Computer-assisted Intervention using Touch-screen Video Game Technology on Cognitive Function and Behavioural Symptoms for Community-dwelling Older Chinese Adults with Mild-to-Moderate Dementia

Preliminary Results of a Randomized Controlled Trial

Ruby Yu[1], Dawn Poon[2], Ashley Ng[2], Kitty Sit[2], Jenny Lee[1], Bosco Ma[1], Cm Lum[3], Fannie Yeung[1], Martin Wong[1], Elsie Hui[3] and Jean Woo[1]

[1]*Department of Medicine & Therapeutics, The Chinese University of Hong Kong, Sha Tin, New Territories, Hong Kong, China*

[2]*Occupational Therapy Department, Shatin Hospital, Sha Tin, New Territories, Hong Kong, China*

[3]*Department of Medicine & Geriatrics, Shatin Hospital, Sha Tin, New Territories, Hong Kong, China*

Keywords: Ageing, Behavioural and Psychological Symptoms, Cognitive Function, Computer-Assisted Intervention, Dementia, Video Game.

Abstract: Objective: This study explored the potential benefits of a computer-assisted intervention using touch-screen videogame technology on cognitive function and behavioural symptoms in older adults with mild-to-moderate dementia. Methods: A randomized-controlled-trial is being conducted comparing a videogame training and a conventional cognitive training. Until January 2015, 32 community-dwelling older Chinese adults (mean age 83y, range 70-99y, 69% women) with mild-to-moderate dementia were randomly assigned to the videogame training (intervention group n=16) or the cognitive training (control group n=16). The intervention group performed a computer-assisted training encompassing 4 videogames using touch-screen interfaces for 30 minutes/session, 1-2 sessions/week for a total of 8 sessions; the control group performed a matched training encompassing 4 cognitive activities for same amount of time. Results: The intervention group demonstrated significant improvements in game performance, Montreal Cognitive Assessment language sub-score, Neuropsychiatric Inventory (NPI) total and distress scores, while the control group showed improvement in activity performance and NPI distress score (all $P<0.05$). Compared to the control group, the intervention group had significantly improved Cohen-Mansfield Agitation Inventory total score and verbally aggressive sub-score (both $P<0.05$). Conclusions: Touch-screen videogame training can alleviate behavioural symptoms in older adults with mild-to-moderate dementia. Its efficacy to improve cognitive and other related functions warrants further investigation.

1 INTRODUCTION

With a rapidly ageing population, dementia has become an important public health issue worldwide. It is a chronic neurodegenerative disease characterised by progressive neuropathologic changes (neocortical atrophy, neuron and synapse loss, neuritic plaques, and neurofibrillary tangles) and declines in cognitive function (Twamley, 2006). Nevertheless, evidence from neuroimaging studies have suggested that individuals with early dementia retain a range of cognitive capacities and can engage additional brain regions during cognitive tasks (Becker, 1996, Grady, 2003). These findings provide evidence of plasticity in the neural systems in individuals with dementia. Research on interventions and particularly cognitive training have demonstrated altered patterns of brain activity and task-specific performance enhancement in healthy adults (Olesen, 2004, Erickson, 2007). As such, regular training on specific tasks may be able to provide a progressive challenge to individuals' (even with dementia) cognitive abilities and may improve their cognitive function.

Yu R., Poon D., Ng A., Sit K., Lee J., Ma B., Lum C., Yeung F., Wong M., Hui E. and Woo J..
Computer-assisted Intervention using Touch-screen Video Game Technology on Cognitive Function and Behavioural Symptoms for Community-dwelling Older Chinese Adults with Mild-to-Moderate Dementia - Preliminary Results of a Randomized Controlled Trial.
DOI: 10.5220/0005490402970302
In *Proceedings of the 1st International Conference on Information and Communication Technologies for Ageing Well and e-Health* (AGEWELL-2015), pages 297-302
ISBN: 978-989-758-102-1

Computerised cognitive training (video games training) have been recognized as a powerful tool for improving cognitive function (Green, 2008). Research results from the last decade have demonstrated positive effects not only on the specific cognitive domain(s) being practiced (Stern, 2011, Oei, 2013) but transfer effects to other related cognitive functions (Mahncke, 2006, Basak, 2008, Nouchi, 2012). A recent systematic review reported that for healthy older people, video game training improved performance in specific cognitive domains (e.g., reaction time, processing speed) relative to the control (Kueider, 2012). However, a large-scale online study of video game training among adults aged 18–60 failed to show transfer of proficiency from trained tasks to untrained tasks (Owen, 2010). More recently, several small studies have been performed, with mixed results (van Muijden, 2012, Bozoki, 2013).

