Computer-based cognitive training to facilitate neural plasticity

It was wonderful to see that the European Silver Paper recommends cognitive stimulation to 'facilitate neural plasticity' in older adults[1]. It provides further evidence that the concept of neural plasticity is becoming well accepted in the field of gerontology and geriatrics. Neural plasticity refers to the brain's lifelong capacity for physical and functional change. It provides an opportunity to drive positive brain changes to produce better performance in a wide range of functional domains including cognition.

Computer-based training programs are ideally suited for cognitive training. Stimuli can be adjusted rapidly to match the current ability level of each user. Exercises can be designed to be fun and engaging to improve usage and optimize learning[2]. These programs also provide the opportunity to undergo cognitive training using home computers. This empowers individuals experiencing age-related cognitive decline to improve their own cognitive function and quality of life.

The number of computer-based cognitive training programs available commercially has expanded rapidly in recent years. These programs vary widely in their quality of design with many intended principally for entertainment purposes. Although many impressive claims are made about these programs, few have been scientifically validated. How can the consumer be confident that a program will be efficacious? The gold standard for scientific testing is to subject an intervention to a large controlled clinical trial. To date only two computer-based cognitive training programs have been subjected to this test: the Brain Fitness Program (BFP) and Useful Field of View (UFOV) training.

The BFP is a commercially available training program[3] designed to improve the speed and accuracy of auditory processing with the goal of improving memory. The program was evaluated in the IMPACT (Improvements in Memory with Plasticity-based Adaptive Cognitive Training) study which included nearly 500 participants aged at least 65[4]. A battery of neuropsychological assessments showed that the BFP group improved significantly in measures of memory and attention compared to an active control group who spent equal time learning from educational programs presented on computers. The training effect sizes ranged from 0.20 to 0.43 and are regarded as clinically important[5].

UFOV refers to the visual area over which information can be extracted at a single glance. UFOV size generally reduces with age leading to negative consequences including elevated automobile crash risk[6]. Multiple studies have shown that UFOV can be expanded using a computer-based training program, including the ACTIVE (Advanced Cognitive Training in the Independent and Vital Elderly) study. ACTIVE is the largest study of cognitive training to date with over 2800 participants aged 65 and over[7]. UFOV training benefits, demonstrated in randomized controlled trials, include reductions in dangerous driving maneuvers and faster reactions to road signs[8], maintenance of driving in difficult situations[9], reductions in the risk of experiencing serious decline in health related quality of life[10], and improved performance on a range of activities of daily living including reading medicine directions, finding correct change, and looking up a number in a telephone book[11]. UFOV training is now incorporated in a commercially available training program called InSight[3].

There has been increasing interest in computer-based cognitive training programs from clinicians, geriatricians, and the general public in recent years. This field is still in relative infancy and the consumer should be wary of products that make claims that have not been directly validated. However, existing evidence from well designed randomized controlled clinical trials indicates that specific types of computer-based training are effective in improving cognitive and real world function, and hold great potential for improving the lives of aging populations.

Conflict of interest statement: All authors have a financial interest in Posit Science Incorporated[12].

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The role of information technology in mental compensation strategies

In response to the European Silver Paper[1], we propose that if properly designed and employed, information technology can support older adults in a variety of cognitive activities.

It has been well documented that in older adults, aging is normally associated with reduced mental functioning[2]. Among the various cognitive elements, spatial ability has been identified as one of the mediating factors, evidenced by the age-related performance deficits found in the processing of spatial information[3]. To compensate the vulnerability of older adults in spatial cognition, 3D virtual reality (VR) has been demonstrated as a promising vehicle for training and/or human computer interaction. VR is a class of computer technology that enables presentation of content information using real-world (Euclidean) laws of spatial structures from a viewer-centered perspective. In a project aiming to assist the older patients of a local hospital to familiarize themselves with the layout of emergency exits, it was found that the recall accuracy for the VR-based training significantly outperformed that for the traditional map condition[4]. The

older participants undergoing the VR treatment even achieved a level of mental rotation performance comparable to that by the young counterpart. Opportunities exist where this type of information technology, featuring interactive exploration of a simulated 3D world, could benefit older adults in strengthening their cognitive maps.

There is also evidence indicating that VR has the potential to serve as a valid and practical means (in the sense of time, safety, etc) to assess the mental activities for those older adults who are cognitively impaired. For example, by utilizing a VR-based environment, the source of difficulty in learning to adapt to movements corrections for those older adults with Parkinson's disease can be quantitatively identified[5]. VR was also shown to allow a testing context in which the evaluation results of deficits in navigational skills for aging and Alzheimer disease closely correlated with the data found in a real-world setting[6].

Multimedia is another type of information technology that could potentially contribute to the mental compensation for older adults. Multimedia is a computer system where information can be presented through a rich variety of display channels such as static and dynamic visuals, narration, and sounds. Van Gerven et al.[7] formulated recommendations for the design of computer-based instruction (CBI) that account for cognitive aging, John Sweller's cognitive load theory[8], and Richard Mayer's cognitive theory of multimedia learning[9]. According to these recommendations, age-specific CBI appears to have gained a sound applicability because the accounted theories already support sufficient use of available cognitive resources on one hand, and on the other, the technology itself offers high degrees of freedom for calibration of experimental parameters.

Evidence indicating positive learning effects from multimedia-based instruction is available. For example, Chen and Yeh[10] found older patients with degenerative osteoarthritis significantly improve the operative preparation and functional activity after receiving the multimedia training treatment comprising text, pictures, films, animations, and sounds. In a study that examined the effect of learning health-care knowledge (e.g., cardiovascular disease), it was found that the older learner trained by animated visuals and narrated key phrases performed equally well as did their young counterpart in terms of recall accuracy and comprehension[11].

