R.P., and A.C.R.; formal analysis, S.R.P., and A.C.R.; investigation, C.R.D., S.R.P., and A.C.; resources, C.R.D., and A.C.R.; data curation, S.R.P., and A.C.R.; writing—original draft preparation,

S.R.P., A.C.R., and M.P.G.; writing—review and editing, S.R.P, A.C.R., M.P.G., and, C.R.D.; supervision, S.R.P, A.C.R., M.P.G., C.R.D., and, E.M.S.L.; project administration, A.C.R., and, M.P.G.

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Conflict of interest

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Table 1

Sociodemographics data, cognitive status, cognitive reserve, and mood of participants

Characteristics	CCT (N=43)	CCT-FB (N=43)	Between-group comparison *p* value
Age $\bar{x}$ (SD) [range]	69.65 (5.98) [60-88]	70.07 (5.78) [61-90]	.907
Sex (% women)	84.8	83.7	1
Years of education (SD)	5.19 (3.03)	5.23 (3.61)	.174
MMSE $\bar{x}$ (SD)	27.84 (1.94)	28.33 (1.07)	.059
CRQ $\bar{x}$ (SD)	6.16 (2.93)	6.35 (2.72)	.770
GDS-30 $\bar{x}$ (SD)	8.65 (6.07)	8.56 (5.99)	.630

Note: CCT = Training group with VIRTRAEL; CCT-FB = training group with VIRTRAEL and Facebook; MMSE = Mini-Mental State Examination; CRQ = Cognitive Reserve Questionnaire; GDS-30 = Geriatric Depression Scale-30.

