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Functional Tasks Exercise for Older Adults with Cognitive Impairment at Risk of Alzheimer's Disease

Thesis submitted by

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STATEMENT ON THE CONTRIBUTION OF OTHERS

I declare that all persons whom have contributed to this thesis have been included as co-authors for published papers or are acknowledged below.

The contribution of my three supervisors; Dr. Fiona Barnett, Professor Matthew Yau and Professor Marion Gray throughout the research, in the publication of papers and in the completion of this thesis is greatly appreciated and acknowledged.

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DECLARATION ON ETHICS

The research presented and reported in this thesis was conducted within the guidelines for research ethics outlined in the *National Statement on Ethical Conduct in Research Involving Humans* (2007) and the *James Cook University Code for the Responsible Conduct of Research* (2007). The research methodology outlined here received clearance from the James Cook University Human Research Ethics Committee (approval number: H4269) and the Hospital Authority Ethics Committee, Hong Kong (approval number: KC/KE-11-0097/ER-3).

5 August 2013

Signature Lawla Law Date

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ABSTRACT

Cognitive impairment is a common problem in older adults and increases in prevalence with age with or without the presence of pathology. Individuals with mild cognitive impairment (MCI) are at high risk of progressing to Alzheimer's diseases and other dementias. In the absence of pharmacological treatment for individuals with MCI, it is critical to explore the potential effects of non-pharmacological interventions. Studies have shown that combined cognitive-motor intervention is promising for improving cognitive functions in older adults.

Daily functional tasks are innately cognitive-demanding and involve components of stretching, strengthening, balance and endurance as seen in a traditional exercise program. Functional task exercise programs, with an exercise component incorporated into performing everyday tasks and used as a means of combined cognitive-exercise intervention, may be more meaningful and practical for individuals with cognitive impairment. A structured functional tasks exercise program was subsequently developed as a combined cognitive-exercise intervention with the purpose to facilitate the cognitive functions of older persons with mild cognitive impairment.

The aim of this thesis was to examine the feasibility of application and the potential effects of this newly developed functional task exercise program for improving the cognitive functions and functional status of older persons with mild cognitive impairment.

A validation study was conducted to validate a Chinese version of the Problems in Everyday Living test (PEDL). The Chinese prototype of the PEDL (C-PEDL) was used

for an outcome measurement in the pilot study which was conducted to initially test the feasibility as well as the effectiveness of the functional tasks exercise program for older adults with MCI.

The pilot study used a single group repeated-measures design**.** A total of 11 participants (mean age 71.8 years) were recruited to participate in the intervention program for 10 weeks. All outcome measures were undertaken at baseline, post-intervention and 6-months follow-up using Neurobehavioral Cognitive Status Examination (NCSE), Category Verbal Fluency Test (CVFT), Chinese Version Verbal Learning Test (CVVLT), Lawton Instrumental Activities of Daily Living Scale (Lawton IADL) and C-PEDL. Data were analyzed using Repeated Measures Analysis of Variance. The Cohen's *d* effect size was calculated to assess the practical significant effects.

At post intervention, the participants showed significant improvement in NCSE composite score ($p < 0.000$, $d = 0.79$), CVVLT total free recall ($p < 0.0005$, $d = 0.76$), CVFT ($p = 0.014$, $d = 0.45$), CVVLT 10-minute delayed free recall ($p = 0.008$, $d = 0.40$), Lawton IADL ($p = 0.025$, $d = 0.60$) and C-PEDL ($p < 0.0005$, $d = 1.37$). The improvements were also sustained at 6-months follow-up. Thus, the newly designed functional task exercise program demonstrated to be feasible and encouraged further investigation on the effects in a larger population.

A randomized controlled trial was further conducted to compare the effects of a functional tasks exercise program to a cognitive training program in older adults with mild cognitive impairment. A total of 83 participants (mean age 73.8) were randomized to either a functional task exercise group (n = 43) or an active cognitive training group (n = 40) for 10 weeks. All outcome measures were undertaken at baseline, post-intervention and 6-months follow-up using NCSE, Trail Making Test A (TMT-A) and Chinese version Trail Making Test B (TMT-B) as well as the outcome measures performed in the pilot study. For data analysis, repeated measures Analysis of Variance (ANOVA) was performed to evaluate within-group effects and Analysis of Covariance (ANCOVA) to evaluate the between-group effects. Cohen's *d* was also calculated to estimate the between-group effect sizes.

At post intervention, significant between-group differences were found in general cognitive functions (NCSE composite score; $p = 0.001$ and NCSE normal domains; $p < 0.001$), memory (CVVLT immediate recall; $p = 0.028$ and delayed recall; $p = 0.022$), executive function (TMT-B; $p = 0.045$ and CVFT; $p = 0.029$), everyday problem solving ability (C-PEDL; $p < 0.001$) and functional status (Lawton IADL; $p = 0.049$). During 6-months follow-up, significant between-group differences were still evident in the intervention group for general cognitive functions (NCSE composite score; $p = 0.025$ and NCSE normal domains; $p = 0.034$), memory (CVVLT delayed recall; $p = 0.043$), executive function (TMT-A; $p = 0.011$) and everyday problem solving ability (C-PEDL; $p = 0.008$).

Overall, results from this thesis support the findings of previous studies that combined cognitive and exercise training is effective for influencing different cognitive domains and improving cognitive functions. The positive benefits of the intervention enhancing cognitive functions may ameliorate the progression of cognitive decline, which could potentially delay the conversion of pre-clinical stage to the clinical stages of AD or other dementias.

In conclusion, findings from this thesis have shown that a functional tasks exercise program using simulated functional tasks as a cognitive-exercise intervention is feasible for improving cognitive functions and functional status of older adults with mild cognitive impairment. Moreover, the improvements can be sustained over time after completion of training. The present study contributes to the efficacy of combined cognitive-exercise interventions in populations with cognitive impairment.

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Definitions

Combined cognitive-exercise intervention: Structured interventions that combine cognitive training and physical exercise, either in sequence or simultaneously.

Demanding task: Task requires sustained attention and concentration to learn and master.

Enriched environment: An environment with increased complexity or stimuli that facilitates opportunity of improvement.

Exercise: A form of physical activity that is planned, structured and repetitive over an extended period of time, with the purpose to improve performance.

Interference: A form of intervening stimuli that is purposefully introduced to demand attention as an aspect of a secondary task.

Task switching: Ability to shift rapidly from one task, object or mental set to another.

Visual spatial task: Task that involves visual stimuli and location in space stimuli.

Visuospatial ability: refers to the cognitive ability to orientate attention to visuospatial stimuli, manipulate and transform the visuospatial information to use in a goal-directed way.

Working memory: Brain system that provides temporary storage and manipulation of information necessary for complex cognitive tasks such as comprehension, learning, and reasoning.

Chapter 1

Introduction

Cognitive impairment is a common problem in older adults which increases in prevalence with age with or without the presence of pathology (Hanninen *et al.*, 1996; Stott, 2006). With the global phenomenon of population aging, there is a growing concern on the increasing prevalence of cognitive impairment (Dodge, Shen, Pandav, DeKosky, & Ganguli, 2003; World Health Organization, 2012).

1.1 Impact of Cognitive Impairment

A Delphi consensus study in 2005 estimated that there were 24.3 million people who had dementia globally, with an increase of one new case every 7 seconds (Ferri *et al*., 2005). The number of elderly living with Alzheimer's disease (AD) is estimated to increase from 26.6 million in 2007 to 106.2 million worldwide by 2050 (Brookmeyer, Johnson, Ziegler-Graham, & Arrighi, 2007).

In Australia, in the absence of a cure or effective interventions to slow the progress of disease, the population of people with dementia is predicted to increase over four-fold from 245,000 in 2009 to 1.1 million people by 2050. And there are many more with cognitive impairment (Brookmeyer *et al.*, 2007). Dementia is the leading single cause of disability in older Australians (aged 65 years or older) and is one of the fastest growing sources of major disease burden, overtaking coronary heart disease in its total wellbeing cost by 2023 (Access Economics, 2009). It was also suggested that 60.3% of people with dementia (137,182) were still living in the community in 2008. There is a trend of increase in the number of people with dementia living in the community over time and 98.5% of people with dementia are disabled and use medical services more than the age-average (Access Economics, 2009).

Similarly, in Hong Kong, the percentage of total population aged 65 or above will increase from 12% (822, 852) in 2006 to 26% (2 228, 252) in 2036. It has been found that the prevalence of dementia will double for every five years' increase in age after the age of 60, from 1.2% among those aged 60 to 64 to 32.1% among those aged 85 and above (Lam et al., 2008). The overall prevalence of dementia for persons aged 70 or above was 9.3%. About one in ten aged 70 or above and about one in three aged 85 or above among the community-dwelling elderly in Hong Kong had dementia (Ng & Chan, 2009). A recent study has also projected that the number of people aged 60 and above with dementia will increase to more than double from 0.11 million in 2010 to 0.28 million in 2036 (Yu *et al.*, 2012).

An updated report by the Alzheimer's Disease International (ADI) estimated that the global prevalence of dementia reached more than 35 million in 2010, with 7.7 million projected new cases of dementia each year, indicating a new case of dementia in every 4 seconds which was much faster than the previous 2005 report (World Health Organization & Alzheimer's Disease International, 2012). The World Health Organization (WHO) has urged for global efforts to take a serious focus on the potential impacts of dementia on the societal and health care systems worldwide (WHO & ADI, 2012).

Alzheimer's disease (AD) is the most common form of dementia and accounts for 50-70% of dementias (Alzheimer's Association, 2013). Access Economics (2004) modeled the effects of any successful intervention that would delay the onset of AD, and projected its impacts on the number of new cases and on the prevalence of AD in the future. The results indicated that there would be a 50% reduction in new cases each year, if the average onset of AD could be delayed by 5 years. Importantly, there would be a 5% reduction in new cases each year even if the average onset of AD could be delayed by 5 months and produce savings of $6.6 billion by 2040.

The need to develop adequate preventive strategies or interventions to delay the onset or progression of dementia has drawn increasing attention to the problem of mild cognitive impairment in the elderly (Petersen, 2004; Winblad *et al.*, 2004). Mild cognitive impairment (MCI) refers to an intermediate state between physiological age-associated cognitive decline in normal aging and the more pronounced pathologic decline in Alzheimer's disease and other dementias (Petersen, 2004). People with MCI have an increased risk of developing dementia, with a reported rate of 10–15% per year as compared to1-2% in healthy elderly (Petersen *et al*., 2001). Nevertheless, studies have shown that people with MCI may remain stable without progressing to the stage of dementia or even revert and improve in their cognitive performance (Amieva *et al*., 2004; Ganguli, Dodge, Shen, & DeKosky, 2004; Visser, Kester, Jolles, & Verhey, 2006). It is highly possible to delay the onset of dementia through interventions by slowing the rate of cognitive decline or improve the cognitive functions in persons with MCI.

