Comparing Data from a Computer Based Intervention Program for Patients with Alzheimer's Disease

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Abstract. Nowadays, dealing with Alzheimer's disease (AD) includes a combination of pharmaceutical and non-pharmaceutical treatment. But, current drugs do not, and potential future drugs might not, improve quality of life. Evidence suggests psychosocial interventions, like educational and arts programs, do in fact have such a benefit. Supportive and enriching information technology may be more important than biotechnology (Whitehouse, 2013). So non-pharmaceutical treatment including physical and mental exercising as well seem to perform better. There are many forms of mental exercising from simple crosswords puzzles to sophisticated video games that exercise different cognitive skills. Main object of this report is to present the results of a computer-based intervention program for people with AD that take place in two Day Care Centers of Greek Association of Alzheimer's Disease and Related Disorders in Thessaloniki, Greece. There is a significant amount of data that include patients, who have taken part in interventions programs since 2009. For the purpose of this study we included data for a period of one year only. These patients have been tested before and after each intervention program (pre-test and post-test). Our work was to compare these data to examine how the program performs and which cognitive skills seem to have better improvement. The results showed that patients' overall scores were preserved for this period of time and had a slightly improvement which is a promising result indicating that this intervention program has positive effects.

Keywords: computerized cognitive training, Alzheimer's disease, cognitive rehabilitation.

1 Introduction

According to recent data, it is expected that the number of elderly people will increase dramatically. Indeed, it has been suggested that the advancements in the medical sciences, in combination with the adoption of a healthy lifestyle can help us live longer than before and improve our quality of life. As the human population ages, it is more than a necessity to make elderly peoples' life easier, so that they would be able

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to live on their own, without depending on someone else that would help them perform their everyday activities. However, it is commonly accepted that as an adult getting old, his/her brain is also getting old in a way that it gets more and more weakened as the years go by. A weakened brain could result to reduced cognitive ability and performance, and, consequently, the individual might not be able to perform daily activities. Even worse still, s/he might not be able to take care him/herself. This is a basic factor that characterizes dementia and its most common form, Alzheimer's disease (AD).

AD is a neurodegenerative disease that progressively destroys brain cells and the interconnections between them. As a result, the patient who suffers from this disease loses core functions and abilities day by day, presenting symptoms like reduced memory capacity, disorientation, and judgment and reasoning declines. Furthermore, s/he may also exhibit less self-control, and listening and speaking disorders, such as problems in naming objects or other people, text and speech understanding, and reduced visual-spatial perception. During the later stages of the disease the patient may lose core abilities and functions and he cannot even live by himself, as he may not be able to move, walk, feed, and get dressed.

Unfortunately, the attempts to find a pharmaceutical treatment of AD have come to a dead end, as there is no medicine that can heal the patients and bring them to their prior condition. Although, there are some treatment methods that can deal with the disease's symptoms that are available and already implemented and research is ongoing. The best way to deal with AD is to provide each patient with the appropriate medication in order to improve specific biological indexes. However, these medicines cannot prevent AD from progressing, but they can decrease the symptoms and slow the progression temporarily, improving patients' quality of life and fostering their caregivers.

Nowadays, there is a tendency all over the world by health associations focusing on research for better ways of treatment, which will try to delay AD's onset and development. It is proven that the best way so far, to treat the disease is the implementation of a combination of pharmaceutical treatment and cognitive training (CT), which may be remarkably useful and improve mental abilities and brain functionality. Cognitive training is a term which is described as an intervention that uses properly structured exercises to improve, maintain or restore mental function (Valenzuela, 2008.). CT can be used in order to limit and offset the cognitive abilities that have been affected. Another term for CT is "brain fitness" because it is possible to create new brain cells and train the brain in order to discover alternative ways to perform functions that controlled by brain regions which have been damaged. A characteristic advantage of CT is that does not demand large amounts of effort from the patients, as they are not involved in complex activities, but in contrast, they take part in simple, everyday activities familiar to those which already perform.