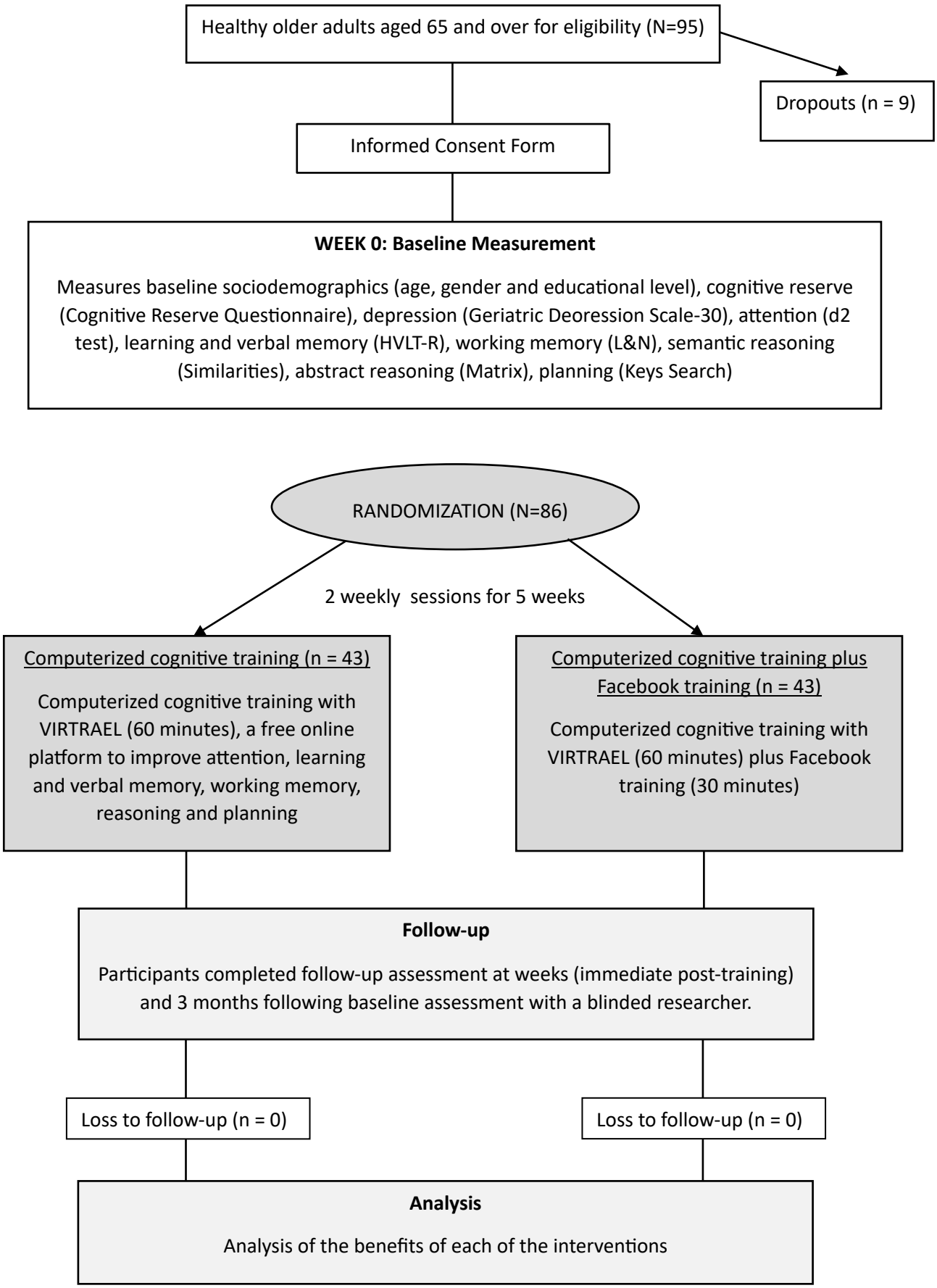
Table 2

Results of the CCT and the CCT-FB group comparisons in cognitive variables and effect sizes

Cognitive domain (test)	Variable	CCT			CCT-FB			Interaction Effect Gr*M		Pairwise comparisons *p* value		Cohen's *d*	
		Pre $\bar{x}$ (SD)	Post $\bar{x}$ (SD)	Follow-up $\bar{x}$ (SD)	Pre $\bar{x}$ (SD)	Post $\bar{x}$ (SD)	Follow-up $\bar{x}$ (SD)	*F*	*p*	Post	Follow-up	Post	Follow-up
Attention (d2)	Concentration	102.28 (34.93)	119.26 (40)	121.86 (30.39)	114.84 (28.11)	126.37 (30)	127.19 (35.42)	1.220	.272				
Verbal Memory (HVLT-R)	Learning	8.33 (1.61)	9.26 (1.54)	8.98 (1.63)	7.86 (1.46)	9.79 (1.60)	8.77 (1.67)	5.089	.007	.118	.558		
	Delayed recall	6.51 (2.40)	7.58 (2.07)	6.56 (2.14)	5.95 (2)	8.09 (2.29)	6.30 (2.16)	2.591	.078				
	Recognition	10.53 (1.18)	11.12 (1.03)	10.60 (1.22)	10.60 (1.28)	11.21 (1.06)	10.84 (1.11)	0.178	.674				
Working Memory (WAIS)	L&N	5.72 (1.84)	6.67 (2.36)	6.88 (2.04)	5.88 (1.55)	7.33 (1.89)	6.58 (1.48)	4.393	.014	.161	.434		
Reasoning (WAIS)	Similarities	12.41 (4.31)	16.44 (3.23)	15.23 (4.46)	12.53 (3.75)	16.58 (3.92)	15.14 (4.74)	0.109	.896				
	Matrix	7.56 (3.51)	10.58 (3.65)	9.47 (3.78)	7.56 (2.47)	13.84 (3.65)	9.79 (3.95)	13.374	≤.001	<.001	.697	.893	.083
Planning (BADS)	Key Search	6.14 (2.86)	6.91 (2.64)	7.16 (3.18)	6.47 (2.81)	7.60 (3.54)	7.42 (2.93)	0.347	.557				

Note: CCT = Training group with VIRTRAEL; CCT-FB = training group with VIRTRAEL + Facebook; d2CON= concentration index of the Attention Test d2; HVLT-R=Hopkins Verbal Learning Test–Revised (Learning: learning on trial 3; Delayed recall: No. correct words in the delayed free recall trial; Recognition: No. target words correctly recognized); WAIS: Wechsler Adult Intelligence Scale III & IV; L&N: Letters and Numbers; BADS: Behavioral Assessment of the Dysexecutive Syndrome tests battery; Gr * M = Group x Time interaction effect.