1.2 Epidemiology of Dementia and Mild Cognitive Impairment

Most of the people with dementia live in developing countries, with approximately 60% in 2010 and will increase to about 65% in 2030 and 71% by 2050 (Prince *et al*., 2013). The overall prevalence of dementia doubles for every five year increase in age between the age of 65 to 75 years and drops slightly to an increase of 1.5 around the age of 85 (Gao, Hendrie, Hall, & Hui, 1998). The Alzheimer's Association has reported that one in eight people aged 65 and older (13 %) has Alzheimer's disease and nearly half of people aged 85 and older (45 %) have Alzheimer's disease. Of those with Alzheimer's disease, it is estimated 4 % are under age 65, 6 % are aged 65 to 74, 44 % are aged 75 to 84, and 46 % are aged 85 or older (Alzheimer's Association, 2012). The duration of the preclinical phase before a diagnosis of Alzheimer's disease or dementia can be up to ten years (Elias *et al*., 2000).

Mild cognitive impairment (MCI) is commonly recognised as a state of cognitive decline greater than that expected for an individual's age and education level but is not severe enough to meet the criteria for a dementia (Gauthier *et al.*, 2006). The reported prevalence and prognosis of mild cognitive impairment varies due to the variation in definitions of MCI, study populations and diagnostic methodologies (Bischkopf, Busse, & Angermeyer, 2002; Hänninen, Hallikainen, Tuomainen, Vanhanen, & Soininen, 2002; Stephen *et al*., 2013). The prevalence of MCI varies from 2% - 30% in the general population to 6% - 85% in clinical settings (Lopez *et al.*, 2003; Manly *et al.*, 2008; Visser *et al*., 2006).

The reported conversion rates of MCI to AD also vary from 12% over 1 year follow-up to 60% over 5-year period (Morris *et al*, 2001; Petersen, 2004). Flicker, Ferris, and Reisberg (1991) reported a higher conversion rate of 72% in 2 years. Similarly, depending in part on the duration of follow-up, the reported conversion rates of MCI back to normal cognition vary from 4% to 15% in clinic-based studies (de Jage & Budge, 2005; Gallass *et al.*, 2010) and from 35% to 55% in population-based studies (Fisk, Merry, & Rockwood, 2003; Ganguli, Dodge, Shen, & DeKosky, 2004; Ganguli, Snitz, Saxton *et al.*, 2011). Nevertheless, those who reverted still remained at increased risk for future cognitive decline upon follow-up (Koepsell & Monsell, 2012; Patel & Holland, 2012) and it has been found that MCI with impairment in memory or multiple domains have greater progression and lesser reversion in prognosis (Ganguli *et al.*, 2011).

1.3 Diagnostic Criteria and Classification of Mild Cognitive Impairment

Although there is increasing recognition of mild cognitive impairment (MCI) as a preclinical stage of Alzheimer's disease (AD) and other dementias, there are no standard criteria for defining MCI mainly due to its heterogeneity in etiology, clinical presentation and long-term outcomes or prognosis (Patel & Holland, 2012; Stephan *et al.*, 2013). The most widely used MCI definition in clinical and research practice is that of amnestic MCI defined by Petersen, Smith, Waring *et al.* (1999) which also has undergone several revisions over the years up to 2009 (Petersen, 2004; Petersen, Doody, Kurz *et al.*, 2001; Petersen, Roberts, Knopman *et al*., 2009; Portet *et al*., 2006; Stephan *et al.*, 2013).

According to Petersen, Doody, Kurz *et al.* (2001), the criteria for amnestic MCI include (1) Subjective memory complaints, preferably qualified by an informant; (2) Memory impairment, with consideration for age and education; (3) Preserved general cognitive function; (4) Intact activities of daily living; and (5) Absence of overt dementia. The tests for impairment are not specified but a 1.5 standard deviation (SD) below the normative value is proposed as impairment. The 1.5 SD limit is strictly applied on a group basis but not on an individual basis. The definition by Petersen *et al.* (1999) however, has been criticised for being too stringent, resulting in the underestimation of the prevalence of MCI (Portet *et al*., 2006). Petersen (2004) and an International Working Group on Mild Cognitive Impairment (Winblad *et al*., 2004) further revised the criteria by including other non-amnesic subtypes.

Mild Cognitive Impairment can be classified into four clinical subtypes based on the differences in etiology and prognosis, which include amnestic MCI–single domain, amnestic MCI–multiple domains, nonamnestic MCI–single domain, and nonamnestic MCI–multiple domains (Winblad *et al*., 2004).

The amnestic subtypes predominantly involve memory problems and have a higher risk of progressing to Alzheimer disease (AD) (Bischkopf *et al.*, 2002; Petersen, 2004). The non-amnestic subtypes involve domains of cognition other than memory, such as executive function, and have a higher likelihood of progressing to a non-AD dementia, such as Lewy body dementia and fronto-temporal dementias (Molano *et al.*, 2010). Of particular importance, the subtypes (amnestic or non-amnestic) with multiple domains have higher risk of progressing to AD or dementia (Hughes, Snitz, & Ganguli, 2011; Mitchell, Arnold, Dawson, Nestor, & Hodges, 2009).

In view of the absence of consensus on the diagnostic criteria for MCI, an international working group convened by the National Institute on Aging and the Alzheimer's Association revised the criteria for the symptomatic pre-dementia phase of Alzheimer's disease (AD), which referred as MCI due to AD, taking into account recent findings (Albert *et al*., 2011). The newly defined criteria included: (1) Cognitive concern reflecting a change in cognition reported by patient or informant or clinician (i.e., historical or observed evidence of decline over time); (2) Objective evidence of impairment in one or more cognitive domains, typically including memory (i.e., formal or bedside testing to establish level of cognitive function in multiple domains); (3) Preservation of independence in basic functional abilities/ mild problems performing complex functional tasks; and (4) Not demented.

The newly revised criteria are mostly similar to that developed by the MCI Working Group of the European Consortium on Alzheimer's Disease (EADC) in 2006 (Portet *et al.*, 2006). Cognitive concern and objective evidence of impairment in domains other than memory as well as mild problems in complex functional tasks performance are included in the new criteria. There is no more proposed cutoff point (i.e. 1.5 SD below the normative value) and no neuropsychological tests are stipulated. The working group specifically emphasized the importance of applying clinical judgment in making a decision on the distinction among normal cognition, MCI and dementia. However, since there is operationally no consensus on the assessment batteries, the evaluation methods still vary across studies. Nevertheless, it has been recommended that apart from the use of specific neuropsychological evaluations, the diagnosis of MCI should be made by further clinical investigations, laboratory tests and brain imaging (Burns & Zaudig, 2002).

1.4 Current Interventions for Mild Cognitive Impairment

1.4.1 Pharmaceutical Intervention

At present, there is no proven or established treatment for MCI (Alzheimer's Association, 2013). There are no medications approved by the U.S. Food and Drug Administration (FDA) to treat mild cognitive impairment (Alzheimer's Association, 2013). Medications approved for Alzheimer's disease or dementias have not shown any lasting benefit in delaying or preventing progression of MCI to dementia. Moreover, the administration safety of the medications in MCI has also been challenged (Dinz *et al.*, 2009; Raschetti, Albanese, Vanacore, & Maggini, 2007). The medical practice guidelines recommended for the care of MCI mainly focus on early identification and regular monitoring because of their increased risk for progression to AD and other dementing conditions. In addition, persons with MCI are recommended to have regular exercise and participate in mentally stimulating and socially engaging activities, which may help sustain brain functions (Alzheimer's Association, 2013; American Academy of Neurology, 2013).

1.4.2 Non-pharmaceutical Intervention

1.4.2.1 *Cognitive intervention*

In light of the positive benefits of maintaining an active lifestyle and engaging in mentally stimulating activities for promoting the cognitive vitality in normal aging and in AD, various studies have examined the potential effects of cognition-based interventions on cognition of persons with MCI (Belleville *et al.*, 2006; Bond, Wold-Wilets, Fiedler, & Burr, 2000; Gunther, Schafer, Holzner, & Kemmler, 2003; Kurz, Pohl, Ramsenthaler, & Sorg, 2009).

A recent systematic review has found that cognitive interventions do lead to limited performance gains for persons with MCI but the improvements observed do not exceed that in the active control conditions (Martin, Clare, Altgassen, Cameron, & Zehnder, 2011). Therefore, the authors have concluded that there is currently little evidence on the effectiveness and specificity of cognitive interventions for individuals with mild cognitive impairment. Another systematic review on cognitive interventions in amnestic MCI also found limited effects from the results of standardized neuropsychological tests although some improvements were found from results of non-standardized cognitive measures and subjective measures (Simon, Yokomizo, & Bottino, 2012).

1.4.2.2 *Physical exercise*

The benefits of exercise on cognition are widely recognized (Cotman & Berchtold, 2007; Kramer & Erickson, 2007; van Praag, 2009). Studies have suggested that physical exercise may have a protective effect against dementia and AD (Larson *et al*., 2006; Laurin, Verreault, Lindsay, MacPherson, & Rockwood, 2001; Wilson *et al.*, 2002). The beneficial effects of physical activity and exercise in improving cognitive function have been observed in cognitively normal elderly (Baker *et al*., 2010; Colcombe, & Kramer, 2003; Kramer, Colcombe, McAuley, Scalf, & Erickson, 2005) and in older adults with cognitive impairment or dementia (Eggermont, Swaab, Luiten, & Scherder, 2006; Lautenschlager *et al*., 2008; Penrose, 2005). However, diverse findings can still be found in studies where there was no observed effect of physical activity interventions on cognition in people with dementia (Christofoletti, Oliani, Gobbi, & Stella, 2007; Etnier, Nowell, Landers, & Sibley, 2006; Gregory, Parker, & Thompson, 2012). A recent systematic review by Snowden *et al*. (2011) also did not find sufficient evidence that physical activity or exercise could improve cognition in older adults. Strong evidence to support the effects of exercise interventions on cognitive functions is still lacking.

1.5 Rationale of Combined Cognitive-Exercise Intervention

1.5.1 Effects of Exercise

Animal studies have consistently shown exercise increases cell proliferation and neurogenesis in the dentate gyrus of the hippocampus (Fabel *et al.*, 2003; Kronenberg *et al.*, 2006; van Praag, Kempermann, & Gage, 1999), an important brain area for learning and memory. Other studies found exercise influenced the production of new neurons in the motor cortex (Ehninger & Kempermann, 2003) and prefrontal cortex (PFC) which improved PFC-dependent cognition and memory (Mandyam, Wee, Eisch, Richardson, & Koob, 2007). Colcombe *et al*. (2006) have suggested that exercise correlates with an increase in brain volume over the frontal, parietal, and temporal cortices in humans. Therefore, despite the discrepant findings, the evidence on the effects of exercise on the brain is mounting.

