Development Of An Hypothesis Driven Serious Game Capitalizing Music And Reminiscence Therapy

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Problem

Increased number of Alzheimer's Disease cases (35.6 million people Worldwide in 2009) :

In 2009 Alzheimer's disease **(AD)** worldwide healthcare costs reached about $422 billion. Portugal alone had health related costs of $2120.4 million. Moreover, AD not only affect family caregivers physically and psychologically, but also impairs and limit daily living of their carriers **(see Figure 1)**

Memory Lost
Challenges in planning activities of solving problems
Problems in completing daily chores
Confusion with time/space
Problems with oral and/or written communication
Difficulties in understanding visual images and spatial relationship
Putting things in abnormal places

Figure.1 – Signs of Alzheimer disease

Adapted From: 2015, Memory Loss & 10 Early Signs of Alzheimer's, www.alz.org/10signs.

These impairments are due to the progressive degeneration of the brain **(see figure.2)**. The disease evolves in a gradual and logical way. Thus, it is possible to predict which faculties will be affected during the course of the disease.

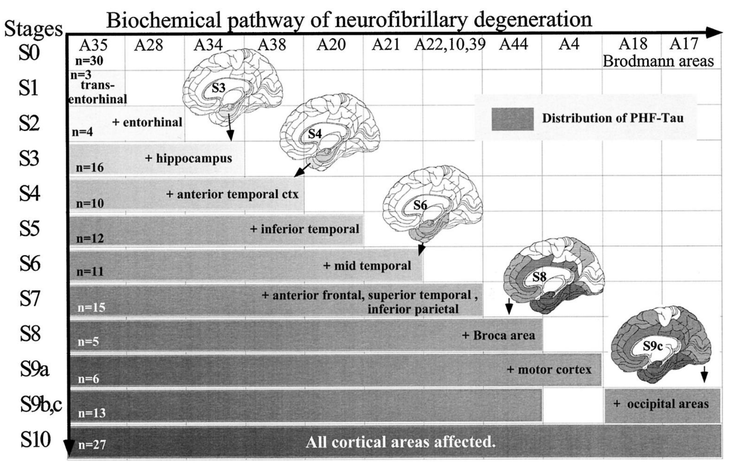

Figure.2 – Biochemical pathway of neurofibrillary degeneration

Adapted From: Delacourte, A., David, J.P., Sergeant, N., Buee, L., Wattez, A., Vermersch, P., Ghozali, F., Fallet-Bianco, C., Pasquier, F., Lebert, F., others, 1999. The biochemical pathway of neurofibrillary degeneration in aging and Alzheimer's disease. Neurology 52, 1158–1158.

Competences

As brain degeneration progresses, Alzheimer's patients lose competences. However, these can be (re)learned and stimulated via Serious Games (Foloppe et al., 2015). Yet, it's important to know which Play experiences they are capable to identify as the capability to understand ***Play*** changes throughout the disease **(see Figure 3).**

Impaired
Healthy

	Earliest AD	Mild to Moderate AD	Advanced AD	Brain structures
Challenge				Dorsolateral prefrontal cortex, Anterior cingulate cortex
Eroticism				Orbitofrontal cortex, Dorsolateral prefrontal cortex , Amygdala
Expression				Right prefrontal, Posterior temporal, Parietal cortices
Fellowship				Orbitofrontal cortex
Humour				Nucleus accumbens Caudate, putamen
Nurture				Orbitofrontal cortex Striatum
Relaxation				Primary somatosensory cortex
Reminiscence				Widely distributed
Sensation				Primary somatosensory cortex
Simulation				
Sympathy				Orbitofrontal cortex
Subversion				Orbitofrontal cortex

Figure.3 – Suitable Play experiences

Adapted From: Anderiesen, H., E. Scherder, G. Goossens, V. Visch, and L. Eggermont, 2015, Play experiences for people with Alzheimer's disease: International Journal of Design, v. 9, p. 155-165.

Working Memory and Competences

The working memory (WM) is a temporary storage system which allows manipulation of information that is necessary to perform multiple cognitive tasks such as **comprehension, learning and reasoning.** The following scheme (**Figure 4)** illustrates the current Working Memory of Baddeley.

