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BRAIN AND SKILLS TRAINING APPLICATIONS IN A GAME BASED ENVIRONMENT FOR OLDER PEOPLE

Karel Van Isacker, Mariya Goranova-Valkova
Marie Curie Association

Eleni Chalkia, Katerina Touliou
(CERTH/HIT)

Abstract

In the context of the OASIS project (Open architecture for Accessible Services Integration and Standardization (for older people)), OASIS focuses, among many other things, on the development of brain and skills training applications in a game based environment for older people. As the project is a research project, we aim at establishing games that will provide specific cognitive training exercises and activities so as to activate the frontal and parietal cortical areas as well as short-term memory processing.

Keywords: e-Inclusion, elderly, user centred design, gaming, brain and skills training

1 INTRODUCTION

OASIS (Open architecture for Accessible Services Integration and Standardization - www.oasis-project.eu) is a Collaborative Project (Large-scale Integrating Project – IP) that introduces an innovative, ontology-driven, open Reference Architecture and System, through which over 12 different types of services are connected with the OASIS System for the benefit of the elderly. This foremost required an in-depth understanding of the elderly that would be involved in the piloting of the OASIS services (Van Isacker, 2008). Having identified the target end-user groups, user needs and wants were collected in terms of Independent Living Applications (nutritional advisor, activity coach, brain and skills trainers, social communities platform, health monitoring and environmental control), Autonomous Mobility and Smart Workplaces Applications (elderly-friendly transport information services, elderly-friendly route guidance, personal mobility services, mobile devices, biometric authentication interface and multimodal dialogue mitigation and other smart workplace applications). OASIS thus addresses through this vast array of services the daily needs of elderly, ranging from those who are still active and continue to work, to those that are living independently but can use support to make their daily activities less cumbersome. This paper will specifically focus on the brain training applications that are being developed in OASIS and were defined according to current findings that the use of computerised brain training by the elderly can rejuvenate elder brain by ten years. As will be pointed out in the next section, the collaboration of lead cognitive scientists and major software companies have led to hopeful research based on the suggestions that cognitive decline is both reversible and evitable. The transition from mild cognitive impairment (MCI) to dementia is still under instigation. It appears to be the common ground force for all involved scientists is the elder's preservation of quality of life. The innovative feature of the brain trainer development within OASIS project is the direct link between daily living activities and cognitive exercises.

2 SUCCESSFUL AGING

If a criterion had to be adopted to distinguish between two periods in life, namely development and aging, beyond the conventional threshold of 60 years (Fisk et al., 2004), then we need to consider three order of changes simultaneously: biological, psychological and social (Fisk et al., 2004). *Biological aging* could be defined as a genetic and physiological process related to cellular and extra-cellular changes, aggravated by injuries and producing a progressive imbalance in organism' systems; *social aging* is the changing social role and position assigned to an old adult

because of his/her age, thus influencing and defining his/her participation in society (Atchley, 1988); and *cognitive psychological aging* is characterised by a change in the ability to process and elaborate meaning, process involved in the architecture of mind.

Aging could consist at first look only of the deterioration of lifetime acquisitions, but there are also gains deriving from aging and relying on the large number of experiences accumulated by older people (Hummert et al., 1994). For instance, Baltes et al. (1999) relied on the distinction between 'fluid' (e.g. problem-solving, distribution of attention on multiple tasks) and 'crystallised' intelligence (e.g. cultural knowledge, linguistic competence), which they connected respectively to the mechanics of cognition (basic information processing) and the pragmatics of cognition (acquired cultural knowledge). They found only the first one is affected by aging especially the elaboration of new and complex stimuli. Dixon (2000) grouped the gains of aging into three categories: "gains qua gains" (some abilities continue to grow, like wisdom); "gains as losses of a lesser magnitude" (e.g. redefining the goals of life can help to cope the impossibility to maintain some usual high standards) and "gains as a function of losses" (for example, the brain is able to develop compensatory ways to perform a cognitive task, thanks to its 'plasticity'). The possibility of a "successful aging" ("adding life to the years" and "getting satisfaction from life", Havighurst, 1961) is strictly related to this ability to reshape thoughts and goals and to cope in front of any kind difficulties derived from the elder condition (retirement from work, for example).