1.5.2 Importance of Training and Enriched Environment

Although numerous new neurons can be generated in the adult brain, studies have found that about half of the newly generated cells in the brain die during the first 1-4 weeks (Cameron & McKay, 2001; Cameron, Woolley, McEwen, & Gould,1993; Dayer, Ford, Cleaver, Yassaee, & Cameron, 2003). Research has found that spatial learning or exposure to an enriched environment can rescue the newly generated immature cells and promote their long-term survival and functional connection with other neurons in the adult brain (Ambrogini *et al*., 2000; Epp, Spritzer, & Galea, 2007; Tashiro, Makino, & Gage, 2007; Wurm, Keiner, Kunze, Witte, & Redecker, 2007). Notably, only cognitively challenging environments or demanding tasks, which require sustained efforts and concentration as well as repeated trials to learn, can enhance cell survival (Leuner, Waddell, Gould, & Shors, 2006; Waddell, Anderson, & Shors, 2011; Waddell & Shors, 2008). Simple tasks, which require minimal effort to learn, do not rescue new cells (Beylin *et al*., 2001; Clark & Squire, 1998). Furthermore, positive effects on rescuing the new cells can only be found in cases demonstrating successful learning (Curlik & Shors, 2011; Dalla, Bangasser, Edgecomb, & Shors, 2007).

The surviving neurons, once rescued, stay in the dentate gyrus (Leuner *et al*., 2004) and functionally integrate into the existing neural circuitries in the working brain for learning and memory (Jessberger & Kempermann, 2003; van Praag *et al*., 2002). Therefore, exercise in the context of a cognitively challenge environment induces more new neurons and benefits the brain rather than the exercise alone (Fabel & Kempermann, 2008).

1.5.3 Potential Effects of Combined Cognitive and Exercise Training

Animal studies have found that a combination of exercise and an enriched environment induce a greater increase in neurogenesis than either exercise or environmental enrichment alone (Fabel *et al.*, 2009; Olson, Eadie, Ernst, & Christie, 2006). A combination of mental and physical training may have additive effects on the adult brain, which may further promote cognitive functions (Curlik & Shors, 2013; Kempermann, 2008; Oswald, 2004).

Findings from neurophysiological research have suggested that combined mental and physical activities enhance synaptic connections between the brain cells and neuronal plasticity (Bennett, Diamond, Krech, & Rosenzweig, 1966; Spatz, 1966). Studies in elderly populations have also found that combined cognitive and exercise interventions are more promising than single cognitive or exercise training for improving cognitive functions (Fabre *et al*., 2002; Oswald, Gunzelmann, Rupprech, & Hagen, 2006). The combination of a cognitive and exercise training program appears to be of particular value for improving cognitive functions.

1.6 Functional tasks Exercise in Occupational Therapy Context

According to the Model of Occupational Performance, the environment can exert demand and offer opportunities for development of occupational performance (Forsyth, & Keilhofner, 2006). Occupational Therapy practitioners emphasize the use of meaningful occupation as a "means" of therapeutic interventions to promote cognitive functioning and occupational performance (American Occupational Therapy Association, 2008). The use of meaning functional activities as a means of therapeutic intervention is common and is the core in occupational therapy practice (Kielhofner, 2007; Reed, Hocking, & Smythe, 2011; Rosenstein, Ridgel, Thota, Samame, & Alberts, 2007).

Daily functional tasks are innately cognitive-demanding (Alescio-Lautier *et al.*, 2007; Thornton & Dumke 2005) and involve components of stretching, strengthening, balance and endurance as seen in a traditional exercise program (de Vreede, Samson, van Meeteren, Duursma, & Verhaar, 2005). Particularly, visual spatial functional tasks, such as locating a key or finding the way through a familiar or new environment, demand complex cognitive processes and play an important part in everyday livings (Possin, 2010).

It is hypothesised that functional tasks exercise can influence different cognitive domains leading to improvements in cognitive functions, whereby the functional tasks act as a cognitively demanding activity to provide an enriched environment to influence cognitive functions which is further enhanced by the exercise component. It is further hypothesised that using cognitively challenging functional tasks as a cognitive-exercise intervention will be more meaningful and more practical for individuals with cognitive impairment, and will increase the likelihood for the participants to adopt the learned 'functional task exercise' into their daily routine and better perpetuate the desirable cognitive intervention benefits.

1.7 Mode of Delivery

Structured center-based programs with professional guidance and ongoing professional support are known to be effective for the promotion of physical activity in the older adult and have demonstrated high participation rates in the short-term (Foster, Hillsdon, & Thorogood, 2005). Long term adherence and retention to the exercise program within the daily routine is crucial to maintain the potential benefits from the training program. However, long-term center-based programs are relatively expensive to conduct.

Participant and caregiver factors may contribute to the ability of community-dwelling individuals with dementia to adhere to a regular exercise routine. It has been suggested health care providers who wish to encourage their clients to be more physically active should consider these dyadic contributions (McCurry *et al.*, 2010). Studies have showed that caregivers should be trained successfully to supervise different treatment programs for patients with Alzheimer's disease (Teri, Gibbons, McCurry *et al.*, 2003; Teri, Logsdon, Whall *et al.*, 1998). In addition, a center-initiated home- based intervention program can increase the adoption of physical activity and retention of participants in an exercise program in the short and the long term (Cox, Burke, Gorely, Beilin, & Puddey, 2003). Therefore, a center-initiated home-based functional task exercise program involving caregivers as exercise partners may promote active learning and better compliance of the program.

1.8 Meaningful Outcome Measures

The ability to maintain independent living in the community is of particular importance for most elderly adults (Mack, Salmoni, Viverais-Dressler, Porter, & Garg, 1997). Studies have shown that persons with MCI, regardless of the cognitive subtypes, have difficulties in daily functioning, especially in complex everyday tasks that rely heavily on memory and reasoning (Aretouli & Brandt, 2010; Pérés *et al*., 2006; Perneczky et al., 2006). This imposes a potential impact on the safety and quality of life of the person with MCI as well as the burden on the care-giver and the overall society (Gauthier *et al*., 2006; WHO 2012).

Most studies assess instrumental activities of daily living (IADLs) (Pérés *et al*., 2006; Perneczky *et al*., 2006; Tabert *et al*., 2002) or executive functions (Marshall *et al*., 2011; Pereira, Yassuda, Oliveira, & Forlenza, 2008;) to reflect the performance in everyday function. However, the changes in everyday function of persons with MCI could be subtle that render commonly used neuropsychological or subjective evaluation tools not able to capture the difference (Kim *et al*., 2009; Tabert *et al*., 2002; Teng *et al*., 2010). Therefore, it has been suggested that more focus should be on higher order ability when assessing everyday function associated with MCI (Farias *et al*., 2006; Greenaway, Duncan, Hanna, & Smith, 2012).

Problem solving has been defined as a high-level cognition and an important construct in everyday function (Allaire & Marsiske, 1999; Morris, Miotto, Feigenbaum, Bullock, & Polkey, 1997; Sánchez-Benavides *et al*., 2010). It is also considered as a higher order executive function which involves working memory, visuospatial memory, psychomotor speed, and inhibition for a successful performance (Morris *et al*., 1997; Zook, Davalos, Delosh, & Davis, 2004).

Measures of everyday problem solving, which assess skills that older adults need to adapt to everyday living in complex real-world contexts, are regarded as more ecologically valid higher level assessments for measuring everyday function compared with traditional neuropsychological tools (Allaire & Marsiske, 1999; Mienaltowski, 2011). Significant decreases in the problem-solving ability in the MCI patients have been identified as a strong risk factor for the imminent development of dementia (Brandt *et al.*, 2009; Jin *et al.*, 2011). It is therefore important to assess everyday problem-solving abilities in intervention studies of patients with MCI.

1.9 Outline of Thesis

This thesis is presented as a thesis by publication. The chapters are adapted, with minor alternations to ensure consistency, from the author's articles published or submitted for publication in peer reviewed journals.

Studies reported in this thesis aimed to investigate the potential effects of functional tasks exercise as a combined cognitive-exercise intervention in persons with mild cognitive impairment at risk of Alzheimer's diseases.

A systematic review (Chapter 2) was firstly undertaken to retrieve existing evidence regarding the effects of combined cognitive and exercise training in older adults. A second systematic review (Chapter 3) was conducted to identify existing tools available and culturally relevant for assessing everyday problem solving abilities for the target population. The target population in this thesis was the Chinese older adults with mild cognitive impairment in Hong Kong.

A structured functional tasks exercise program was developed and a pilot study involving patients with MCI (Chapter 4) was conducted to investigate the feasibility of application and the potential effects of this newly designed functional tasks exercise program on cognitive functions of older adults with MCI. Since the studies were conducted in Hong Kong and no existing Chinese version everyday problem solving assessment tool was available, it was required to translate the identified everyday problem solving assessment tool, the Problems in Everyday Living Test (PEDL), into a Chinese version. A second study (Chapter 5) was conducted to validate the translated Chinese version of the PEDL in a population with mild cognitive impairment.

The final study (Chapter 6) reported in this thesis investigated the effects of functional tasks exercise in older adults with MCI compared with an active cognitive training group.

1.10 Aim and Objectives of the Thesis

The aim of the thesis was to determine whether functional tasks exercise as a means of combined cognitive-exercise intervention is effective for improving cognitive functions in older persons with mild cognitive impairment.

The specific objectives of the studies described in this thesis were as follows:

1. To examine the existing evidence of combined cognitive and exercise training on cognitive functions of older adults.
2. To identify the existing and culturally relevant outcome measures for assessing

everyday problem solving abilities of the target population, Chinese older adults with mild cognitive impairment in Hong Kong.

3. To examine the reliability and validity of a translated Chinese version of the Problems in Everyday Living Test in older adults with and without mild cognitive impairment.
4. To evaluate the feasibility of application and potential effects of a new structured functional tasks exercise program on cognitive functions in older adults with cognitive impairment.
5. To examine the effects of functional tasks exercise program on functional status and everyday problem solving ability of older adults with mild cognitive impairment.
6. To compare a functional tasks exercise program with an active cognitive training program for older adults with mild cognitive impairment.

Chapter 2

Systematic Review – Effects of Combined Cognitive and Exercise Interventions on Cognition in Older Adults with and without Cognitive Impairment

This systematic review chapter has been submitted to *International Psychogeriatrics* in May 2013. This journal was selected for the submission as it is an international multidisciplinary, peer-reviewed journal publishing important papers in mental health of older people, with an Impact Factor of 2.24 in year 2011.

Lawla LF Law, Fiona Barnett, Marion A Gray, Matthew K. Yau. Effects of combined cognitive and exercise interventions on cognition in older adults with and without cognitive impairment: A Systematic Review. (Submitted to International Psychogeriatrics, under review)

2.1 Introduction

The increasing prevalence of cognitive impairment has led to global concern over its potential impact on the individuals with cognitive impairment, their families as well as on the healthcare system (WHO 2012). Individuals with mild cognitive impairment (MCI) are at high risk of progressing to Alzheimer’s diseases and other dementias, with reported conversion rate of 50% in 2-3 year (Amieva et al., 2004) and even up to 60%-100% in 5 to 10 years (Morris et al., 2001; Petersen, 2004).