The implication of CT can be done in a variety of ways with different tools and stimuli but there are specific processes that are fundamental and consist of repeating actions that are common in a person's life and providing appropriate guidance, support and help to the patient. Suitable tools which can foster a CT program are electronic cognitive exercises or in general computer based CT that can use different modalities for such kind of activities. Electronic exercises can be implied usually by a PC or a portable device (smartphones, tablets) which are appropriate tools for repeating procedures and organize activities, according to each person's needs. A core principle is the potentiality to provide adapted content, according to each person's mental status, needs, targets and expectations. Also, a CT program should motivate and stimulate the user in order to be regularly engaged in realistic situations and activities so that he can transfer the acquired knowledge in his real life scenarios.

An individual, through CT intervention programs, could improve existing core functionalities or even develop new, alternative ones which will allow him/her to have, if possible, a normal life and a better quality of living. Also, the ability to adapt the content according to cultural characteristics or each user's cognitive status and the ease of customization in general is an important and helpful prospect in order to create personalized activities. Moreover, computer based applications offer instant monitoring and control of every user as well as data collections and metrics of each action in the electronic environment, in a way that let us monitor the performance and the overall progress, which is also useful for the user to be informed and have the right feedback. Feedback is an important aspect because it enhances user's performance, leads to better results and motivates him to perform better, so that strengthens his participation and reduces his disorientation. Finally, electronic applications for CT can include enriched multimedia elements such as images, audio and video to make more attractive activities that are more pleasant and enjoyable for the users.

Greek Association of Alzheimer's Disease and Related Disorders (GAADRD) offers a variety of services for patients and their caregivers including cognitive therapies for memory, attention and language enhancement. Besides traditional forms of therapies, such as cognitive tasks and exercises, cognitive music- therapy there are also computerized cognitive exercises for attention and language practice through personal computers (PC)s. The main intervention program consists of exercises that focus on memory and attention enhancement, each patient works on his own PC and deals with several exercises which are specifically designed for memory, logic, verbal, numeric and visual-space training that improve the patient's corresponding cognitive functions. These exercises demand an important amount of attention, processing speed and memory effort and the difficulty is escalading as the patient improves his cognitive status. This is a two times per week program.

In addition to that, there is also a training program that allows patients to exercise and familiarize with computers and technology. This program includes educational exercises for learning how to operate a PC and the acquisition of basic skills such as working on Windows based platforms, using Office's suite applications (MS Word, Excel), surfing on the internet and using e-mail services. This program usually happens also two times per week. The main target is to familiarize with a PC, for people with no previous experience and to learn new skills using the current technology.

Each exercise has five levels of difficulty, according to each patient's mental status, so they are suitable for both low-level and high-level patients and additionally, they do not require any previous knowledge of computers or technological education. Furthermore, the program takes place in a room with eight PCs, so that every patient sits on his own, and all of them have a touchscreen, a feature that lets patients to use the computer just by touching in specific spots on the screen.

Every patient has a record in GAADRD's database, which uses the OpenClinica's format configured especially for the needs of GAADRD. The database holds records about patient's personal information, demographic characteristics, medical and psychological tests and other important information. We have gathered data from 41 patients who attended a specific computer-based intervention program which was designed according to each patient's mental status. Some patients started in 2008 and still continue to participate in non-pharmaceutical intervention programs. Thus, our data are for a period of nearly five years, by we selected data form only a specific period of twelve months, in order to have more homogeneous sample.

In the next sections we present the sample's profile and patients' characteristics, we describe the method that followed and the intervention program, then the results that we gathered and finally, a discussion with comments and conclusions on the study.

2 Method

Participants. The patients who were selected fulfilled some specific criteria. First of all, they were aware of their memory deficits, they didn't suffer from depression or any other psychiatric or neurological disorder and their Mini Mental State Examination was equal or above 24. All of them, preserved satisfactory sensory abilities, lucked of any speech and language disorders and weren't on cholinesterase exhibitors. It is important to mention that patients' diagnosis was "Mild Cognitive Impairment" (MCI). MCI is a medium condition between normal senescence and dementia. As there is normal cognitive functionality decay through the years, it is possible that this decay may lead to dementia and MCI is the stage just before dementia appears.