Successful aging reflects the current orientation to ameliorate the quality of life of the elderly population, not only to extend the duration of their own life. 'Gerontechnology' (Burdick and Kwon, 2004) is the expanding field where technology is used to improve the life conditions of elderly people and which, following a User-Centred Interactive Design approach, should consider their particular limitations and needs, at a cognitive, social and health level. We will illustrate two ways in which technology can assist elderly people: by sustaining their sociality and by supporting their health.

One problem with studies comparing old and young brains is that old brains are different not only because they have been around longer. The lives their owners lead are different. The elderly tend to have fewer new experiences, be less physically active and socially engaged, and live in less complex environments. All of these impair the production of new neurons and the maintenance of neural circuitry. Research has shown that there are some elderly brains that act and think like young ones. One possibility for this to happen is due to training. Attention and focus are top-down functions, in that the prefrontal cortex orders regions that see or hear to pay attention to important stuff and ignore the rest. Top-down activity seems to be among the most trainable mental functions.

A basic change the brain undergoes with age may also be reversible with training. Older brains often use both the left and right half of a region for something young brains do with only one side. Sometimes that improves performance. Older adults who activate both the left and right prefrontal regions, which are involved in memory, have pretty good short-term memory (Illinois' Kirk Erickson). The reason may be that two-sided activation of the prefrontal regions compensates for deficits in the hippocampus. In contrast, on tasks such as judgment, decision-making, concentration and multitasking, two-sided activation seems to impair performance, as if the brain is too scattered.[1]

Studies of adult brain plasticity have shown that substantial improvement in function and/or recovery from losses in sensation, cognition, memory, motor control, and affect should be possible, using appropriately designed behavioural training paradigms. Driving brain plasticity with positive outcomes requires engaging older adults in demanding sensory, cognitive, and motor activities on an intensive basis, in a behavioural context designed to re-engage and strengthen the neuromodulatory systems that control learning in adults, with the goal of increasing the fidelity, reliability, and power of cortical representations. Such a training program would serve a substantial unmet need in aging adults. Current treatments directed at age-related functional losses are limited in important ways. Pharmacological therapies can target only a limited number of the many changes believed to underlie functional decline. Behavioural approaches focus on teaching specific strategies to aid higher order cognitive functions, and do

[1] As mentioned on http://findarticles.com/p/articles/mi_qn4188/is_20060313/ai_n16208867/

not usually aspire to fundamentally change brain function. A brain-plasticity-based training program would potentially be applicable to all aging adults with the promise of improving their operational capabilities. Research found that older adults could learn training programs quickly, and could use them entirely unsupervised for the majority of the time required. Thus, a brain-plasticity-based intervention targeting normal age-related cognitive decline may potentially offer benefit to a broad population of older adults (Mahncke HW, Bronstone A, Merzenich MM., 2006).

3 STATE OF THE ART

The earliest games have been used to support training and learning objectives (Coleman, 1971). The first games and simulations, for specifically educational purposes, were in fact war games. Against a context of the development of computers and in particular personal computing and most recently the internet, the broadening use of leisure games and simulations has produced an increased interest in how 'immersive learning' can be used to support brain training practices.

Simulations to date have been widely employed to support specified training needs, in particular to support professional and vocational training needs, e.g. military, surgical, medical and business training. These approaches have not necessarily been taken up in areas of more abstract learning, e.g. to support conceptual and higher level cognition. Simulations, and more recently games, have been used more frequently to practice scenarios and skills in advance of taking up a professional employment opportunity. The trend for using simulations in this way has perhaps had an influence upon how games might be used for education and although these are different forms, there are clear links between the two, not least historically. However while simulations are regarded as acceptable training tools, games due their association with violence and leisure time activities have been more widely resisted by tutors and parents alike.