Addressing the lack of pharmacological treatment for individuals with MCI, it is critical to explore the potential effects of non-pharmacological interventions. Emerging evidence has suggested that combined cognitive and exercise interventions promotes greater increase in neurogenesis and have more promising than single cognitive or exercise training for improving cognitive functions (Fabre, Chamari, Mucci, Massé-Biron, & Préfaut, 2002; Fabel, Wolf, Ehninger et al., 2009; Oswald, Gunzelmann, Rupprecht, & Hagen, 2006).

This Chapter presents a systematic review conducted to examine the latest results and efficacy of combined cognitive and exercise training for older adults with or without cognitive impairment.

2.2 Review Objectives

The aims of this review are: (1) to summarise the latest results on combined cognitive and exercise training in older adults with or without cognitive impairment; (2) to assess the efficacy of combined cognitive and exercise training to improve cognitive functioning in older adults with or without cognitive impairment; and (3) to examine the methodological quality of the included studies.

The specific questions are: (1) what types of combined cognitive and exercise interventions have been used to influence cognitive functioning of older adults with or without cognitive impairments? (2) What is the efficacy for combined cognitive and exercise training or combined cognitive-motor interventions to influence cognitive functioning in these populations? (3) What is the methodological quality of these studies?

For the purpose of this review, combined cognitive and exercise interventions are structured interventions that combine cognitive training and physical exercise, either conducted in sequence or simultaneously under dual-tasking paradigms. Cognitive training involves structure repeated practice on tasks with an inherent problem, using standardised tasks targeting specific cognitive domains and/or teaching strategies, and skills in order to optimise cognition and functioning (Clare & Woods, 2003; Martin, Clare, Altgassen, Cameron, & Zehnder, 2006). Exercise is defined as a form of physical activity that is planned, structured and repetitive over an extended period of time, with the purpose to improve fitness, performance or health (Casperson et al., 1985).

2.3 Methods

2.3.1 Search Strategies

A systematic computer-based search of Cinahl, Medline, PsycINFO, ProQuest, EMBASE databases and the Cochrane Library was conducted for the time period between January 1995 and October 2012. The following search terms were used:

combine* interventions or rehabilitation or dual-task or multi-modalities combined with exercise, physical activity, resistance training, endurance training, cognitive training, cognitive-motor, and mental, cognitive impairment, cognit*, cognitive function, dement*, Alzheimer*. The search was limited to publications in English. All reference lists in selected journal articles were further screened and additional internet searches from Google Scholar using the same search terms were done for further potentially relevant articles.

2.3.2 Inclusion/Exclusion Criteria and Selection Process

Articles found through the above search strategy were screened. As recommended in the Cochrane Handbook of Systematic Review of Interventions, two reviewers (LL[1] and FB[2]) independently screened the titles and abstracts to identify relevant articles and potentially relevant studies. Disagreements between the reviewers about inclusion were resolved through discussion (Higgins & Green, 2011).

Studies were included in this review if they met the following criteria: (1) design: randomised controlled trial (RCT), non-randomised controlled trial (NRCT); (2) sample population: older adults (aged 60 and older) with or without cognitive impairment/decline or dementia but no mental or neurological disorders other than dementia, such as stroke or major depression; (3) intervention: combined cognitive and exercise training; and (4) outcome: cognitive function assessed using neuropsychological tests as primary or secondary outcomes.

Studies were excluded if they were: (1) nonintervention studies; (2) theoretical articles

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[2] Fiona Barnett, PhD supervisor

or descriptions of treatment approaches; (3) review articles; (4) unpublished studies, abstracts or dissertations; (5) articles without adequate specification of interventions; (6) non-peer reviewed articles and book chapters; and (7) non-English language articles. Multicomponent interventional studies which did not distinguish the contribution of combined cognitive and physical exercise component on the effects were also excluded.

2.3.3 Data Extraction and Analysis

Data were extracted using a data extraction form for the description of methodology and important trial characteristics including study populations, intervention type, training delivery, volume of training, outcome measures, and follow-up (Form sample in Appendix 1). This review focused on a description of the studies and their results, and on qualitative synthesis of the findings. However, Cohen's d effect sizes (Cohen, 1988) for cognitive and functional outcomes at pre- and post-intervention were derived on the basis of reported statistics. The standard effect sizes were calculated by dividing the mean score differences of the combined intervention and control groups in each study by the pooled estimate standard deviation for the two groups. When means and standard deviations were not available, effect sizes were computed from the P-value or F-values reported in the study (Thalheimer & Cook, 2002). The 95% confidence intervals (CIs) were also derived to compare groups before and after the intervention.
(Practical effect size calculator retrieved March 9, 2013 from http://gunston.gmu.edu/cebcp/EffectSizeCalculator/d/means-and-standard-deviations.html).
Effect sizes were interpreted as small, d = 0.20; medium, d = 0.50; or large, d = 0.80 (Cohen, 1988).

2.3.4 Quality Assessment

Methodological quality of the included studies was independently assessed by 2 reviewers (LL and FB) using a 13-item checklist modified from the Delphi list (Verhagen, de Vet, de Bie, *et al.*, 1998), the Physiotherapy Evidence Database (PEDro) scale (Maher, Sherrington, Herbert, Moseley, & Elkins, 2003) and the "Design-specific criteria to assess for risk of bias" by the Agency for Healthcare Research and Quality (AHRQ; Viswanathan *et al.*, 2012). Any disagreements identified between the two reviewers were resolved by a third reviewer (MY[3]) as a final decision maker.

The Delphi list was a generic quality checklist originally designed for assessing RCTs in systematic reviews (Verhagen, de Vet, de Bie, *et al.*, 1998). The list has been used for non-RCT reviews as well as being adapted to be used for both RCT and non-RCT in systematic reviews (Macedo *et al.*, 2010; Verhagen, Karels, Bierma-Zeinstra, *et al.*, 2007). Since the introduction of the risk of bias tool to assess the internal validity of trials for systematic reviews by the Cochrane Collaboration, there are increasing recommendations to encourage assessing risk of bias in quality assessment of individual studies for systematic reviews (Ryan, Prictor, & McKenzie, 2013; Viswanathan *et al.*, 2012). In fact, Verhagen and colleagues have defined "Quality" as a set of parameters in the design and conduct of a study that reflects more than internal validity alone (Verhagen *et al.*, 1998). Areas of risk of bias assessment have already been embedded in the Delphi list including selection bias (randomization, concealed allocation, eligibility criteria); performance bias (care provider/participant blinding); detection bias (assessor blinding); reporting bias (data presentation, intention-to-treat) and other source of bias (baseline similarity). Nevertheless, to enhance the quality of the assessment, additional

[3] Matthew Yau, PhD supervisor

items to assess risk of bias of studies were added with reference to systematic review recommendations (Ryan *et al*., 2013; Viswanathan *et al*., 2012).

One item to assess attrition bias was extracted from the Physiotherapy Evidence Database (PEDro) scale, which was developed to rate the quality of RCTs or CCTs (Maher *et al*., 2003). Two more items on detection bias and one more on reporting bias were selected from the "Design-specific criteria to assess for risk of bias" by the Agency for Healthcare Research and Quality (AHRQ; Viswanathan *et al*., 2012). Therefore, a list of total 13-items quality assessment with the corresponding rating criteria based on the Delphi list, PEDro and AHRQ recommendations was adapted for use in this review. Details of the modified quality checklist and the rating criteria are presented in Table 2.1 and Table 2.2 respectively. All items on the list applied to both RCT and non-RCT.

Table 2.1 Modified Quality Rating Checklist

All items have a "yes," "no," or "unclear" answer option with 1 point for each item with a "yes" answer ''yes'' = 1, ''no'' = 0, ''unclear'' = 0

1.	Was a method of randomization performed for treatment allocation?	Yes	No	Unclear
2.	Was the treatment allocation concealed?	Yes	No	Unclear
3.	Were the eligibility criteria specified?	Yes	No	Unclear
4.	Were the groups similar at baseline regarding the most important prognostic indicators?	Yes	No	Unclear
5.	Was the outcome assessor blinded?	Yes	No	Unclear
6.	Was the care provider blinded?	Yes	No	Unclear
7.	Was the participants blinded?	Yes	No	Unclear
8.	Were all primary outcomes valid and reliable measures?	Yes	No	Unclear
9.	Was the length of follow-up the same between the groups?	Yes	No	Unclear
10.	Were measures of outcome obtained from more than 85% of the subjects initially allocated to groups?	Yes	No	Unclear
11.	Were all pre-specified outcomes reported?	Yes	No	Unclear
12.	Were both point measures and measures of variability presented for the primary outcome measures?	Yes	No	Unclear
13.	Was an intention-to-treat analysis included when there were subjects unavailable for outcomes?	Yes	No	Unclear

Table 2.2 Rating guidelines for modified quality rating checklist

A point is given only when a criterion is clearly satisfied and reported.

Criterion 1: Randomization (Selection bias)	The report states that allocation was random and the random sequence was generated with adequate methods. This includes methods that produce a non-predictable assignment pattern: computer-generated random numbers, random number tables, coin tossing and dice-rolling. Quasi-randomization methods such as allocation by case record number, birth date, week days or alternation, do not satisfy this criterion.
Criterion 2: Concealed Allocation (Selection bias)	The report states that the allocation was by sealed opaque envelopes, central randomization and allocation without knowing the participant's characteristics, contacting someone "off-site" for instruction or by pre-numbered/coded identical containers administered serially to participants. Procedures that the allocation sequence may be accessed or predicted by investigators before allocation to groups do not satisfy this criterion. It is no need to explicitly state that allocation was concealed.
Criterion 3: Eligibility Criteria (Selection bias)	The report needs to describe clearly the source of participants and the criteria to determine who was eligible to participate in the study.
Criterion 4: Baseline similarity (other source of bias)	The report states that the intervention and control groups were comparable at baseline on key diagnostic variables, key outcome measures and demographic characteristics. When groups were not reasonably equivalent and this was not adjusted through analysis, this criterion is not satisfied. The report must provide baseline data for comparison of important demographic variables and key diagnostic and outcome variables. This criterion is satisfied if completer comparison is presented meeting the above conditions.
Criterion 5, 6, 7: Blinding of assessors, care providers and participants (Performance bias)	The report states the measures to keep the person in question (assessors, care providers or participants) blinded or unable to distinguish which group the participant had been allocated. Participants and care providers are only considered to be "blind" if it could be expected that they would have been unable to distinguish between the interventions applied to different groups.
Criterion 8: Valid and reliable outcome measures (detection bias)	The report states evidence or reference of evidence on reliability of all primary outcome measures used. This includes test-retest, inter-rater, internal consistency or comparison with proxy response. AND The report states evidence or reference of evidence on validity of all primary outcome measures. This includes content validity (factorial analysis or expert consensus), convergent correlations (comparison with other measures) or discriminant (group difference).
Criterion 9: Length of follow-up (detection bias)	The report states the duration of follow-up and the length of follow-up was the same across the groups

Criterion 10: Measures of key outcomes from more than 85% of subjects (attrition bias)	The report explicitly states both the number of subjects initially allocated to groups and the number of subjects completed key outcome measures. AND When outcomes were measured at several points in time, at least the primary outcomes must have been measured in more than 85% of subjects at one of those points post-intervention.
Criterion 11: Pre-specified outcomes reported (Reporting bias)	The report states pre-specified outcomes in the study and all the pre-specified outcomes were fully reported
Criterion 12: Data presentation (Reporting bias)	The report states the intervention effects (point estimates) and which were presented with the measures of variability (in text, tabulated or with graph). This may be described as a difference in group outcomes, or as the outcome in (each of) all groups. Measures of variability may include standard deviations, standard errors, confidence intervals or ranges (quartile or minimum-maximum).
Criterion 13: Intention-to-treat analysis (Attrition bias)	The report states "intention to treat analysis" was used when there were subjects did not receive treatment (or the control condition) as allocated or complete outcome measures as planned. This criterion is also satisfied if the report explicitly states that all subjects received treatment or control conditions as allocated. Completer analysis or analysis per protocol in non-randomized trials is accepted as satisfy for this criterion.