Each patient was evaluated before and after his participation in the intervention program and each program lasted at least for one year. It is mentioned that some of the patients were already participated in these interventions, or they are still continue to take part. Both pre and post-tests include the same measurements for the following neuropsychological tests:

- Mini-Mental State Examination (MMSE), a short group of tests that used for detection of possible mental decline.
- Clinical Dementia Rating (CDR), a scale used to distinct different phases of dementia.
- Functional-Cognitive Assessment Scale (FUCAS), a scale based on personal interviews with the patient.
- Functional Rating Scale for Symptoms of Dementia (FRSSD), a scale for symptoms of dementia based on interviews with caregivers.
- Test of Everyday Attention (TEA), which tests the level of attention through three different activities. It consists of six individual tests which are TEA 1-A, TEA1-B, TEA4-A, TEA4-B and TEA6.
- Trail Making Test (TMT) Part B, for testing working memory and executive functionality.
- Rey-Osterrieth Complex Figure Test (ROCF), which tests visual-spatial memory by two individual tests ROCFT1 and ROCFT3.
- Rey Auditory Verbal Learning Test (RAVLT), which tests verbal learning and memory and consists of two tests RAVLT1 and RAVLT2.
- Rivermead Behavioural Memory Test (RBMT), a scale which tests episodic memory by two tests RBMT1 and RBMT2.
- Verbal Fluency Task, a test for detecting the ease of a patient to produce semantic or/and phonological words.

Intervention Program. The main intervention program includes a number of memory exercises with the use of computers. It takes place in a room with eight Pc's, where each patient has in front of him a touchscreen and performs the exercises. It aims at both low-level and high-level patients. It doesn't require knowledge of computers. There are 5 levels of difficulty in each exercise and the following categories:

1. visual - spatial exercises
2. speech exercises
3. numerical exercises
4. reasonable exercises
5. memory exercises

The training program is aimed mainly at high-level patients or caregivers. The team is a group 6-8 people and it takes place in a class. It is desirable for students to possess a PC in order to run the exercises that are given. The modules are:

1. Usability and familiarity with a PC - Microsoft Windows XP
2. Word Processor - Microsoft Office Word 2007
3. Internet use - Internet Explorer
4. Using accounts - Microsoft Office Excel 2007

The software used for the interventions is the “Complete Brain Workout” which is a commercial product. It has forty cognitive training activities districted in the five categories that mentioned before and it can stimulate the brain by exercising the mind, improve concentration and memory. Some of the exercises that includes are: Number Recall, Stepping Stones, What’s in the Box, Boxes, Linker, Path Finder and other. You can find further information in the following link: http://www.oak-systems.co.uk/index.php?option=com_content&task=view&id=51&Itemid=9 .

3 Results

For the statistical analysis we used IBM’s SPSS 19. We performed descriptive analysis and paired T-tests for each variable in Table 2. In Table 1 there are statistics about the age and the years of education of our sample. As we see, the average age is 66 years (Std. Dev.=8 years) and the average years of education is 11 years (Std. Dev.=4.5 years). So we have a well-educated sample and not quite old enough. In Table 2 we see the average and Std. Dev. for every test that took a subject before and after the intervention program. And in Table 3 there are the Paired Sample Statistics that indicate which pairs of tests present significant differences in their scores. Overall, we can see that there is improvement in all scores of all post-tests. As we can see, according to Sig. (2-tailed) index, there are four tests that have significant differences before and after the intervention program. These are the RAVLT2, TEA1-A, TEA1-B and VFT.

Table 1. Descriptive Statistics

Descriptive Statistics		
N=41	**Age**	**Education**
Mean	66,8049	11,4146
Std. Deviation	8,24384	4,59334