Today's games developed on games engines can be played on personal computers, on games consoles, on handheld devices, on mobile phones and using mixed interfaces, e.g. augmented reality and mobile devices, and can be created without the use of programming languages (using editing tools and software development toolkits), such as call out boxes on games consoles and engines. Increasingly these software applications are being regarded as interactive technologies that can be used in a flexible and interchangeable manner with other ICT tools and devices, e.g. social software, to support many different activities and for supporting small and large communities of practitioners and learners (DfES, 2005), as well as computer games on decision making for people with intellectual disabilities (Standen, Rees, Brown, 2009). The potential of game-based brain training to take advantage of these diverse delivery mechanisms and to offer truly immersive learning experiences seems a possibility now, although making game based brain training effective and relevant to all still presents substantial challenges.

4 BRAIN TRAINER FUNCTIONALITIES

This section aims to describe the main functionalities of the brain trainer module which will be developed in OASIS based on collected user requirements from the target user groups, which were subsequently captured and transposed in use cases. This chapter is divided in 5 parts which reflect the major functionalities' categories.

4.1 INTRODUCTION AND COMPREHENSIVE GUIDE

The introduction part will briefly describe the scope and aims of the brain trainer module and its relation to the other OASIS services. A comprehensive guide will provide information with regard to the content and the various types and nature of cognitive exercises. The users will get a set of clear instructions for each exercise. A separate menu selection will aid users to return to the instructions whenever it is required or desired. The information regarding the exercise will be threefold: a) nature/type, b) its relevance to daily living activities, and c) exact instructions. The narrative feature of the module will provide all necessary information for users in order to be able to explain the components and procedures of each exercise. Plausibly, this section may also be provided in a printable pdf format for elderly to refer to it whenever/wherever they want.

4.2 LOGIN ACCESS/PROCEDURE

The log in option will allow the personalisation and security/safety protection and preservation of sensitive data. The user will chose a username and password in order to enter the cognitive exercises area. The personalisation process will include age, gender, educational level and occupational status information. Moreover, all users will be screened with the

application of neuropsychological assessment battery to exclude demented users.

4.3 BASELINE ASSESSMENT

Baseline assessment will comprise two standardised, well-established short tests in order to determine the user's cognitive level.

i) *Word recall test* (verbal span short-term memory): 15 words will be flashed on screen. Afterwards, the user is asked to immediately recall as many words as possible. The number of errors or omissions is taken into account. The cognitive skills used are extremely important for everyday activities as people need to retain information they hear and read during the day (e.g. remember a phone number before storing it into your agenda or phone).

ii) *Stroop test* (selective attention, attentional fatigue): Two objects will appear on the screen. The user needs to decide on their similarity on shape and colour bases. In case they are similar he/she presses the right arrow. Similarly, if he/she decides they are different on the required basis, he/she presses the left arrow key. Number of errors and reaction time (in msecs) are being recorded.

The results will be presented in the form of a text accompanied by a graphical representation and the suggested level of initial testing. The application of two instruments for baseline assessment ensures the validity and reliability of the user's allocation to a level. Age and educational level will be correlated with the tests' results. Then, he/she gets feedback on his level. Last, he/she may confirm the storage of initial assessment and his/her profile. After the assessment the users -in accordance to their cognitive performance -will be able to access the cognitive exercises (training).

4.4 COGNITIVE EXERCISES (TRAINING)

The users will have a considerable variety of exercises to train. All exercises will be scalable. The available levels are: Beginners, Intermediate, and Advanced. The central idea of the exercises is to avoid the strict testing environment and to present tests in a playful manner and elicit a game-like experience. Consequently, the elderly are more motivated to use them. In addition to playful means of administration, we aim at providing the tests with direct association with the daily activities. The main assumption is that if the training procedures share similarities with the real daily activities, the cognitive improvements will be implemented easier (e.g. if a user is being trained on naming household objects, then their daily usage will augment the results, thus facilitating the implementation and reinforce continuation of training), and their face validity will be higher (i.e., users think it measures how well they can perform in real life environment).