With reference to the "Cochrane Collaboration's tool for assessing risk of bias adapted using EPOC's criteria for studies other than RCTs", non-RCT should be rated as 'High risk' or score 'unclear' if not specified in the paper for "Randomisation" and "Allocation Concealment" (Ryan *et al*., 2013). Therefore, the mark lost from the items on "Randomisation" or "Allocation concealment" was counted as an indication of a lower quality or higher risk of bias of the study. Following the rating system of the Delphi list, one point for each item with a "yes" answer and a quality score ranging from 0 to 13 was calculated for each study. All items on the list applied to both RCT and non-RCT. A quality score ranging from 0 to 13 was calculated for each study.

The score is only used to provide a quantitative reference of the degree/likelihood that the reported methodology and results of the included studies are approaching free of bias. As a summary on quality, a study was defined as: (1) High quality when presenting a positive score on 10 or more items; (2) Medium quality when presenting a positive score on 7-9 items and (3) Low quality when presenting a positive score on <7 items (<50% of the maximum attainable score) (Verhagen *et al*., 2007; Viswanathan *et al*., 2012).

2.4 Results

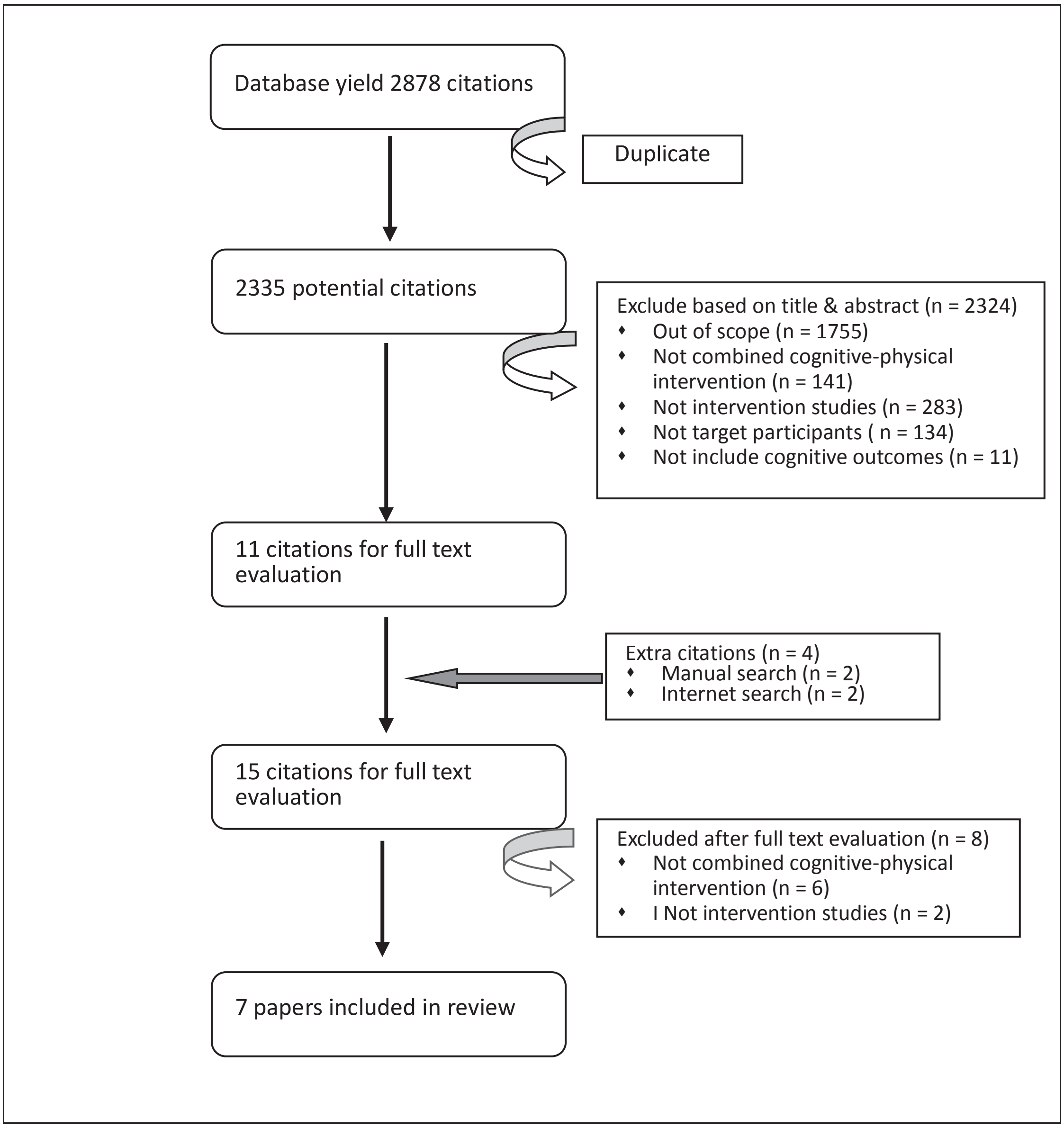
2.4.1 Study Selection

The initial database search identified a total of 2878 potentially relevant citations with 1230 from Cinahl, 201 from Medline, 351 from PsycINFO, 572 from ProQuest, 431 from EMBASE and 93 from Cochrane Library. After excluding duplicated articles, 2335 citations were left. All titles and abstracts were screened according to the inclusion/exclusion criteria described earlier and subsequently 2324 articles were discarded.

The common reasons for exclusion of articles were the following: the articles were out of the scope of this review (1755), they were not combined exercise and cognitive intervention (141), they were not intervention studies or were reviews/theoretical articles (283), they did not include the target population under this review (134), and did not include cognitive outcomes (11). Full texts of 11 articles were retrieved from the initial database search and carefully examined. Cross-referencing led to two more articles and the internet search using the same search terms identified two more articles. A total of 15 articles were finally retrieved for full text screening.

After further screening with the inclusion/ exclusion criteria, eight articles were discarded as six articles used exercise only or did not use combined exercise and cognitive interventions and two were non-intervention articles. A total of seven studies were therefore included for this review. A summary of the selection process is illustrated in Figure 2.1.

Figure 2.1: Flow diagram of study selection process



2.4.2 Methodological Quality of Reviewed Studies

The results of the methodological quality assessment are presented in Table 2.3. The reviewed studies fulfilled 7 to 11 quality criteria out of the maximum of 13 items. Only one RCT (Schwenk, Zieschang, Oster, & Hauer, 2010) performed a concealed randomisation and was the only study that had both rater and subject blinded. However, this was the only one study that did not use intention-to-treat in data analysis. Two RCT (Legault *et al*., 2011; Suzuki *et al*., 2012) did not state the method of random sequence generation or whether the random allocation was concealed. The RCT by Legault *et al*. (2011) was stated as single-blinded but did not report the party which was blinded. The RCT by Suzuki *et al*. (2012) and one other non-RCT (Kounti *et al*., 2011) reported rater-blinded. One study (Oswald *et al*., 2006) recruited a random sample but the group allocation was not random.

All the included studies reported eligibility criteria, baseline similarity (one with analysis adjustment), same follow-up length, pre-specified outcomes, as well as point measures and measures of variability for the primary outcome measures. All studies achieved obtaining measures of outcome from more than 85% of the subjects initially allocated to groups at least at one time point of measures. Main methodological shortcomings or bias identified included no or inadequate randomisation, non-concealed allocation, lack of blinding and unclear reliability of outcomes measures in some studies. All studies fulfilled the criteria for 7 or more quality items, with one (Schwenk *et al*., 2010) meeting 11 out of 13 quality criteria. Therefore, six of the reviewed studies were considered to be of medium quality and one was assessed as high quality.

Table 2.3 Overview of Quality Rating of Reviewed Studies

Study	Randomization	Concealed Allocation	Eligibility Criteria	Baseline similarity	Assessor blinded	Care provider blinded	Subject blinded	Valid reliable measures	Same follow -up length	Outcome from > 85% subjects	Pre-specified outcomes	Data presentation	Intention -to- treat	Sum Score
Coelho, et al., 2012	No (assigned)	No	Yes	Yes (baseline characteristics presented	Unclear (not stated)	No	Unclear (not stated)	Yes (reference stated)	Yes	Yes (number presented)	Yes	Yes (mean & SD)	Yes (completer comparison)	8
Fabre, et al., 2002	No (randomly assigned)	No	Yes	Yes (baseline characteristics presented)	Unclear (not stated for outcome measures)	Unclear (not stated)	No	Yes (reference stated)	Yes	Yes (stated)	Yes	Yes (mean & standard error)	Yes (explicitly reported same number of subjects at pre and post)	8
Kounti, et al., 2011	No (assigned)	No	Yes	Yes (completer baseline comparison)	Yes (stated)	No	No	Yes (data & reference stated)	Yes	Yes (completer comparison)	Yes	Yes (mean & SD)	Yes (completer comparison)	9
Legault, et al., 2011	Unclear (method of random sequence generation was not stated)	Unclear (not stated)	Yes	Yes (baseline characteristics presented)	Unclear (not stated)	Unclear (not stated)	Unclear (not stated)	Unclear (stated reference without information)	Yes	Yes (data reported)	Yes	Yes (mean & SD; mean change & SE)	Yes (stated)	7
Oswald, et al., 2006	No (stated)	No (stated)	Yes	Yes (baseline characteristics presented & with adjustment in analysis)	No (stated)	Unclear (not stated)	Unclear (not stated)	Unclear (not all stated)	Yes	Yes (completer comparison at post-interventio n)	Yes	Yes (z-score mean & SD; effect size d)	Yes (stated)	7
Schwen k, et al., 2010	Yes (numbered container)	Yes (by independent person)	Yes	Yes (stated baseline and completer baseline comparison)	Yes (stated)	No	Yes (stated)	Yes (reference stated)	Yes	Yes (data reported)	Yes	Yes (mean & SD)	No (completer analysis)	11
Suzuki, et al., 2012	Unclear (method of random sequence generation was not stated)	Unclear (not stated)	Yes	Yes (baseline characteristics presented)	Yes (stated)	No	No	Yes (reference stated)	Yes	Yes (data reported)	Yes	Yes (group mean difference & confidence intervals)	Yes (stated)	9

