



# Cognitive training through DVD: Working memory task as a tool for rehabilitation in elders

## Abstract

Studies have shown that working memory tasks minimize the cognitive disabilities associated with old age. In this context, the present study examined the behavioral changes of working memory in elders during a cognitive training through DVDs. The results show that there is significance in MMSE tests ( $p=0.001$ ), self-evaluation ( $p=0.002$ ) and verbal fluency test in the semantic category ( $p=0.022$ ). However, verbal fluency tests of spelling criterion and free evocation did not present significant differences ( $p \geq 0.05$ ). Based on the findings, we suggest that recurring training with working memory tasks through DVDs promotes neural adaptations compared to retaining and recalling the memory, promoting a compensatory effect in the performance and maintenance of cognitive skills. In addition, the training of working memory through DVDs offers a non-invasive, non-pharmacological and low-cost alternative for rehabilitation.

**Keywords:** Cognitive training, working memory, elders, rehabilitation.

## Introduction

The world population ageing is a phenomenon that has occurred in recent decades, becoming an adjunct in risk of diseases that impair cognition and executive functions [1,2]. In this context, studies that associate training and cognitive rehabilitation attempt to slow down or even minimize the deficiencies from old age, as well as the decline of the neurobiological aspects such as memory and executive functions [3,4]. Thus, with the findings regarding brain functioning in function of cognitive demands, this, through neuroimaging and electrophysiological mapping, allowed creating effective strategies to enhance the implementation of mechanisms involved in neural memory, and even stop or reverse the cognitive decline caused by old age and lack of intellectual activity [1,2-6].

Memory decline is not only associated with ageing, but mainly with reduced intellectual activity [4]. Neural integration machinery, in particular structures such as the prefrontal cortex associated with the hippocampus, is relevant to initial storage, capacity to acquire, retain and recall information from memory, essential for all bodies' survival [7-9]. Based on the analysis of memory-relevant information processing, the main association route in the short to long-

term conversion is evidenced by the working memory, based on the attention control model, visuo-spatial processing, in addition to episodic integration for long-term memory [10,11].

Rehabilitation-based behavioral investigations are likely to determine phenotypes associated with working memory demand [12]. The literature seeks to trace a profile of cognitive training through multimedia that promotes differential sensitivity to cognition stimuli, in order to improve the quality of life of patients with cognitive deficits and healthy individuals with advanced age, maximizing the use of brain functions involved in that neurobiological aspect, with education of compensatory strategies and acquisition of new skills [2,4,13]. Cognitive training through multimedia provides the patient's awareness regarding their remaining capacities, in addition to producing compensatory effects on cognitive function [9,10,14]. The present study focuses on the training of working memory, since it can reduce the signs and symptoms of cognitive impairment through experience and task recurrence [15]. The proposed training encodes changes in neuronal interconnections and directs them to a mechanism of neural integration, which possibly improves memory skills in elders

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[1,16-18]. Studies show that the memory skills in elders who do not have dementia can improve with instruction and practice, through systematic training [19,20]. Therefore, our study presents a biologically plausible framework for improving and maintaining memory-related cognitive aspects, aiming at the elaboration of a non-invasive and easily applicable instrument for working memory training in a geriatric population, based on audio-visual resource and DVD video.

## Material and Methods

### ■ Participants

We developed a prospective and qualitative-quantitative study at the Gafree Guinle University Hospital (HUGG) along the UNIRIO multiprofessional health residency, aiming to test the effects of working memory training through DVD in elders that attend the *Grupo Renascer* (Reborn Group) - HUGG (TABLE 1). We selected healthy individuals attending the *Projeto Renascer* (Reborn Project) at the HUGG, both sexes, aged 60 years or more, able to answer the self-evaluation questionnaire and perform the cognitive assessment, in addition to attending at least 75% of the cognitive training. We applied a detailed questionnaire in order to exclude individuals that could cause biases of evaluation, without minimum score of 24 points in the Mini Mental State Examination and consciousness level compatible with the speech therapy evaluation. Then, the participants signed the Informed Consent Form. This study was approved by the Ethics Committee of the Gafree Guinle University Hospital (HUGG) with the number 1.084.251, in accordance with the ethical standards inherent to researches involving human beings, considering Resolution 466 of 12 December 2012, of the Health National Council.