The basis for the training scheme development is the daily living activities inventory and its evaluation of basic performance in everyday activities such as grooming, eating, bathing, etc. Hence, the environment in which the tests are delivered and the content will be delivered in a daily activities context and at the same time maintaining the nature of a neuropsychological test. The chosen implementation rationale will increase user acceptance. The parameters recorded will be speed (reaction time), number of errors/omissions, and time it takes to complete the task on 3 levels (Beginners, Intermediate, and Advanced).

The selected cognitive exercises reflect the daily living activities that most profoundly are severed in elderly:

i) *Bathing* (visuospatial memory, selective attention, item recognition):

Bathroom environment (beginners): Ten different items (e.g. toothbrush, towels, shampoo, shower hose, bathmat, etc) are presented. They disappear from the screen and then reappear in different places. Some of them appear near the original position. The user should check if they are in the right position. No clues will be provided with regards anticipated position of item (e.g., a toothbrush is usually placed on the board above the sink).

(Intermediate) The ten different items disappear. You have to place them in the right position and they are mixed up with items that did not exist in the first screen. The items disappear and re-appear mixed up with not previously shown items (not usually found in a bathroom). The use should place the item on the right place but at the same time he/she needs to distinguish which ones were shown before.

(Advanced) The same as previous, but the extra items that did not exist in the initial screen, are relevant to a bathroom environment.

ii) Cooking (working memory, selective attention, associative memory, abstract thinking, executive function):

(Beginners) The recipe is shown for a few seconds to memorise it. Then the ingredients are shown and you have to choose the right ones with the right order in order to perform the recipe.

(Intermediate) Second you need to combine the right ingredients with the right utensils.

(Advanced) Different dishes are shown on the kitchen board and you need to put them in order to prepare it and serve it as it was shown (just a flash at the beginning of the test).

iii) Bills/Financial (arithmetic memory and calculations, attention, speed of processing):

(Beginners) Simple calculations appear on the screen with the choice of two answers (wrong vs. right).

(Intermediate) The calculations are on the same difficulty level but the user needs to type in the amount.

(Advanced) Calculations appear on the screen and the user needs to remember his "Budget" (was flashed instantaneously at the beginning). Decides on the amount but in the end has to decide if the amount left is above or below his budget.

iv) Transportation (short memory, attention):

(Beginner) Reveal type of transport mode (find the two similar cards).

(Intermediate) Reveal word and the drawing.

(Advanced) Reveal destination and word/or drawing,

4.5 EDUTAINMENT MODULE

This module will provide a selection of either a game of finding the pairs of two same objects with cartoon-like figures or information on memory decline in a documentary narrative style.

5 PILOTING

The Testing and evaluation of the developed games will be initiated in the course of 2010. They will be conducted in the UK, Germany, Italy, Romania, Bulgaria and Greece at older people's homes, as well as sheltered homes for older people, and living labs.

The aim is that the created framework in OASIS will be open, thus allowing third parties to plug in their games/services, and aligning them using e.g. semantically annotated webservices, applying the OASIS ontologies.

6 CONCLUSION

Europe's population will drop from the current 591 million to 542 million in 2050, and the continent will remain the global leader in population aging (Krohnert, 2008). The issues that will and are arising from having such an older and also healthier elderly population can be looked at as a challenge to which OASIS aims to contribute, through its vast array of services. One of them will be the implementation of the OASIS brain-plasticity-based training program that will directly link with the daily activities of older people. Extensive piloting in 6 European Countries should be able to further fine-tune the developed brain training modules.

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