2.4.3 Characteristics of the Reviewed Studies

2.4.3.1 *Participants and settings*

The seven studies involved a total of 1236 participants. A description on the design, participant characteristics and interventions of the reviewed studies is presented in Table 2.4. Of the seven studies, three studies (1 RCT and 2 non-RCTs) involved older adults with normal cognition (Fabre *et al*., 2002; Oswald *et al*., 2006; Legault *et al*., 2011) and four studies (2 RCT and 2 non-RCTs) involved older adults with cognitive impairment including dementia (Schwenk *et al*., 2010), Alzheimer's disease (AD) (Coelho *et al*., 2012), mild cognitive impairment (MCI) (Kounti *et al*., 2011) and amnestic mild cognitive impairment (aMCI) (Suzuki *et al*., 2012). Two of the studies were conducted in Germany, one in Brazil, one in Greece, one in United States, one in Japan and one in France. Participants were recruited from community or medical settings such as geriatric hospitals or daycare centers.

The age of the study population with cognitive impairment ranged from 60.5 to 92 years and those with normal cognition aged from 60 to 93 years. All of the four studies in older adults with cognitive impairment used the Mini-mental Status Examination (MMSE) score as a baseline measure on cognitive function, with an average score of 22.5 ranging from 15.4 (Coelho *et al*., 2012) to 29.6 (Kounti *et al*., 2011), suggesting a wide disparity in cognitive function of the study populations across the four studies . For the studies with cognitively healthy participants, only one study assessed modified MMSE score at baseline (Legault *et al*., 2011).

The sample sizes varied from 27 to 61 in the studies with cognitively impaired populations and from 32 to 375 in the studies with cognitively healthy populations.

Over half of the studies, in both groups, included more than 50 participants (Kounti *et al*., 2011; Legault *et al*., 2011; Oswald *et al*., 2006; Schwenk *et al*., 2010; Suzuki *et al*., 2012). Only one of the studies included more than 100 participants (Oswald *et al*., 2006).

2.4.3.2 *Interventions*

With regard to intervention characteristics, all the reviewed studies used supervised group training. There were no marked differences in the range of intervention duration (2 to 12 months) between the studies with cognitively impaired participants and those with cognitively healthy participants.

Studies with cognitively impaired participants

All four studies used dual-task exercise. Three of these studies used dual-task training in addition to traditional exercise by including resistance training or muscle strengthening, balance training and dual-task training within the same training sessions (Coelho *et al*., 2012; Schwenk *et al*., 2010; Suzuki *et al*., 2012). Coelho *et al*. and Suzuki *et al*. also included moderate intensity aerobic exercise. The dual-task training involved performing motor tasks (e.g. walking, throwing/bouncing ball) and concurrent cognitive tasks (e.g. calculation, naming or reacting to verbal command). The remaining study (Kounti *et al*., 2011) conducted dual-task training using cognitive-based kinetic exercise with visual and verbal cues (e.g. wreath, boards with letters, cards with colors, shapes and numbers, balls and rings).

Studies with cognitively healthy participants

All three studies used combined cognitive training and physical training sessions (Fabre *et al*., 2002; Legault *et al*., 2011; Oswald *et al*., 2006). Oswald *et al*. also included a combined psycho-education and physical training group and a single psycho-education training group. The content of cognitive training varied including computer-based cognitive training, visual searching and memory exercise, memory strategy training or structured multicomponent cognitive training. The physical exercise training included jogging, flexibility training and gymnastic exercise as well as walking, strengthening or balance training. Fabre *et al*. also included moderate intensity aerobic exercise.

With regard to the intervention dosage, the average volume of exposure to training measured by intervention time per week for the combined cognitive and physical training (average 188 minutes, range 135 – 220 minutes) was similar to that for the dual- task exercise training (average 172.5 minutes, range 90 – 240 minutes).

2.4.3.3 *Group comparisons*

Studies with cognitively impaired participants

All four studies were two-arm controlled trials comparing a single intervention group with a control group, including motor placebo (Schwenk *et al*., 2010), no treatment (Coelho *et al*., 2012; Kounti *et al*., 2011) and health education (Suzuki *et al*., 2012).

Studies with cognitively healthy participants

The studies of Fabre *et al*. (2002) and Legault *et al*. (2011) were four-arm controlled trials comparing the combined cognitive and exercise training, single cognitive training, single exercise training and control groups. Fabre *et al*. (2002) used no treatment control whereas Legault *et al*. (2011) used health education as control. The remaining study (Oswald *et al*., 2006) was a six-arm controlled trial comparing combined cognitive and physical training, combined psycho-educational and physical training, single cognitive training, single psycho-educational training, single physical training and no treatment control groups.

Table 2.4 Reviewed studies reported by design, subject and intervention characteristics

Studies with Cognitively Impaired Populations				
Study	**Design**	**Participants**	**Interventions**	**Control**
Coelho, et al., 2012	Non- RCT	n = 27; community-dwelling elderly patients with Alzheimer's disease (AD) ; Brazil IG: n = 14 CG: n = 13 Mean age: IG: 78.0 ±7.3 years CG: 77.1 ± 7.4 years MMSE score: IG: 19.5 ± 4.1 CG: 19.0 ±2.9	Supervised group Multimodal Dual-task exercise: Strength/resistance training, moderate intensity aerobic capacity/balance training ,motor activities (bouncing ball, walking, exercise with weights) and cognitive tasks (naming/words generation or reacting to verbal command) simultaneously 16 weeks; 3x/week; 60 min/session	No intervention
Kounti, et al., 2011	Non- RCT Rater-blinded	n = 58; patients from day care center with mild cognitive impairment; Greece IG: n = 29 CG: n = 29 Mean age: IG: 70.48 ±7.52 years CG: 67.83 ±7.29 years MMSE score: IG: 28.03 ± 1.61 CG: 27.34 ± 1.83	Supervised group: 5 members/group Dual task visuomotor, and verbal-kinetic exercise including visual and verbal kinetic stimuli (e.g. wreath, boards with letters, cards with colors, shapes and numbers, corridors with numbers, balls, wands, rings, and cones); 20 weeks, 1x/week; 90 min/session	Wait-list no-therapy
Schwenk, et al., 2010	RCT Double-blinded (Rater & subject blinded)	n = 61 at randomization; geriatric hospital patients with confirmed dementia; Germany IG: n = 26 CG: n = 35 mean age: IG: 80.4 ± 7.1 years CG: 82.3 ± 7.9 years MMSE score: IG: 21.0 ± 2.9 CG: 21.7 ± 2.9	Supervised group: 4-6 members/group Progressive resistance and functional balance training; then progress to specific dual-task training (e.g. walking while throwing ball/calculation; 10-15 min individual) 12 weeks; 2x/week; 120min/session	Motor placebo group: flexibility exercise, calisthenics, and ball games while sitting 12 weeks 2x/week; 60 min/session

Note: IG, Intervention Group; CG, Control Group; MMSE, Mini-mental State Examination

Study	Design	Participants	Interventions	Control
Suzuki, et al., 2012	RCT Rater-blind	n = 50; older adults with amnestic mild cognitive impairment (aMCI) from community center; Japan Mean age: 76 ±7.1 years; IG: n = 25 CG: n = 25 MMSE score: IG: 26.8 ± 1.8 CG: 26.6 ± 1.6	Supervised group: 16-17 members/group Multicomponent exercise included moderate intensity aerobic exercise, muscle strength, postural balance & dual task training. And self-monitoring daily home-based exercise (outdoor walking) 80 sessions over 12 months; 2x/ week; 90 min/session	Health education; 3 sessions over 12 months
Studies with Cognitively Healthy Populations				
Study	**Design**	**Participants**	**Interventions**	**Control**
Fabre, et al., 2002	Non- RCT	n = 32; healthy elderly from clubs France IG: Aerobic training (AT): n = 8 Mental training (MT): n = 8 combined AT & MT (AMT): n = 8 CG: n = 8 Mean Age: IG: AT: 65.4 ± 2.2 years MT: 67.5 ± 1.2 years AMT: 64.9 ± 1.4 years CG: 65.7 ± 1.5 MMSE score: not conducted	Supervised group AT: brisk walking and/or jogging 2 months, 2x/ week for 60 min/ session MT: session with eight themes: perceptive activities, attention, intellectual structuration, association and imagination, language, spatial marks, temporal marks and associated recruiting. 2months, 1x/ week; 90 min/ session AMT: combined protocol AT + MT as above	Daily routine activities/ leisure activities No training

Note: IG, Intervention Group; CG, Control Group; MMSE, Mini-mental State Examination

Legault, et al., 2011	RCT	n = 73 ; community-dwelling healthy persons; United States IG: Cognitive training (CT): n = 18 Physical training (PT): n = 18 Combined CT & PT: n = 19 CG: n = 18 Mean age: IG: CT: 76 ± 5.2 years PT: 77.5 ± 4.8 years Combined CT + PT: 76.9 ± 4.0 years CG: 75.4 ± 4.8 years Modified MMSE (3MSE): IG: CT: 95.6 ± 3.4 PT: 94.6 ± 3.9 combined CT + PT: 94.6 ± 4.3 CG: 94.3 ± 2.4	Supervised group Cognitive training (CT): ≤ 6 member/group Computer-based memory training; 24 sessions (2x /week, for 2 months + 1x/week for 2 months); 40-50 min/session Physical training (PT): regular walking/ stationary cycling + flexibility training; 32 center-based sessions (2x/week for 4 months); 60 minutes/session; + 1-2 session/week self-monitored home-base walking sessions for the first month; ? time/session; targeted 150 min/week Combined CT +PT: 24 sessions CT + 32 sessions PT for 4 months as above; PT followed CT on the same day.	CG: Health education; 1x/week
Oswald, et al., 2006	Non- RCT Pre-, post at 1 year and follow up at 5 years	N = 375; community volunteer elders; Germany Age range: 75-93 years CG: n = 103 IG: Psychoeducational training (Psy T): n =115 Cognitive training (CT): n = 57 Physical training PT): n = 32 Combined Psy T + PT: n = 36 Combined CT + PT: n = 32 MMSE score: Not conducted	Supervised group : 15-20 member/group Cognitive training group (CT): Visual search tasks; verbal/visual memory tasks; memory strategies. Physical Training (PT): Training of balance, perceptual, motor coordination flexibility; gymnastic exercises and games Psychoeducational training (Psy T): Everyday-oriented psychoeducational training (e.g. fall prevention, medication intake, community resources); group discussion; role playing. 30 sessions; 1x/week over 1 year CT/ Psy T: 90 min/session PT: 45 min/session Combined Psy T + PT or CT + PT: PT was carried out before CT or Psy T in a part of the training groups and following CT or Psy T in another part of the groups	No treatment

Note: IG, Intervention Group; CG, Control Group; MMSE, Mini-mental State Examination

2.4.3.4 *Outcome measures*

A description of the outcome, key findings and effect sizes of the reviewed studies is presented in Table 2.5. Outcome measures adopted varied including dual-task cost, general cognitive functions, specific cognitive domains, emotion and functional status and gait variables. Specific cognitive outcomes covered attention, memory, visual spatial construction, executive function, processing speed and language. As reported by Schwenk *et al*. (2010), dual task cost was calculated as “time for ([dual-task – single task]/ single task x 100)”.