### ■ Experimental procedure

Initially, we applied two cognitive evaluation questionnaires in order to evaluate the different aspects of short-term memory:

(1) Verbal fluency test (VFT) is a test of lexical

access capability that provides information on the storage capacity of the semantic and spelling memory system, as well as the ability to retrieve information consolidated in memory.

(2) Mini Mental State Examination is a cognitive screening instrument aiming to exclude the elders that feature positive criteria for dementia.

The study occurred in three stages: Cognitive evaluation of the participants. Then, we developed the working memory training through DVD, lasting 1 hour, held in eight meetings for a week. Three months after completing the training, the reevaluation was done in order to comply with the reliability of the Mini Mental State Examination.

### ■ The working memory training program

The DVD for working memory training was developed through 50 hours of image capture at a studio; eight hours of external images; 80 hours for art-completion of roughly 300 inserts of images with audio, among cards and pictures; in addition to 32 hours for audio completion. The final product consisted of three DVDs, with seven hours of stimuli, the first one containing a menu with three explanatory sessions, the second DVD, a menu with a first example of five practical memory training modules and a third DVD with a second example of five practical training modules, so that users could reinforce the training. Nevertheless, the training was applied only through DVD 1 and 2.

The program uses memory training techniques available in the literature [2,19]. We started with a non-traditional approach to the training DVD, since it assumes the user engagement and potential improvement of cognitive functions. Given this, the use of instructions for implementation is an effective strategy to improve the elders' cognition during the execution of specific tasks [2,19]. The main objective is to raise the participants' awareness about the positive effects of memory training. The first non-traditional approach consists of exploring automatic components of cognitive function, which does not decline with age, as it relates to the ease of adherence to certain behaviors that favor the memory development [19]. The DVD application is clarified at that stage through three sessions: the process of memory formation, automatic and voluntary attention, as well as the most effective strategies to improve the memory. The description of

TABLE 1: Patient profile.

Patient's Profile	
Gender	Sample (%)
Male	2 (8.7)
Female	21 (91.3)
Age (years)	Mean $\pm$ SD
Minimum - Maximum: 63-91	76.4 $\pm$ 7.4

this session promotes greater participants' adherence and commitment with the training that will be offered, as well as facilitates retaining information during training.

In the sequence, the visual stimuli associated with auditory stimuli were divided into five practical modules, which included memorization techniques based on traditional approaches. The stimuli were inserted in modules in increasing levels of amount and complexity [1-3]. The selection criteria of the stimuli based on working memory components [20-22]. The Visual stimuli through image detection and discrimination of figures tend to facilitate the selective attention, influence the parahippocampal gyrus activation and can improve the short-term information storage [23]. In addition, playful or common daily stimuli were privileged in order to promote greater motivation during the task [20].

Furthermore, the proposition of name mnemonics techniques was developed through filming with 108 people, chosen randomly, in order to promote a greater proximity with the reality and avoid repetition of names in the task. The technique consists of memorizing information, which makes a new connection between information to be stored and the memory already consolidated, relating information in order to chain them together logically. The selection criteria of words and tasks presented in the exercises were chosen without semantic or phonological similarity, since they are easier to memorize. Lexical selection took into account only the morphological aspect. Initially, monosyllabic or disyllabic words were offered and with gradual syllabic increase, since polysyllabic words can produce cortical activation a bit slower than those with fewer syllables [24]. Logical activities were proposed because they are related to the increased speed of information processing and improved memory performance [1,2]. The selected exercises of logical reasoning are easily solved, considering the great difficulty of elders with this type of task. The aim was to

minimize possible frustration while developing such activities.

## Statistical Analysis

The variables were analyzed statistically by the R commander through absolute and relative frequency as well as mean and standard deviation. For comparison of the variables of the study, the non-parametric paired test of Wilcoxon was used. The significance level was fixed at  $p \leq 0.05$ .

## Results

The population consisted of 42 elderly individuals, attending the Reborn Group-HUGG, 19 were excluded (13 were absent in more than 20% of the cognitive training, five did not reach the minimum score in the MMSE and one did not have the minimum age for the study). The final sample consisted of 23 participants: 21 (91.3%) elderly women and two (8.7%) elderly men. The age group of the study population was  $76.4 \pm 7.40$  years, with variation between 63 and 91 years (TABLE 1).