Supplemental material 1. Flowchart of the procedure.



Supplemental material 2. Description of VIRTRAEL exercises and sessions.

The exercises have different levels of difficulty, support and incentives in order to improve adaptation to cognitive baseline status and participant's motivation. VIRTRAEL automatically records the time spent performing each activity, as well as the accuracy and failure rate. Once participants successfully reach an 80% of accuracy of a certain level, a virtual reward is displayed and they proceed to the next level. In addition, two elements are provided to motivate the participants:

- At the beginning of the activities, an avatar is displayed as an assistant and explains the objectives and steps of the exercises.
- Users receive virtual medals (gold, silver, and bronze) at the end of each exercise to reward their performance. This kind of feedback stimulates competitiveness and provides a sense of achievement.

VIRTRAEL contains 9 sessions of training, with a minimum duration of 40-60 minutes each. During each of these sessions different tasks are carried out:

- *Lists of Errands*: which is designed to improve verbal learning and episodic memory through strategy instruction and practice. In order to use ADL, the lists comprise common errands that older people normally carry out.

- *Balloons:* an n-back task (1-back, 2-back and 3-back) designed with balloons (each carrying a printed letter) which move from the right to left-hand side of the screen, and then appear and disappear one at a time in order to train both focused and sustained attention and working memory. The exercise will last two minutes, during which the user must be attentive to detect repetitions of letters. It has several levels: in level 1, the objective of the exercise is to press on the screen each time a balloon appears with the

same letter as the previous one; at level 2, when a balloon appears containing the same letter as the balloon that appeared two positions earlier; and, at level 3, when the balloon containing the same letter appeared three positions earlier.

- *Gift Purchase*: designed to improve planning skills (establishing goals, control implementation and measuring results). The screen shows a shopping area and the participant must buy a series of gifts for other people on account of each person's listed preferences and within a limited budget.
- *Long-term memory of the List of Errands*
- *Messy objects*, an exercise that has been specially designed to improve the user's sustained, selective and alternating attention. The user must scroll through the different rooms in the house. The aim of the game is to find any household object which is in the wrong place and move it to its correct place. Users are also asked to collect the coins they find in each room. The user must find the objects which are not usually found in that room.
- *¿What is different?* It is an exercise in reasoning with figures, which aims to stimulate the user's perceptual organization capacity. This will have to identify and select, from among the various figures that are presented, the figure that is different from the others.
- *Semantic series*: It is a verbal reasoning exercise, which establishes relationships between categories of words. In each screen that is presented to the user, a series of words are shown, and the user has to select that word that has no relation to the others.

- *Logical series*: This is a reasoning exercise with figures, which aims to measure the capacity for perceptual organization, presenting on different screens several series of figures (one series per screen) that follow a sequence, according to a certain criterion. The user will have to find out in each case the criterion in question and select, from among the figures proposed in the lower part, which of them is the appropriate one to complete the series

- *Puzzle pieces:* This exercise aims to stimulate the visual perception of the user through images. The user will be presented with an image in the middle of the screen. Several snippets of that image will also be shown to you at the bottom of the screen, along with two other snippets that don't belong to the image. The user will have to select the two pieces that do not belong to the image shown in the central part.

- *Semantic Analogies:* Like the semantic series, it is a verbal reasoning exercise, which is based on deductive and comparative thinking. The user is presented with an expression that contains an association of words such as: "If such a thing is as such another, then this is like ...". He will have to finish the sentence, selecting from among the proposed options the one he thinks is correct.

- *Classifiable Objects*: task which is based on semantic and category strategy use for learning new materials. It is an exercise to stimulate visual memory. In the test, the user will be presented with a screen with different objects that they will have to classify in their corresponding categories. Once the test is finished, the user will have to perform memorization exercises. To do

this, you will be presented with a series of images of objects (9 in level 1) from different categories that you will have to memorize for a specified time. The number of objects and the time increase based on performance.