2.4.3.5 *Effects of interventions*

Studies with cognitively impaired participants

All four studies reported significant intervention effects. Schwenk *et al*. (2010) reported significant improvement in dual task cost (DTC) of motor performance ($p < 0.001$) and combined motor-cognitive performance [$p = 0.026$, $d = 0.99$ (95% CI = 0.39 to 1.59)]. Although the study found no significant effects on cognitive performance under complex dual task conditions, the standard effect size was clinically significant [$d = 0.65$ (95% CI = 0.68 to 1.24)].

Kounti *et al.* (2011) also found significant improvement in general cognitive performance [$p = 0.047$, $d = 0.63$ (95% CI = 0.11 to 1.16)], speed of selective visual attention [$p = 0.002$, $d = 0.24$ (95% CI = -0.28 to 0.76)], visual spatial construction [$p = 0.013$, $d = 0.52$ (95% CI = 0.001 to 1.048)], language skills [$p = 0.015$, $d = 0.62$ (95% CI = 0.09 to 1.14)] and functional status [$p = 0.009$, $d = 0.59$ (95% CI = 0.06 to 1.11)].

Suzuki *et al.* (2012) reported significant between- group differences in general cognitive function and immediate recall during mid-intervention period at 6 month. There were significant group × time effects on general cognitive function, immediate memory, and language ability at 12 months.

Coelho *et al.* (2012) reported significant improvement in global frontal cognitive functions [$p < 0.001$, $d = 1.18$ (95% CI = 0.37 to 2.01)], executive function [$p = 0.001$, $d = 0.96$ (95% CI = 0.16 to 1.76)] and attention [$p < 0.001$, $d = 1.57$(95% CI = 0.71 to 2.44)].

Studies with cognitively healthy participants

Two studies reported positive intervention effects. Fabre *et al.* (2002) reported significant improvement in memory [$p < 0.001$, $d = 1.29$ (95% CI = 0.21 – 2.3)]. Oswald *et al.* (2006) also found the combined cognitive and physical training group demonstrated the largest significant improvements in cognitive function, emotional status and physical function among all comparison groups at post-intervention. The reported pre-post intervention effect sizes (d_+) were very large on cognitive function ($d_+ = 1.14$). Moreover, significant longitudinal effects were also found at 5-year follow-up on general cognitive functions and functional status. The reported pre-post intervention effect size at 5-year follow-up (d_{++}) was large ($d_{++} = 0.75$) for general cognitive functions and small ($d_{++} = 0.26$) for functional status. However, Legault *et al.* (2011) reported no significant improvements.

Overall, all the studies with cognitively impaired participants found significant improvements in dual-task cost, general cognitive function, executive function, attention, visual spatial construction, language, functional status and memory, with moderate to very large effect sizes (range *d* = 0.56 -1.18).

The results in studies with cognitively healthy participants are conflicting. One RCT found no effects while two non-RCTs revealed significant improvement in general cognitive functions, emotional status, physical function, functional status and memory, with mild to very large effect sizes (range *d* = 0.27 -1.29). One of these studies also showed significant longitudinal effect at 5-year follow-up.

Table 2.5 Reviewed studies reported by subjects, interventions, outcome measures, key findings and effect sizes

Studies with Cognitively Impaired Populations						
Study	**Subjects**	**Interventions**	**Outcome Measures**	**Key Findings**	**Effect Sizes (95% CI)**	
					Pre-intervention	**Post-intervention**
Coelho, et al., 2012	n = 27; community-dwelling elderly patients with Alzheimer's disease (AD) ;	IG: dual task exercise CG: No intervention	Frontal Cognitive function: Frontal Assessment Battery (FAB) Executive function: Clock Drawing Test (CDT), Attention: Symbol Search Subtest of the Wechsler Adult Intelligence Scale-III (Symbol) Gait-cadence, stride length and stride speed under single and dual task conditions	Significant improvement in frontal cognitive variables (abstraction, organization, motor sequencing, flexibility, behavior, inhibitory control) from FAB, CDT and attention from Symbol Search Subtest Significant group x time interaction in variables of gait (stride length and error counting) under dual task condition	FAB Total: *d* = -0.35 (-1.11 – 0.41) CDT: *d* = -0.14 (-0.89 – 0.62) Symbol: *d* = -0.04 (-0.79 –0.72)	FAB Total: *d* = 1.18 (0.37 – 2.01) CDT: *d* = 0.96 (0.16 – 1.76) Symbol: *d* = 1.57 (0.71 – 2.44)
Kounti, et al., 2011	n = 58; patients from day care center with mild cognitive impairment	IG: Visuomotor, and verbal-kinetic tasks/exercise CG: Wait-list no-therapy	Mini-mental state examination (MMSE); Test of Everyday Attention (TEA); Rey Auditory Verbal Learning Test (RAVLT) Rey-Osterrieth Complex Figure Test (ROCFT-C); Verbal Fluency Test (FAS); Functional Rating Scale of Symptoms of Dementia (FRSSD); Functional Cognitive Assessment Scale (FUCAS); Wisconsin Card Sorting Test (WCST); Wechsler Adult Intelligence Scale-Revised (WAIS-R);; Rivermead Behavioral Memory	Significant between-group improvement in general cognitive performance (MMSE), speed of selective visual attention (speed TEA), visual spatial construction (copying) abilities (ROCFT-C), verbal fluency (FAS) and ADLs (FRSSD) Significant within-group improvement in verbal learning [RAVLT], delayed story recall [RBMT], and attention	MMSE: *d* = 0.40 (-0.12 – 0.92) speed TEA: *d* = 0.08 (-0.44 – 0.59) ROCFT-C: *d* = 0.01 (-0.50 – 0.53) FAS: *d* = 0.38 (-0.14 – 0.90) FRSSD: *d* = 0.17 (-0.34 – 0.69) FUCUS: *d* =-0.01	MMSE: *d* = 0.63 (0.11 – 1.16) speed TEA: *d* = 0.24 (-0.28 – 0.76) ROCFT-C: *d* = 0.52 (0.001 – 1.048) FAS: *d* = 0.62 (0.09 – 1.14) FRSSD: *d* = 0.59 (0.06 – 1.11) FUCUS: *d* =0.35

Note:
CI: confidence interval;
IG: intervention group; CG: control group;
d: standard effect size; d_+: pre-post effect size reported in study; d_{++}: pre-post effect size at follow-up reported in study

			Test (RBMT) delayed story recall; Boston Naming Test (BNT);	switching of TEA	(-0.52 – 0.51) WCST: *d* = -0.43 (-0.95 – 0.09) WAIS-R: *d* = 0.38 (-0.14 – 0.90) RAVLT: *d* = -0.51 (-1.03 – 0.02) RBMT: *d* = 0.25 (-0.27 – 0.77) BNT: *d* = 0.65 (0.12 – 1.17)*	(-0.18 – 0.87) WCST: *d* = 0.40 (-0.92 – 0.12) WAIS-R: *d* = 0.31 (-0.21 – 0.83) RAVLT: *d* = 0.22 (-0.29 – 0.74) RBMT: *d* = 0.56 (0.04 – 1.09) BNT: *d* = 0.42 (-0.10 – 0.94)
Schwenk, et al., 2010	n = 61; geriatric hospital patients with dementia	IG: Dual-task training CG: Motor placebo	Motor performance Gait performance and spatial gait variables using an electronic gait analysis system measured under single and dual-task conditions followed dual-task protocol. Cognitive performance: Number of correct calculation in forward and backward calculation followed dual-task protocol. Decrease in performance during dual tasks compared to single task expressed as motor, cognitive, and combined motor/cognitive dual-task cost (DTC); Consortium to Establish a Registry for Alzheimer's Disease (CERAD) test battery; Trail Making Test (TMT)	IG significant improvement in dual task performance (motor performance and combined motor-cognitive performance) but no significant effects on cognitive performance under complex dual task conditions No significant effects on CERAD or TMT Higher baseline DTC were associated with higher percentage of improvement in DTC for both cognitive and motor variables.	No data for calculation	DTC Cognitive performance: (serial 2 forward): *d* = - 0.22 (-0.8 – 0.34) DTC Cognitive performance (serial 3 backward): *d* = 0.65 (0.68 – 1.24) DTC Combined performance (serial 3 backward): *d* = 0.99 (0.39 – 1.59)

Note:
CI: confidence interval;
IG: intervention group; CG: control group;
d: standard effect size; d_{+}: pre-post effect size reported in study; d_{++}: pre-post effect size at follow-up reported in study

Study	Subjects	Interventions	Outcome Measures	Key Findings	Effect Sizes (95% CI) Pre-intervention	Post-intervention
Suzuki, et al., 2012	n = 50; older adults with amnestic mild cognitive impairment (aMCI) from community center	IG: dual task exercise CG: Health education	General cognitive function: Mini-mental state examination (MMSE); Logical memory: Logical Memory I & II subtests of the Wechsler memory scale-revised (WMS-LM I immediate recall; WMS-LM II: 30 min delayed recall); Processing speed: Digit symbol-coding (DSC) subset of the Wechsler Adult Intelligence Scale III; Total response of letter verbal fluency test (LVFT) & category verbal fluency test: CVFT); Executive function: Stroop Color and Word Test (SCWT).	Significant between- group differences at after 6 months in MMSE & WMS-LMI; Significant group × time interaction on the MMSE, WMS-LM I, and LVFT scores at 12 months. Significant within-group difference in the WMS-LM II, DSC and SCWT at 12 months	MMSE: *d* = 0.44 (-0.44 – 0.67) WMS-LMI: *d* = 0.09 (-0.46 – 0.65) WMS-LM II: *d* = 0.25 (-0.31 – 0.81) LVFT: *d* = -0.16 (-0.71 – 0.40)	MMSE: *d* = 0.11 (-0.45 – 0.66) WMS-LM I: *d* = 0.16 (-0.39 – 0.72) LVFT: *d* = 0.22 (-0.34 – 0.77)
Studies with Cognitively Healthy Populations						
Study	**Subjects**	**Interventions**	**Outcome Measures**	**Key Findings**	**Effect Sizes (95% CI)**	
					Pre-intervention	**Post-intervention**
Fabre, et al., 2002	n = 32; healthy elderly	IG: Aerobic training (AT) Mental training (MT) Combined aerobic & mental training (AMT):	Physical: maximal O2 uptake (V˙ O2max); maximal O2 pulse; ventilatory threshold; Cognitive: General cognitive function by BEC 96 questionnaire; Wechsler memory scale (WMS);	Cognitive outcomes: Pre-post mean difference in memory quotient was significantly higher in AMT than in the other training and control groups. Significant within-group difference on memory quotient, paired associates	Wechsler memory scale: Memory quotient *d* = -0.66 (-1.67 – 0.34) Paired associated	Wechsler memory scale: Memory quotient *d* = 1.29 (0.21 – 2.36) Paired associated