Table 2. Means and Std. Dev. for all the tests that performed

Test	Mean	Std. Dev.
preMMSE	28,3171	1,73838
postMMSE	28,1463	1,65168
preFRSSD	2,7073	2,27205
postFRSSD	3,0000	1,34164
preRAVLT1	4,7317	1,89769
postRAVLT1	5,1707	1,43008
preRAVLT2	7,7317	4,12931
postRAVLT2	6,2195	3,11859
preTEA1-A	26,3415	8,66490
postTEA1-A	30,0000	9,84886
preTEA1-B	44,5854	10,94069
postTEA1-B	48,6341	8,56959
preTEA4-A	7,1573	2,93934
postTEA-A	7,5122	2,35714
preTEA4-B	6,41	4,567
postTEA4-B	7,64	4,520
preTEA6	4,52	1,907
postTEA6	4,13	1,494
preRBMT1	12,8293	3,49930
postRBMT1	12,5366	3,43946
preRBMT2	11,4268	3,73591
postRBMT2	10,9756	4,18621
preROCFT1	31,8902	4,21235
postROCFT1	32,2683	5,45103
preROCFT3	16,5122	7,35568
postROCFT3	17,5976	7,28974
preTRAILB	208,2000	109,74871
postTRAILB	208,7250	103,66069
preVFT	11,11	4,237
postVFT	11,96	4,762
preFUCAS	43,1707	1,73064
postFUCAS	42,9756	1,66565

Table 3. Paired Samples Test which indicate significant statististical differences

Test	Paired Differences				p
	Mean	Std. Dev.	Lower	Upper	
preMMSE - postMMSE	,17073	1,59534	-,33282	,67428	,497
preFRSSD - postFRSSD	-,29268	2,15921	-,97421	,38885	,391
preRAVLT1 - postRAVLT1	-,43902	1,78954	-1,00387	,12582	,124
preRAVLT2 - postRAVLT2	1,51220	4,03189	,23958	2,78482	**,021**
preTEA1-A - postTEA1-A	-3,65854	8,15049	-6,23115	-1,08592	**,006**
preTEA1-B - postTEA1-B	-4,04878	8,95531	-6,87542	-1,22214	**,006**
preTEA4-A – postTEA-A	-,35488	2,78271	-1,23321	,52345	,419
preTEA4-B - postTEA4-B	-1,233	6,633	-3,327	,860	,241
preTEA6 - postTEA6	,391	1,402	-,051	,834	,081
preRBMT1 - postRBMT1	,29268	2,71794	-,56520	1,15057	,494
preRBMT2 - postRBMT2	,45122	3,69257	-,71430	1,61674	,439
preROCFT1 - postROCFT1	-,37805	6,17230	-2,32627	1,57017	,697
preROCFT3 - postROCFT3	-1,08537	5,53613	-2,83279	,66205	,217
preTRAILB - postTRAILB	-,52500	108,70638	-35,2909	34,2409	,976
preVFT - postVFT	-,850	2,612	-1,675	-,025	**,044**
preFUCAS - postFUCAS	,19512	1,22922	-,19287	,58311	,316

4 Discussion and Conclusions

Results showed significant statistical differences in four psychometric tests (namely RAVLT2, TEA1-A, TEA1-B and VFT) according to pre and post scores. Concerning RAVLT2 test we can see that there is a reduction between the pre and post scores. RAVLT2 test examines learning skills, thus we can conclude that after a year of intervention patients have less learning abilities. Further research has to be done in the future, in order to compare this result with a controlled group that will not participate in an intervention program. It is important to examine if this reduction is the same and/or has the same rate between these groups. The next two tests that have significant statistical differences belong to Test of Everyday Attention (TEA1-A & TEA1-B). Both tests examine the level of attention. In this case, the subjects presented better scores in both tests after the intervention. This means that the program improves selective attention and patient's ability to stay focused. Considering that the intervention program aims to foster attention, we can say that it fulfills this purpose. The last test that has significant statistical difference is VFT which examines verbal fluency and executive functions. We can conclude that there is improvement in verbal fluency and related language functions. This is a very important improvement due to the fact that this has also effect on high-level attention abilities.

Concerning the rest of tests we can conclude that even if there is no significant statistical difference, the findings are very encouraging concerning the mental status of the subjects. More specifically, it is important to mention that the scores in three tests (namely TEA6, FUCAS and TRAILB) have been slightly reduced or they have been remain almost the same (namely TRAILB). This is a positive finding, considering that a lower the score is, as better performance is. Furthermore, we can observe that there is a reduction in RBMT and RAVLT tests, probably because the intervention program is mainly targeted on exercising attention, but further research has to be conducted to investigate this fact deeper.

In conclusion, the majority of tests has been improved after a year of intervention and this is a promising result as there was no further progression of impairment. It is expected that an MCI patient gets worse as years go by, but results indicate stability or improvement, thus we can say that this intervention program has produced positive effects in general.

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