In relation to previous memory training, 12 individuals had already been through some type of training (52.2%), all for over six months. When analyzing the professional responsible for this training, eight people reported having done with psychologist (66.7%), one with geriatrician (8.3%) and three could not name the professional (25.0%).

TABLE 2 presents the results of cognitive assessments carried out by individuals before and after training. The highest score for the MMSE assessment is 30 points and for the self-assessment of working memory, 100 points. In relation to the frequency, in the eight weeks of implementation of the program, five individuals attended 100%, eight individuals attended 87.5% and 10 individuals were in 75% of the training.

It also presents the median of the results of

**TABLE 2: Results and significance pre-intervention and post-intervention.**

Pre-intervention and Post-intervention Significance					
Cognitive evaluation	Results				p-value
	Mean $\pm$ SD Before	Median Before	Mean $\pm$ SD After	Median After	
MMSE	26.4 $\pm$ 1.79	26	28.9 $\pm$ 1.6	29	< 0.001*
Self-evaluation	60.0 $\pm$ 15.06	65	69.8 $\pm$ 15.95	70	0.002*
VFT - Semantic category	13.9 $\pm$ 3.77	13	15.5 $\pm$ 4.21	16	0.022*
VFT - Spelling Criterion	17.6 $\pm$ 6.28	17	18.3 $\pm$ 7.65	17	0.332
VFT - Free Evocation	34.7 $\pm$ 10.15	34	37.7 $\pm$ 12.53	37	0.222

Note: MMSE - Mini mental state examination.

the evaluations made by the participants of the survey after the completion of memory training on DVD. There was significance in the MMSE ( $p=0.001$ ) (FIGURE 1), self-evaluation ( $p=0.002$ ) (FIGURE 2) and verbal fluency test in the semantic category ( $p=0.022$ ) (FIGURE 3). There was no statistical significance in the result of verbal fluency tests spelling criterion and free evocation. FIGURES 1-3 display the outcome of cognitive evaluations before

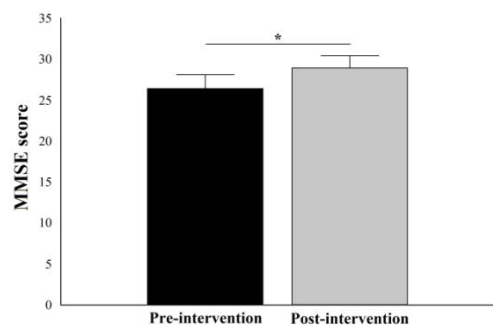
and after the memory training conducted by individuals from the study.

## Discussion

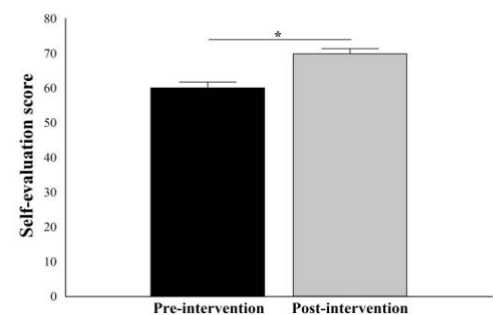
Cognitive training programs have hypothetically the potential to minimize age-related memory decline, extending the cognitive competence [1,4,14,20], due to demonstrating an easily applicable multimedia format and gathering different techniques that stimulate the memory.

The findings related to traditional training approach were the ones with the best results. This type of approach assumes an improvement in the neurobiological aspect of memory, because the presence of an instructor and specific activities of memory training present greater cognitive benefits to its participants, since it reaches a wider range of the population included in the training [2,6]. In order to answer this question, researches have been developed with non-traditional memory training approaches using guidelines and automatic components of cognitive function, in addition to proposing social, intellectual and emotional engagement [2,19,20]. This type of training bases on the orientation of the subject on ways of acquiring memory, in addition to using components that warn at any moment, requesting for help regarding information while performing the task. This way to assist during training enhances cognitive resources in the performance of cognitive tasks [19,20]. However, although the results indicate the patients' improvement in the sets of memory assessments, long-term cognitive gains should be treated with recurrent training. Based on that kind of approach, the DVD also contained information on the stages of acquisition of long-term memory formation and practical exercises that can improve the cognitive memory resources. In addition to guidance on the importance of having social and intellectual activities permanently.