Relatively few studies of video game interventions have been performed in older people with cognitive decline (MCI and dementia) and results have been mixed, with some studies suggesting significant improvements in specific cognitive domains (e.g., verbal learning, memory measures, execution functions) (Schreiber, 1999, Barnes, 2009, Man, 2012, Zaccarelli, 2013) and others reporting no effects (Hofmann, 1996, Finn and McDonald, 2014) or no incremental effects on top of a conventional cognitive training (Gaitan, 2013). Therefore, the widely held belief that computerized cognitive training programs improve cognitive function in older people with dementia in our opinion lacks empirical support. If such training enhances cognitive function, then the question is whether those benefits transfer to other untrained cognitive functions? In addition, the effects of video game training on behavioural and psychological symptoms (BPSD) in dementia are still lacking. Therefore, we performed a randomized controlled trial (RCT) to compare the effects of a computer-assisted video game training using touch screen technologies with a conventional cognitive training in older adults with mild-to-moderate dementia. The present study documented the preliminary findings of the changes in task-specific performance, cognitive functions, and BPSD after the treatments.

2 METHODS

2.1 Study Design

This is a RCT. After eligibility check, subjects and their carergivers were randomly allocated into either the video game training (intervention) or the conventional cognitive training (control) group. Block randomization was adopted. Subjects and their carergivers were aware of the treatment assigned. The rater was blinded to the treatment allocation. The trainer (trained research assistant) for both the intervention and the control group were blinded to the outcome performance. The study was carried out in the Geriatric Day Hospital of Shatin Hospital, Hong Kong.

2.2 Subjects

Community-dwelling older adults aged 60 years and above with mild-to-moderate dementia were recruited from community dementia day care centres, geriatric outpatient clinics, and day hospitals. For this study, subjects with Mini-Mental State Examination (MMSE) (Folstein, 1975, Chiu, 1994) score 10–24 were included. Criteria for a diagnosis of dementia was based on the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) (American Psychiatric Association, 2000). Severity of dementia was determined using Clinical Dementia Rating (CDR) (Hughes, 1982, Morris, 1997). Only subjects with mild-to-moderate dementia (CDR 1 or 2) were invited to participate. Subjects were excluded if they have severe medical conditions limiting their abilities to complete the treatment. Concurrent psychotropic medication was allowed without restriction, but any change in psychotropic prescription over the course of treatment period was monitored. Informed consent was obtained from every eligible subject agreeing to participate as well as their caregivers. When a subject was unable to give informed consent, proxy consent was obtained.

2.3 Video Game Training

Subjects assigned to the intervention group were invited to participate in the computer-assisted video game training 30 minutes/session, one to two sessions/week for a total of eight sessions, provided by a trained research assistant. Four touch-screen video games, including 1) Bingo, 2) Connect the dot ultimate (lite), 3) Find difference, and 4) Mosquito splash that mainly tap working memory and attention control were used (Figure 1). Interactive touch-screens / displays (Sur 40, I-pad, optical touch computer screen) were used. In Bingo, subjects were given a figure captured from the objects in daily lives and they were asked to identify and press the same figure in a table with different figures. The game was won whenever a horizontal, diagonal or vertical line was made from the pressed figures in the table. In Connect the dot ultimate (lite), subjects were asked to connect the dots by pressing the number on the dots in an ascending order to draw a cartoon figure. In Find difference, subjects were asked to find the differences between two photos by pressing the point of difference within a time limit for each set of photo. The time limit would be shortened if mistakes were made. In Mosquito splash, subjects required to press the mosquitoes on the screen to squash them. Butterflies were also appeared on the screen but they should be avoided. Instructions were provided before each training session, which was proceeded for at least 30 minutes. During the sessions, reinforcements were given to encourage participation.

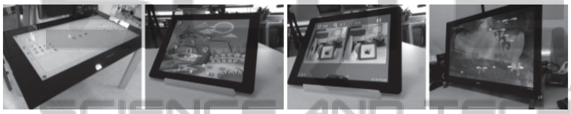

Figure 1: Bingo, Connect the dot ultimate (lite), Find difference, and Mosquito splash (From left to right).