- *Bag of Items*, a working memory training exercise based on a simulated walk through a neighborhood, in which the participant exchanges relevant objects in various local places. The user must memorize the objects that the person picks up and leaves along the route (in each of the establishments that he visits), in order to be able to indicate at the end of the exercise the objects that remain in the bag.

A priori, the 13 sessions will be distributed as follows:

Session 1: Marksmanship test, sociodemographic data registry, Functional Screening (two questionnaires on the performance of Activities of Daily Living) and pre-stimulation Cognitive Screening.

Session 2: Pre-stimulation Cognitive Screening**.**

Sessions 3 to 11: Cognitive stimulation of the different cognitive functions to be treated**.**

- **Session 3:**
    - *Lists of Errands*
    - *Ballons*
    - *Gift Purchase*
    - *Long-term memory of the List of Errands*
- **Session 4:**

- *Messy objects*
- *¿What is different?*
- *Semantic series*
- *Logical series*
- *Puzzle pieces*
- *Semantic Analogies*

- **Session 5:**
  - *Classifiable Objects*
  - *Gift Purchase*
  - *Bag of Items*
- **Session 6:**
  - *Lists of Errands*
  - *Ballons*
  - *Messy objects*
  - *Long-term memory of the List of Errands*
- **Session 7:**
  - *Semantic series*
  - *Logical series*
  - *Puzzle pieces*
  - *Semantic Analogies*
  - *Gift Purchase*

- **Session 8:**
    - *Classifiable Objects*
    - *Bag of Items*
    - *Messy objects*
- **Session 9:**
    - *Lists of Errands*
    - *Semantic series*
    - *Logical series*
    - *Puzzle pieces*
    - *¿What is different?*
    - *Semantic Analogies*
    - *Long-term memory of the List of Errands*
- **Session 10:**
    - *Messy objects*
    - *Gift Purchase*
    - *Ballons*
- **Session 11:**
    - *Bag of Items*
    - *Semantic series*
    - *Logical series*

- *¿What is different?*

- *Semantic Analogies*

- *Classifiable Objects*

Session 12 and 13: Post-stimulation Cognitive Screening with parallel versions of the List of Words, Series of Semantic, Series of Logic and Parcel Delivery tests.

Supplemental material 3. Description of the Facebook training phases.

Facebook training consisted of two phases.

- Phase 1 was aimed at training how to use the Facebook social network following a guideline for beginners (41), during five sessions. The contents addressed in each session of Facebook training were as follows:

  I. *Privacy of data and publications*. This session explained how to edit the personal profile so that the shared information is private and secure, including: personal data, photos, and shared publications. In doing so, we wanted to ensure that people were aware of the usefulness of Facebook without violating the right to publish only what is strictly desired. In addition, the meaning of each of the characters / symbols that appear on the main screen interface and the actions that can be performed through these were specified. Users scrolled through the various tabs to verify that they understood.

  II. *Search for friends and friend request*. In this session, users were explained the steps to follow to search for friends on Facebook, including search by full name or email along with the procedure for sending and / or accepting friend requests. In order to speed up the practice, the attendees were invited to "join" among themselves, always starting from the premise that the action could be undone when they so desired.

  III. *Sharing information* (photos, texts, videos, etc.) In this session, we discussed in more detail the usefulness of Facebook for interacting with people. Subsequently, we indicated how to upload photos or leave comments on their profiles and how to share information about news, photos, or videos of interest. Everyone practiced with material already stored on the computer or, if they preferred, using the Internet browser.

IV. *Commenting or reacting to the publications that others share*. Once users learned to share information, the importance of giving their opinion on what others share was explained to them. Next, they practiced in different ways, including writing comments, reacting via "like" links, and sharing their friends' posts.

V. *Use of private messages.* In this session, the differences between public domain comments and private messages were explained and subsequently put into practice.

- In Phase 2 (Training for the basic use of the account), the competencies acquired sequentially in Phase 1 were then practiced jointly. Each person individually managing their personal profile to carry out all the activities learned and to practice their basic use of the network. During these last four sessions, participants were asked to freely practice everything they had learned, navigate their profile, and ask for help to solve any doubts and problems that arose.