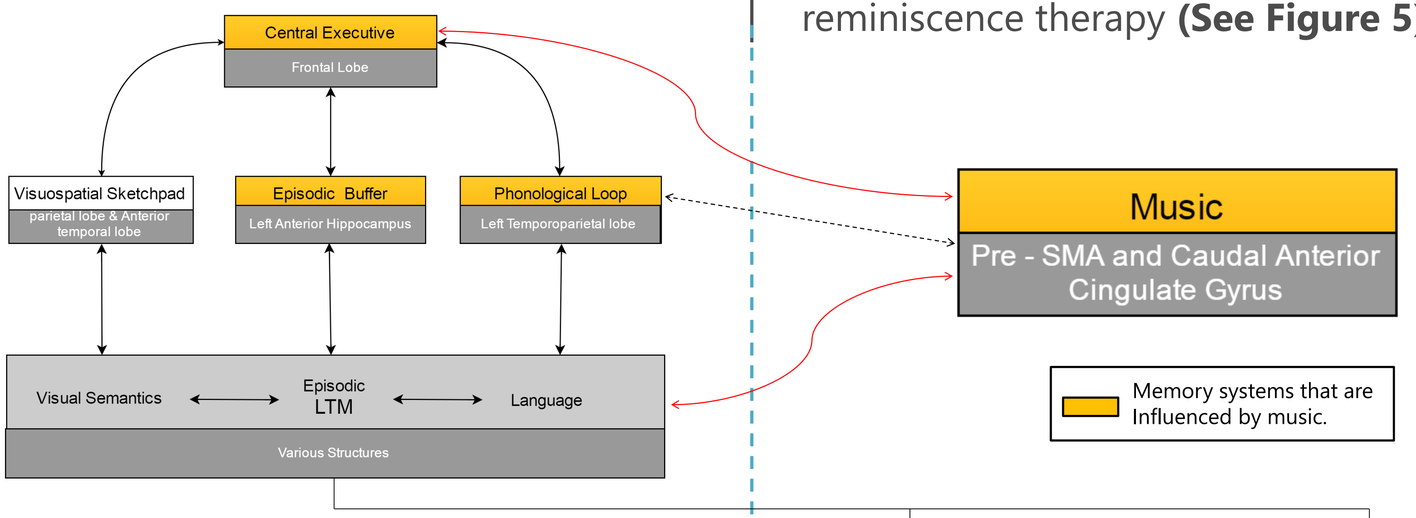

Figure.4 – Baddeley's Working memory

Adapted From: Baddeley, Alan. "The episodic buffer: a new component of working memory?."*Trends in cognitive sciences 4.11 (2000): 417-423.*

The bottom area holds long-term knowledge while the **visuospatial sketchpad**, **episodic buffer** and **phonological loop** areas represent temporary storage systems. Nevertheless, the working memory suffers impairments as Alzheimer's disease progresses:

Impairment of the central executive
Attention allocation failure

1. Impairment of the Episodic Buffer
Failure to join information from different memory system

2. Impairment of the Visuospatial Sketchpad
Visual and spatial related problems

3. Impairment of the phonological loop
Language related problems

Music and Remenescence

Music stimulates **dopamine** production which is important for the proper functioning of the **Central Executive.**, in order to enhance performance. In addition, music stimulates:

• **melatonin** which reduces stress and anxiety.

• **Auto-Bibliographical memories**.

• Music appears to be **intact until the latest stages of the disease.**

We hypothesize that it is possible to develop a Serious Game that enhances the competences that are crucial for **activities of daily living** via music and reminiscence therapy **(See Figure 5).**

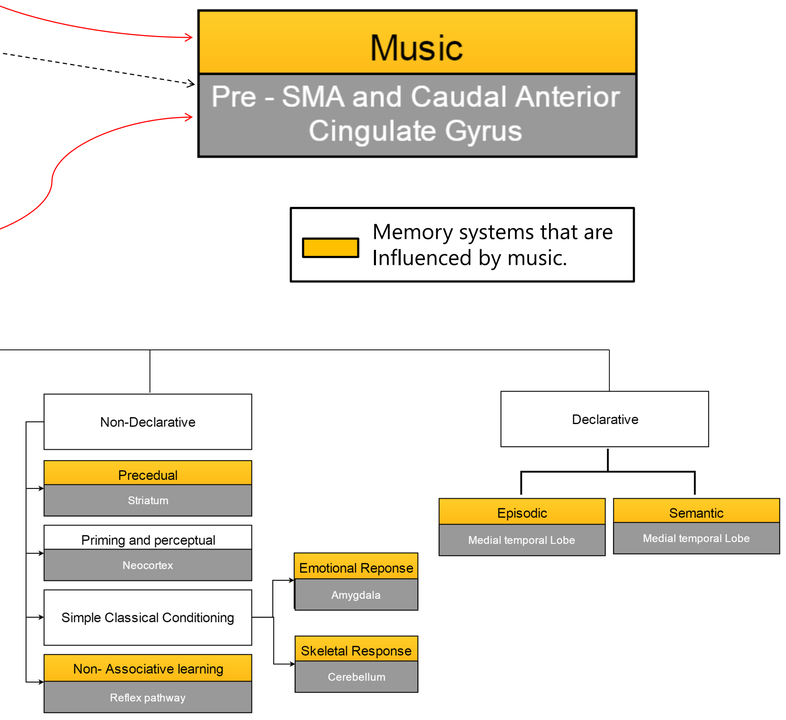

Figure.5 – The Influence of music on the working memory

Adapted From: Squire, L.R., 2004. Memory systems of the brain: a brief history and current perspective. Neurobiol. Learn. Mem. 82, 171–177.

Acknowledgment

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References

Foloppe, D.A., Richard, P., Yamaguchi, T., Etcharry-Bouyx, F., Allain, P., 2015. The potential of virtual reality-based training to enhance the functional autonomy of Alzheimer's disease patients in cooking activities: A single case study. Neuropsychol. Rehabil. 1–25.