2.4 Conventional Cognitive Training

Subjects assigned to the control group received conventional cognitive training activities in which the training elements were matched with those in the computer-assisted videogame training. Four cognitive activities were used, including 1) Beads sequencing, 2) Stringing pegs & pegboard set, 3) Find difference, and 4) Power trainer (Figure 2). In beads sequencing, subjects were asked to stack the colored beads on a dowel to match the patterned cards with figures in specific colours and shapes. In stringing pegs & pegboard set, subjects put the corrected colour pegs in the holes on the crepe rubber pad according to the pattern card given. Then they used corrected colour strings to lace through each peg hole, as indicated in the pattern card. In Find difference, subjects were asked to compare two photos and identify their differences by drawing a circle on the point of difference. In power trainer, subjects were asked to do hand cycling using the machine.

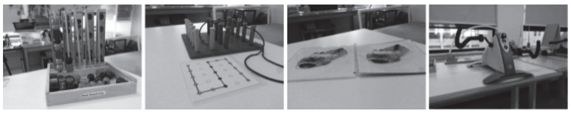

Figure 2: Beads sequencing, Stringing pegs & pegboard, Find difference, and Power trainer (From left to right).

2.5 Outcome Measures

This preliminary analysis focused on task-specific performance, cognitive function as well as psychological and behavioural measures assessed at the baseline (pre-), during, and post-treatment. Task performance was estimated with the task-specific scores of response accuracy (e.g., number of correct responses) and response time (e.g., attention time, time to respond correctly to the stimuli/complete the required task) that were measured across all video games and activities administered. A higher score generally means that the subject performed better.

Cognitive functions were measured with the Chinese version of the MMSE. It contains 20 items and scores range from 0 to 30. A higher score denotes better cognitive functioning. To screen for additional cognitive domains, language and attention subsets of the Montreal Cognitive Assessment (MoCA) (Nasreddine, 2005, Yeung, 2014), digit span (Wechsler, 1997), and the category verbal fluency tests (CVFT) (Thurstone, 1938, Mok, 2004) were also included.

Neuropsychiatric symptoms were assessed with the Chinese version of the Neuropsychiatric Inventory (NPI) (Cummings, 1994, Leung, 2001). It is an informant based standard assessment for a wide range of neuropsychiatric symptoms. Scores of the scale can range from 0 to 144, with the higher score representing higher frequency and/or higher severity of the symptoms. Agitated behaviour was assessed with the Chinese version of the Cohen-Mansfield Agitation Inventory (CMAI) (Cohen-Mansfield, 1989, Choy, 2001). Scores of the scale can range from 29 to 203, with the higher score reflecting more severe agitation. Depressive symptoms were assessed with the Chinese version of the Cornell Scale for Depression in Dementia (CSDD) (Alexopoulos, 1988, Lam, 2004, Lin, 2008). The information was elicited through two semi-structured interviews, one with the patient and one with the caregiver. Scores above 10 indicate a probable major depression. Scores above 18 indicate a definite major depression. The simplified face scale was used to assess mood state before and after each treatment session. It is a very brief, pictorial scale of mood which uses a sequence of seven faces and does not require reading literacy (Wada, 2005)

2.6 Statistical Analysis

An intention-to-treat analysis was carried out, in that all available data was included. Differences between pre- and post-treatment were compared using pair-t-tests. Differences between the intervention and control groups in relation to outcome measures were compared using the analysis of independent-t-tests. Effect sizes were computed. A threshold of 0.2 SD was used to estimate the minimal clinically important differences in task-specific change scores. Subjects were then classified as having "improved" (change score > +0.2 SD, "no change" (-0.2 SD < change score < +0.2 SD), or "declined" (change score > -0.2 SD) for the task-specific performance. X^2 statistics was adopted to examine whether the percentage of those assessed as "improved" is greater within and between the treatment groups. Data analyses were conducted by SPSS. A P<0.05 was taken as the level of statistical significance.

3 PRELIMINARY RESULTS

Recruitment began in June 2014 and the completion of trial is expected for June 2015. Between June 2014 and January 2015, 32 older Chinese men and women aged 60 years and older with mild-to-moderate dementia were recruited and completed the post-treatment assessment. The mean age of the subjects was 83 (range 70-99) years, 69% were women, 75% were classified as mild dementia (CDR=1), and the overall mean MMSE was 16.6± 3.9. All subjects were able to perform the training tasks according to the instructions. On average, 94% subjects engaged in the games/activities properly across the sessions. The intervention group was comparable with the control group with regard to age, sex, education, and the outcome measures, including cognitive functions, BPSD, depressive symptoms, and mood. Of the 32 subjects, 30 completed all eight sessions, one competed seven, and one completed six sessions.

