Does cognitive training with the use of a virtual museum improve neuropsychological performance in aMCI?

Tsatali Marianna, Greek Alzheimer Association,
Tarnanas Ioannis, Greek Alzheimer Association,
Malegiannaki Amaryllis-Chryssi, Greek Alzheimer Association,
Tsolaki Magda, Aristotle University, Greek Alzheimer Association,
Thessaloniki, Greece
Assistive Technology (AT) is a broad term covering a wide range of technology solutions from simple low technology to more complicated applications.
Discussion paper on using technology to support people living with Dementia.

Salamanca, Spain 2010 - 2011

Introduction

This discussion paper focuses on how technology can be used to support people living with dementia, their care partners, carers and the larger domain of dementia care. It is one of a series of white papers reflecting on a range of non-pharmacological interventions produced in a range of workshops in Salamanca, Spain from the winter of 2010 through spring 2011. A significant number of experts from around the world came together at these seminars to discuss the important issue of how we can support people with dementia and their carers using methods other than or alongside medications.

This discussion paper draws on the debate and discussion of participants in the Salamanca Seminar on Technologies and Dementia.

The key themes emerging from the workshop are:
1. Defining technology
2. Categorizing technology
3. Technology within the Dementia system
4. The person and the dementia journey
5. Outcomes of using technology with people who have dementia
6. A comprehensive model / framework for placing technologies in context of the dementia

This discussion paper is intended to generate lively debate and discussion during the Madrid 2011 Summit.
Defining Technologies in Dementia
Categorizing Technologies
The Person and the Dementia Journey

Technology can be helpful on an individual basis at specific needs
- Remembering
- Eating
- Taking a walk
- Speaking
- Walking
- Communicating
- Avoiding accidents (for example cut off the electricity supply)
Virtual environments (VE) have been developed since 1996 (Hodges et al., 1996), and now demonstrate effectiveness in the areas of clinical psychology and neuropsychology.
VR

Computer simulations that create perceivable information for human senses, such as visual and audio stimuli, and that maintain known aspects of the real world, such as space and time.
**VR accomplishes the following functions:**

*Virtual model:* thanks to its dynamism, it allows the validating of hypotheses:

1. architectural solutions
2. reconstruction of fragmented objects
3. transformation of an element over time, etc.
As with any other language, Virtual Reality serves to transmit information over different media (Forte, Kay et al., 2003).

In the specific area of museums there are great advantages.
Figure 1. Stills from the virtual museum route showing a toy placed at a non-decision point (A) and a non-toy at a decision point (B), and schematic overview of the recognition trials (C).

http://www.plosone.org/article/info:doi/10.1371/journal.pone.0018611
VR in memory decline

VR has the opportunity to provide new approaches to the treatment of memory deficits among elders (Optale et al., 2009).
The virtual reality museum is designed to speed up auditory **processing**, improve **working memory**, improve the **accuracy** and the **speed** with which the brain processes cognitive information and reengage the neuromodulatory systems that gate learning and memory.
<table>
<thead>
<tr>
<th>Literature</th>
<th>Use of the Virtual Action Planning Supermarket for the Diagnosis of Mild Cognitive Impairment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Klinger, Chemin, Lebreton and Marié (2004)</td>
<td>Performance within the virtual action planning supermarket (VAP-S): an executive function profile of three different populations suffering from deficits in the central nervous system</td>
</tr>
<tr>
<td>Man, Chung, Lee (2012)</td>
<td>Usability of a cognitive (Gradior) and physical training program based in new software technologies in patients with mild dementia, mild cognitive impairment and healthy elderly people: Long Lasting Memories preliminary findings</td>
</tr>
<tr>
<td>Franco-Martín, Palau, Ruiz, Vargas, Solis, Mellado, Toribio, Losada, Gómez, Bueno, Bartolomé (2011)</td>
<td></td>
</tr>
</tbody>
</table>
In our study, the **virtual reality museum** was designed to:

1. enhance auditory processing, *(ERPs P300)*
2. working memory, *(Digit span)*
3. improve speed of information processing *(Trail B, Stroop Effect Test)*
4. improve visuospatial ability *(Rey Figure)*
Scope 2

Experimental group
Control group
To reverse cognitive disuse and drive brain plasticity, the program strongly engages the brain with demanding exercises and an adaptive and reward-based daily training schedule.
In our approach

We embrace the philosophy of ecological thinking for the Virtual reality applications, interpreting virtual worlds such ecosystems.
Participants:
30 patients with amnestic Mild Cognitive Impairment (aMCI) (experimental group) and
30 control group with aMCI
Age: 65-80
Duration: 2010-2012.
The experimental group attended the “vrmuseum” program.
The control group had been placed on a waiting list.
Non parametric sample
Statistical analyses were carried out using $x^2$ and Mann-Whitney methods.

To evaluate auditory processing, working memory, speed of information processing and visuospatial ability we used: ERPs, MMSE, Trail Making B, FRSSD, Digit Span, Stroop test and Rey-Osterrieth complex figure.
Cognitive exercises are divided into three interrelated categories, that, in aggregate, span the cognitive functions of seniors:

- Listen & Plan:

- Storyteller:

- Exer-gaming:
Results

Intent-to-treat analyses, controlling for age, education, and cluster randomization were adopted.

There was a significant improvement of visuospatial memory performance ($p = .042$ immediate recall and $p = .036$ later recall), ERPs

There have not been observed any changes in general mental and functional performance between the two groups.
Results 2

Improvement in trained tasks:

<table>
<thead>
<tr>
<th>Spatial syllable match memory</th>
<th>Speed of Processing</th>
<th>Visuospatial memory</th>
<th>Working memory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Persons with improvements</td>
<td>93%</td>
<td>77%</td>
<td>91%</td>
</tr>
<tr>
<td>Average improvement</td>
<td>41%</td>
<td>10%</td>
<td>18%</td>
</tr>
</tbody>
</table>

- **Generalization**: Improvement in global auditory memory in the experimental group
- **Stability**: Effect stable also at 3 months follow-up
In conclusion, aMCI patients who participated in the Vrmuseum program outperformed the control group regarding visuospatial memory, suggesting that the present form of virtual reality training improves neuropsychological performance selectively on task related abilities.

Reported pre-post training effect sizes for intervention groups ranged from 0.19 to 7.14 for the total of 16 session Vmuseum interventions.
Discussion

Overall, computerized training findings are comparable or better than those from reviews of more traditional, paper-and-pencil cognitive training approaches, suggesting that consist an effective and less labor intensive alternative.

Main et al., 2004
Are we talking about the term of ‘digital dementia?’
Age-related cognitive decline can be through the selection of proper cognitive intervention programs. However, most existing softwares fail to demonstrate significant transfer of learning from the trained tasks to everyday activities.
Thank you for your attention!!

We don’t stop playing because we grow old, We grow old because we stop playing.
—George Bernard Shaw