Although the present article reports with an optimistic profile, efforts are still needed to build a consistent and comprehensive database. Often cited are usability problems which block older users from successful and pleasing access to information systems[12]. Rigorous system design accommodating the unique needs of older adults based on in-depth aging theories should be strongly promoted. In addition, the computer revolution has made our lifestyle digitally prevalent. Literature concerning how mobile devices would affect living quality of the older population also leaves room to develop.

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Letter from the editor for the 8th volume

At the start of the 8th volume I wish to thank associate and assistant editors, members of the editorial board, and other volunteers, who supported the journal by peer reviewing and editorial work. In addition to editorial board members, the following experts served as peer reviewers: Anthony Almudevar, Ian Cameron, Kerstin Dautenhahn, Brandie Nance Davis, Guy Dewsbury, Rodney Diaz, Lucy Dickinson, Arie Dijkstra, Katinka Dijkstra, Katharina Echt, Jerri Edwards, Paul E. Eshelman, Gert Jan Gelderblom, Joy Goodman, Wiet (L.G.H.) Koren, Yvonne de Kort, Lorna Lines, Christopher Mayhorn, Silvestro Micera, Alan Newell, Eric Sargent, Lauren E. Storck, Paivi Topo, Binh Q. Tran, and John Williams.

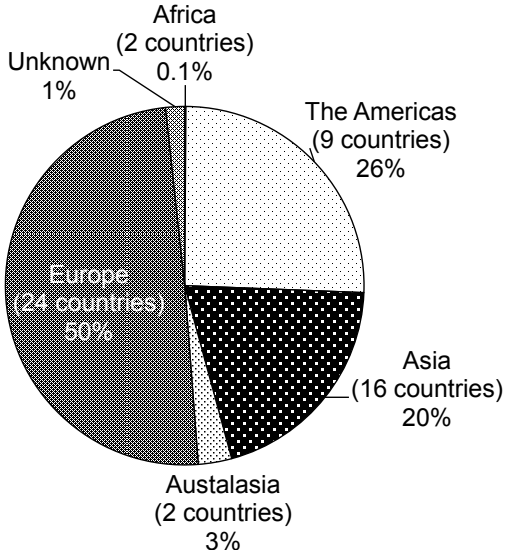
Together we processed 31 manuscripts, of which 16 (52%) could be accepted and published in the issues 7(1), 7(3) and 7(4). Issue 7(2) contained the abstracts of the Pisa conference that were aptly managed by the Italian organizers.

7th volume improvements

The plans stated at the start of the 7th volume[1] were all implemented. World News has been discontinued and ISG business restricted. Starting this issue only the following publication categories will be used: Editorial - Review - Original research - Best Practice - Correspondence - People - ISG Business - Miscellaneous.

Digital object identifiers (dois)[2] have been added to all contributions, and the website was refined to provide a better search function and improved accessibility for Google and other web crawlers, thanks to Cor Pernot and Marijn Nagelkerke.

For the first time we are well informed of our electronic readership. During 2008 the electronic version of our journal has been viewed at least once every hour. Geographically speaking the electronic readership originated from at least 54 countries and all inhabited continents. The journal still has a more or less European outlook, but with increasing interest from Asia and the Americas.



Geographical distribution of electronic page views according to OneStat.Com in 2008; figures from the Netherlands are omitted since they also included editorial work

8th volume organization

To further improve quality and get a better flow of manuscripts a number of organizational changes are taking effect with this issue. The barriers between associate editors and members of the editorial board have been removed and all editorial board members were invited to become editors. Some editorial board members had to resign for different reasons. I thank Geoff R. Fernie (Toronto), Mauno Konttinen (Helsinki), and Hans-Werner Wahl (Heidelberg) for their editorial work and other support of the journal. With another editorial board member, Vladislav V. Povoroznjuk (Kiev), contact was lost.

Most editorial board members have become associate editors and in the colophon of each issue their specialties will be mentioned. In general, associate editors will only handle manuscripts in their domains. When it became apparent that not the whole field of gerontechnology was covered, additional associate editors were invited. I cordially welcome Gloria Gutman (friendly environments for ageing), Ger J. Maas (building governance), Ronie Navon (robotics), and Johanna J. van der Plaats (designing for the ageing brain).

Among the assistant editors two changes occurred. Joost van Hoof resigned and I am grateful to him for his meticulous editorial corrections. The former editorial board member Elizabeth Karol took his place for one year, since starting 2010 she expects to be able to devote more time to the journal and will act as associate editor.

Since the Pisa conference had a positive financial outcome, we could establish an editorial office (GT@gerontechnology.info), currently manned by a student who is starting the job to digitize manuscript handling procedures.

8th volume plans

With the attachment of digital object identifiers (dois) to each accepted manuscript, electronic publishing ahead-of-print became feasible and is being exercised from this issue on. This means that contributions to Gerontechnology journal are available to readers as soon as accepted manuscripts are typeset and the page proofs have been corrected. Also authors can immediately use the doi-link to guide visitors of their own website to the full-text of their publications. Just put http://dx.doi.org/ before the doi and activate the link. Other improvements are foreseen for 2009 including starting an upload / download page for manuscripts, introducing mandatory templates for regular types of tables, figures, etc; and also streamlining the peer review and editorial handling process.

I wish you interesting reading in this new volume 8 of Gerontechnology journal!

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