For task-specific performance (in terms of response accuracy and time), 77% subjects in the intervention group improved on the training games (i.e., "improved" cluster), which was significantly more than the portion of subjects classified into "no change" (15%) or "declined" (7%, P<0.01). The improvement was also seen in the control group (93% improved, P<0.01).

For cognitive function, the intervention group demonstrated significant improvements in MoCA language sub-scores (pre 1.5, post 2.0, P<0.05, Effect Size (ES) 0.82). However, evaluation of other cognitive abilities (e.g., MMSE total score and sub-scores, MoCA attention sub-scores, digit span, and the CVFT) did not reveal any significant changes. For BPSD, both groups reduced their NPI distress scores (intervention pre 2.7, post 1.3, P<0.05, ES 0.62, control pre 3.9, post 2.4, P<0.05, ES 0.28), but only subjects in the intervention group significantly reduced their NPI total score (pre 12.8, post 7.9, P<0.05, ES 0.45).

Compared to the control group, the intervention group had significantly improved CMAI total score (intervention mean-diff -1.4, control mean-diff 2.1, P<0.05, ES 0.84) and verbally aggressive sub-score (intervention mean-diff -1.4, control mean-diff 1.6, P<0.05, ES 0.84). Nevertheless, the pre-to-post differences in CMAI were not significant for either group (P=0.070-0.187). No differences in CSDD or simplified face scale scores were observed within or between groups.

4 DISCUSSION

In this era of digital technology, video game training has been reported in several trials with promising results (Green, 2008). Similarly, there are supporting data that video game training could be an alternative choice for patients with cognitive decline (Schreiber, 1999, Barnes, 2009, Man, 2012, Zaccarelli, 2013). However, others reported no significant effects (Hofmann, 1996, Finn, 2014, Gaitan, 2013). This study explored the potential benefits of a video game training in older adults with mild-to-moderate dementia. The preliminary findings demonstrated that while both treatment groups exhibited some signs of improvement in their performance on cognitive tasks after the training sessions, there were no significant changes on the MMSE total score, and no improvements were found in the specific cognitive domains/related functions, except for the language ability (MoCA language sub-score), which was improved in the intervention group. It is unlikely that the improvements were due to practice effects as the control group was administered the same instrument the same number of times. The improvement in language ability demonstrated a potential transfer effect of the video game training, because language was an untrained cognitive function in this study.

However, we are unable to determine the precise mechanisms by which the beneficial effect was achieved. The mechanism of this transfer effect could be explained by the theory which hypothesized that transfer can occur if the training and transfer tasks involve overlapping processing components and engage the same brain regions.(Jonides, 2004, Dahlin, 2008) Since 77% of our subjects improved their game performance, where working memory and attention control that were trained in the video games in this study are involved in the same brain region (left ventrolateral prefrontal cortex, VLPFC) with language processing (Thompson-Schill, 2005), therefore, the transfer effect of the video game training on language processing could be mediated through VLPFC. However, there were no effects of the performance on recall, attention and calculation, orientation, registration, digit span, or the CVFT. There is a possibility that the training duration of our study may not be sufficient enough to obtain the transfer of training. In addition, our measurements of those specific cognitive domains may not be appropriate to detect the transfer effect to untrained tasks. Hence, the potential transfer effect of video game training warrants further investigation.

We also found that the video game training was more effective in alleviating BPSD than the conventional cognitive training. The NPI total score decreased by as much as 51.9% and 38.5% in the intervention group and the control group, respectively. Furthermore, compared to the control group, the intervention group had significantly improved CMAI total score and verbally aggressive sub-score. The underlying mechanism for this is not clear. Possibly, BPSD are a manifestation of feelings of loneliness, boredom, or feelings that decrease with the involvement of stimulating activities and/or social interaction. Several studies have reported that various psychological interventions and stimulating activities are associated with improvements in BPSD (Ballard, 2002, Cohen-Mansfield, 1997). Therefore, our results seem to corroborate the hypothesis that BPSD are in great part the result of stimulus and social deprivation. To our knowledge, this is the first study to assess the effects of video game training on BPSD in dementia. Our findings suggested that video game training is a possible alternative therapy for managing BPSD in dementia. Further analysis of social interaction during the intervention using observation data will be performed at the next stage to elucidate the possible pathway.