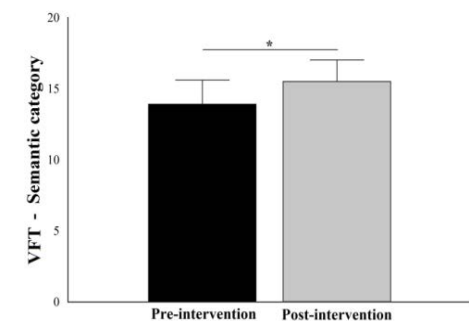
The increased elderly population generates the need for developing techniques or strategies that stimulate cognitive function, through affordable resources, easily used by the public. Our training proposal implements all these addressed issues, in order to overcome the limitations of traditional training, as difficulties to accessibility and cost [1,2,25]. Accordingly, updates through multimedia and training software evolved to provide new treatment and rehabilitation capabilities with consequent benefits to patients, including computerized and



**FIGURE 1: MMSE scores in pre- and post-intervention conditions are presented by median + standard deviation. Significant results are highlighted with an asterisk (\*).**



**FIGURE 2: Self-evaluation scores in pre- and post-intervention conditions are presented by median + standard deviation. Significant results are highlighted with an asterisk (\*).**



**FIGURE 3: VFT - semantic category in pre- and post-intervention conditions are presented by median + standard deviation. Significant results are highlighted with an asterisk (\*).**

online memory training. Therefore, our study allows a modern and easily applicable resource, as well as minimizes the lack of familiarity of the study group with multimedia resources through DVD, making the training program more effective [1,2].

After applying non-traditional approaches, the training program included the memorization techniques used in memory training studies [2,3,10]. The evaluations and training were self-explanatory and exemplified. In the experiment with the DVD, the elders' evaluation started with the Mini Mental State Examination prepared by Folstein et al. [26], creating a cognitive function screening, able to evaluate temporal and spatial orientation, short-term memory, evocation, attention and language skills. We can perceive the increased cognitive load with memory training ( $p < 0.05$ ). Analyzing this change, we can explain this increase primarily by the evocation item score (remembering three words, based on the mnemonic task), whose training participants began to feature better retention of information displayed for the visual stimuli tasks associated with auditory stimuli into five practical modules, which included the memorization techniques based on traditional approaches [26-28].

With respect to the self-evaluation outcome, the individuals' perception in relation to memory after training sessions improved, since the initial average was 65.0% and, on reevaluation, it increased to 69.9%. These improved answers, although discreet, represent the individuals' awareness regarding their cognitive abilities.

Moreover, the verbal fluency test showed that the organization of semantic information can be mediated by the training recurrence. Nevertheless, the different strategies used during the task, i.e. the individuals' words production order, will lead various results. The efficiency in this test requires grouping words within subcategories, and changing for a new sub-category when the first one runs out. The groups rely on verbal memory processes and relate to the temporal lobe; on the other hand, the exchanges require mental and cognitive flexibility and relate to the frontal lobe and executive functions [15]. When we observe the

findings in the study, the semantic category of the verbal fluency test showed significant difference between the mean of pre- and post-memory training results. Nonetheless, the other surveyed categories also showed an improved performance after cognitive training sessions.

The study presents some limitations, such as the sample size, heterogeneity regarding sex, and the absence of an electrophysiological variable that can measure the learning of new skills and maintenance of memory; however, it provides some support for understanding new methodologies of non-invasive memory training. We suggest larger sample and homogeneity of the target population in future studies in order to provide greater subsidies to improve the memory training instrument on DVD and achieve the goal of prolonging cognitive skills, with possibility of social integration and realization of daily functions. In addition to the concurrent analysis with electrophysiological mapping tools in cortical and subcortical areas involved in the neurobiological aspects of memory.

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## Conclusion

Implementing the training program of working memory on DVD can reduce the impact of the biological aspects of aging, in order to slow the age-related memory decline, from the inclusion of memory training techniques into daily life. Working memory training offers an alternative memory keeping, as well as treatment and rehabilitation in individuals with neurological disorders. Further advantages relate to a non-invasive and easily applicable treatment, which minimizes symptoms of memory deficits linked to neurological disorders. Working memory training through DVD differs from the existing treatments for being potentially simple, non-invasive, pharmacological and with low cost.

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## Contributions

The authors contributed equally.

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## Conflict of interest

The authors declare no potential conflict of interest.

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