There are several limitations in this study. We are not able to specify whether the positive effects are the result of a particular video game, or of several, or all in this current analysis. Moreover, the sample size was small which may have obscured the detection of potential difference between the groups. Despite these limitations, our study has several methodological strengths. We used an extensive assessment tools, allowing us to obtain measures in multiple cognitive functions, as well as BPSD, depression, and mood.

5 CONCLUSIONS

These findings suggest that touch-screen video game training is feasible and may be potentially a training approach in alleviating behavioural symptoms in older adults with mild-to-moderate dementia. Its efficacy to improve cognitive and other untrained functions warrants further investigation. Our findings required substantiation by larger samples.

ACKNOWLEDGEMENTS

The study was supported by the Direct Grant for Research 2013/2014 (Reference No.: 2013.1.042), Faculty of Medicine, the Chinese University of Hong Kong.

REFERENCES

Alexopoulos, G. S., et al. 1988. Cornell Scale for Depression in Dementia. *Biol Psychiatry* 23, 271-284.

American Psychiatric Association 2000 Diagnostic and Statistical Manual of Mental Disorders DSM-IV-TR Fourth Edition (Text Revision), Washington, DC.

Ballard, C., et al. 2002. Can psychiatric liaison reduce neuroleptic use and reduce health service utilization for dementia patients residing in care facilities. *Int J Geriatr Psychiatry* 17, 140-5.

Barnes, D. E., et al. 2009. Computer-based cognitive training for mild cognitive impairment: results from a pilot randomized, controlled trial. *Alzheimer Dis Assoc Disord* 23, 205-10.

Basak, C., et al. 2008. Can training in a real-time strategy video game attenuate cognitive decline in older adults? Psychol Aging 23, 765-77.

Becker, J. T., et al. 1996. Compensatory reallocation of brain resources supporting verbal episodic memory in Alzheimer's disease. *Neurology* 46, 692-700.

Bozoki, A., et al. 2013. Effects of a computer-based cognitive exercise program on age-related cognitive decline. *Arch Gerontol Geriatr* 57, 1-7.

Chiu, H. F., et al. 1994. Reliability and validity of the cantonese version of the mini mental state examination a preliminary study. *J Hong Kong Coll Psychiatr* 4(Suppl 2):S25-8.

Choy, C. N., et al. 2001. Agitation in Chinese elderly: validation of the Chinese version of the Cohen-Mansfield Agitation Inventory. *Int Psychogeriatr* 13, 325-35.

Cohen-Mansfield, J., et al. 1989. A description of agitation in a nursing home. *J Gerontol* 44, M77-84.

Cohen-Mansfield, J. and Werner P. 1997. Management of verbally disruptive behaviors in nursing home residents. *J Gerontol A Biol Sci Med Sci* 52, M369-77.

Cummings, J. L., et al. 1994. The Neuropsychiatric Inventory: comprehensive assessment of psychopathology in dementia. *Neurology* 44, 2308-14.

Dahlin, E., et al. 2008. Transfer of learning after updating training mediated by the striatum. *Science* 320, 1510-12.

Erickson, K. I., et al. 2007. Training-induced functional activation changes in dual-task processing: an FMRI study. *Cereb Cortex* 17, 192-204.

Finn, M. and McDonald S. 2014. A single case study of computerised cognitive training for older persons with mild cognitive impairment. *NeuroRehabilitation* 35, 261-70.

Folstein, M. F., et al. 1975. Mini-mental state. A practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res* 12, 189-98.

Gaitan, A., et al. 2013. Efficacy of an adjunctive computer-based cognitive training program in amnestic mild cognitive impairment and Alzheimer's disease: a single-blind, randomized clinical trial. *Int J Geriatr Psychiatry* 28, 91-9.

Grady, C. L., et al. 2003. Evidence from functional neuroimaging of a compensatory prefrontal network in Alzheimer's disease. *J Neurosci* 23, 986-93.

Green, C. S. and Bavelier D. 2008. Exercising your brain: a review of human brain plasticity and training-induced learning. *Psychol Aging* 23, 692-701.

Hofmann, M., et al. 1996. Interactive computer-based cognitive training in patients with Alzheimer's disease. *J Psychiatr Res* 30, 493-501.

Hughes, C. P., et al. 1982. A new clinical scale for the staging of dementia. *Br J Psychiatry* 140, 566-72.

Jonides, J. 2004. How does practice makes perfect? *Nature Neuroscience* 7, 10-1.

Kueider, A. M., et al. 2012. Computerized cognitive training with older adults: A systematic review. *PLoS ONE* 7, e40588.

Lam, C. K., et al. 2004. Depression in dementia: a comparative and validation study of four brief scales in the elderly Chinese. *Int J Geriatr Psychiatry* 19, 422-28.

Leung, V. P., et al. 2001. Validation study of the Chinese version of the neuropsychiatric inventory (CNPI). *Int J Geriatr Psychiatry* 16, 789-93.

Lin, J. N. and Wang J. J. 2008. Psychometric evaluation of the Chinese version of the Cornell Scale for Depression in Dementia. *J Nurs Res* 16, 202-10.

Mahncke, H. W., et al. 2006. Memory enhancement in healthy older adults using a brain plasticity-based training program: a randomized, controlled study. *Pro Natl Acad Sci U S A* 103, 12523-8.

Man, D. W., et al. 2012. Evaluation of a virtual reality-based memory training programme for Hong Kong Chinese older adults with questionable dementia: a pilot study. *Int J Geriatr Psychiatry* 27, 513-20.

Mok, E. H., et al. 2004. Category verbal fluency test performance in chinese elderly with Alzheimer's disease. *Dement Geriatr Cogn Disord* 18, 120-24.

Morris, J. C. 1997. Clinical dementia rating: a reliable and valid diagnostic and staging measure for dementia of the Alzheimer type. *Int Psychogeriatr* 9 Suppl 1: 173-6; discussion 177-8.

Nasreddine, Z. S., et al. 2005. The Montreal Cognitive Assessment, MoCA: a brief screening tool for mild cognitive impairment. *J Am Geriatr Soc* 53, 695-9.

Nouchi, R., et al. 2012. Brain training game improves executive functions and processing speed in the elderly: a randomized controlled trial. *PLoS ONE* 7, e29676.

Oei, A. C. and Patterson M. D. 2013. Enhancing cognition with video games: a multiple game training study. *PLoS ONE* 8, e58546.

Olesen, P. J., et al. 2004. Increased prefrontal and parietal activity after training of working memory. *Nature Neuroscience* 7, 75-9.

Owen, A. M., et al. 2010. Putting brain training to the test. *Nature* 465, 775-8.

Schreiber, M., et al. 1999. Potential of an interactive computer-based training in the rehabilitation of dementia: An initial study. *Neuropsychol Rehabil* 9, 155-67.

Stern, Y., et al. 2011. Space Fortress game training and executive control in older adults: a pilot intervention. *Neuropsychol Dev Cogn B Aging Neuropsychol Cogn* 18, 653-77.

Thompson-Schill, S. L., et al. 2005. The frontal lobes and the regulation of mental activity. *Curr Opin Neurobiol* 15, 219-24.

Thurstone, L. L. and Thurstone T. G. 1938. Primary Mental Abilities. Chicago, Univ of Chicago Press.

Twamley, E. W., et al. 2006. Neuropsychological and neuroimaging changes in preclinical Alzheimer's disease. *J Int Neuropsychol Soc* 12, 707-35.

van Muijden, J., et al. 2012. Online games training aging brains: limited transfer to cognitive control functions. *Front Hum Neurosci* 6, 221.

Wada, K., et al. 2005. Psychological and social effects of robot assisted activity to elderly people who stay at a health service facility for the aged. Proceedings on Robotics and Automation. Taiwan, September 2005.

Wechsler, D. A. 1997. Wechsler Adult Intelligence Scale Third edition. San Antonio, TX: The Psychological Corporation.

Yeung, P. Y., et al. 2014. A validation study of the Hong Kong version of Montreal Cognitive Assessment (HK-MoCA) in Chinese older adults in Hong Kong. *Hong Kong Med J* 20, 504-10.

Zaccarelli, C., et al. 2013. Computer-based cognitive intervention for dementia Sociable: motivating platform for elderly networking, mental reinforcement and social interaction. Proceedings of the 7th International Conference on Pervasive Computing Technologies for Healthcare and Workshops, 430-35.