Note:
CI: confidence interval;
IG: intervention group; CG: control group;
d: standard effect size; d_{+}: pre-post effect size reported in study; d_{++}: pre-post effect size at follow-up reported in study

		CG: Leisure activities		learning and logical memory-immediate recall obtained from the WMS in all IGs Physical Outcomes: Significant within-group improvement in AT and AMT group.	learning: *d* = -0.21 (-1.19 – 0.78) Digit span forward: *d* =-0.19 (-1.17 – 0.80) Logical memory-immediate recall: *d* = -0.22 (-1.20 – 0.76) Mental control: *d* = -1.43 (-2.53 - -0.33) Visual reproductions: *d* = - 1.56 (-2.68 - -0.44)	learning: *d* = 0.52 (-0.48 – 1.51) Digit span forward: *d* = 0.06 (-0.93 – 1.04) Logical memory-immediate recall: *d* = 0.2 (-0.78 – 1.18) Mental control: *d* = - 0.46 (-1.45 – 0.53) Visual reproductions: *d* = -0.56 (-1.56 – 0.44)
Legault, et al., 2011	n = 73 ; community -dwelling healthy elderly	IG: Cognitive training (CT) Physical training (PT) Combined CT +PT CG: Health education;	Executive function: Self-Ordered Pointing Task (SOPT); 1-Back and 2-Back Tests; Eriksen flanker task (EFT); Task Switching test (TST); Trail Making Test (TMT); Episodic memory: Hopkins Verbal Learning Test (HVLT); Logical Memory task from the Wechsler Memory Scale-III (LM1: 1st recall, LM2: total recall)	No statistically significant within-group or between-group difference was found . Combined CT+PT: improvements decreased with age. CG: statistical significant improvement for a test of verbal learning PT: a trend that may convey greater relative short-term benefits on cognitive function.; improvements in the composite score increased across	SOPT: *d* = 0.00; (-0.66 – 0.66) 1-Back Test:: *d* = -0.24 (-0.91 – 0.43) 2-Back Test: *d* = 0.44 (-0.23 – 1.11) EFT: *d* = 0.51 (- 0.16 – 1.19) TST: *d* = -0.03 (-0.70 – 0.63) TMT: *d* = 0.21 (-0.46 – 0.87) HVLT:	SOPT: *d* = 0.14; (-0.52 – 0.80) 1-Back Test:: *d* = - 0.37 (-1.03 – 0.30) 2-Back Test: *d* = -0.05 (-0.61 – 0.72) EFT: *d* = 0.1 (- 0.76 – 0.57) TST: *d* = 0.01 (-0.66 – 0.67) TMT: *d* = -0.32 (-0.34 – 0.99) HVLT:

Note:
CI: confidence interval;
IG: intervention group; CG: control group;
d: standard effect size; d_{+}: pre-post effect size reported in study; d_{++}: pre-post effect size at follow-up reported in study

				the age range; CT: improvements decreased with age.	immediate recall: d = -0.28 (-0.95 – 0.38) delayed recall: d = 0.05 (-0.62 – 0.71) LM1: d = -0.02 (-0.68 -0.64) LM2: d = 0.08 (-0.58 – 0.75)	immediate recall: d = 0.30 (-0.36 – 0.97) delayed recall: d = -0.11 (-0.78 – 0.55)) LM1: d = -0.14 (-0.8 -0.53) LM2: d = -0.04 (-0.70 – 0.63)
Oswald, et al., 2006	n = 375; normal elderly	IG: Cognitive training (CT) Physical Training (PT) Psycho-educational training (Psy T): Combined Psy T + PT Combined CT +PT CG: No treatment	Cognitive function: Composite score from subtests of “Neuropsychological aging inventory; Aging concentration test; Wechsler adult intelligence scale (information & similarities) and Word fluency to assess speed of information processing, memory, attention and reasoning. Cognitive impairment: Sandoz clinical assessment geriatrics SCAG. Physical function: Composite score of physical coordination test; Bending forward and sideward, arm-lifting test; Knocking test; Table-tennis-accuracy-test; Table-tennis juggle test; Walk/run through a course with different tasks; Handgrip test. Emotional status: Zung Self-Rating Depression Scale. Independent living: Composite score of self-rating & interviewer rating on an analogue scale; self-administered	**Post-treatment effects (1 year):** Combined CT + PT: had largest gains in “cognitive function”, “emotional status” and “physical function” relative to the control group and other groups. CT: improvement in “cognitive function” Psy T & PT: improved in “independent living” and “everyday competence”. PT: no improvement in “cognitive function” or “physical function”. **Long-term effects (5 years):** Combined CT + PT group, CT group, combined Psy T + PT and the Psy T group showed significant improvement in “cognitive function” in comparison	Data not available for calculation	Cognitive function: d_{+} = 1.14 d_{++} = 0.75 Cognitive impairment: d_{+} = 0.8 d_{++} = 0.59 Physical function: d_{+} = 0.78 Emotional status: d_{+} = 0.47 Independent living: d_{+} = 0.27 d_{++} = 0.26 Health status: d_{+} = 0.11 d_{++} = 0.35 Well-being: d_{+} = 0.99

Note:
CI: confidence interval;
IG: intervention group; CG: control group;
d: standard effect size; d_{+}: pre-post effect size reported in study; d_{++}: pre-post effect size at follow-up reported in study

			questionnaire on use of health-care services Everyday competence: Interviewer rating of the participant's coping with age-related problems. Health status: Composite score of clinical assessment of organ functions & laboratory tests; Self-rating of perceived health. Well-being: Composite score of self-rating questionnaire on subjective aging, quality of life, general well-being	with the CG. The combined CT + PT group showed the greatest longitudinal effect. Only the combined CT + PT group showed significant differences in symptoms of "cognitive impairment", "emotional status" &"health status" relative to the CG. Both the combined CT + PT group and the combined Psy T + PT group showed significant improvement in "independent living" with the combined CT + PT group showed a higher degree of improvement.		

Note:
CI: confidence interval;
IG: intervention group; CG: control group;
d: standard effect size; d_{+}: pre-post effect size reported in study; d_{++}: pre-post effect size at follow-up reported in study

2.5 Discussion

Seven studies were identified in this review, four of which included a population with cognitive impairment and three studies included a population without cognitive impairment. The paucity of research in this area was obvious, particularly among the wide progressively degenerating cognitive continuum in these populations (Petersen, 2004). The studies were published within the past ten years (2002 to 2012). This recency suggests that research to assess the impact of combined cognitive and physical exercise on cognitive functions in older adults with cognitive impairment is still in its fledgling stage. The identified studies were mainly conducted in developed countries. The potential benefits of combined intervention appears to be attracting the interest of researchers throughout the world however more studies are needed before generalisation of reliable evidence can be reached, especially in developing countries.

2.5.1 Comparison and control group design

Appropriate design of the comparison and control groups is important to allow critical investigation on the comparative effectiveness between the specific components of an intervention and other components or common conditions being studied (Hart, Fann, & Novack., 2008; Kinser & Robins, 2013).

In cognitively healthy populations, Fabre *et al.* (2002) found the combined training demonstrated significant improvement in memory compared to either single memory or aerobic training alone. Oswald *et al.* (2006) showed the combined cognitive and physical training improved general cognitive performance and subjective measures of functional status compared to a no treatment control, and proved more promising than the single training groups. The multi-arm comparison group design in these studies allow a clear comparison between the unique component in the combined intervention and the common components (single cognitive or exercise training) in the comparison groups as well as the non-specific components (staff exposure or social contact) in the control group. This design can greatly strengthen the validity and credibility of the findings in the studies. Nevertheless, the exposure to interventions varied between the combined and single interventions.

In a population with cognitive impairment, all the four studies used a dual- task exercise group compared with a control group reported significant findings. Nevertheless, it can be challenged that the improvements observed in the studies may not be attributed to the interventions or, more precisely, the specific component of the intervention. The use of a no-treatment group by Coelho *et al.* (2012) may control for the effects of time and the effects of repeated testing on outcome measures. The use of a waitlist group by Kounti *et al.* (2011) may also control for the effects from an expectancy of improvement. The use of health education by Suzuki *et al.* (2012) may further control for other non-specific treatment effects (e.g. social contact) but the three sessions' contact time was far less than the 120 hours' intervention time, which may lead to ineffective control of the non-specific moderators by the control group ((Hart, Fann, & Novack., 2008; Safer *et al*., 2006). Schwenk *et al.* (2010) compared the intervention group with a low intensity exercise group. This may allow for a further comparison on the effects from the difference in exercise intensity. Studies have found that moderate intensity aerobic exercise is more effective for improving cognitive function than low intensity exercise (Colcombe & Kramer, 2003), whereas combined aerobic and strength training has a greater effect compared to single mode exercise training (Erickson & Kramer, 2009). A good comparison control should omit the unique intervention component under investigation, while possessing the common ingredients in equal measure (Safer & Hugo, 2006). Although positive findings were reported in all the four studies used dual-task training as intervention, it can still be questionable as to whether the improvements were all attributed to the dual- task components. An appropriate comparison with the potential beneficial components or moderators is important to validate the differential effects under the investigation. As a result, appropriate activity selection in comparison control and a well-designed comparison group are crucial in future studies on the efficacy of combined interventions.

2.5.2 Outcome Measure Selection

The studies by Suzuki *et al.* (2012) in aMCI and Kounti *et al.* (2011) in MCI populations did not find any effects on executive function. In contrast, the study by Coelho *et al.* (2012) in AD patients found significant improvement in executive function and attention. Both aMCI and AD are characterised by progressive memory loss (Pertersen 2004). However, studies have shown that patients with aMCI may show memory deficits similar to those shown by AD, but have preserved executive functions (Alescio-Lautier *et al.*, 2007; Pertersen, 2004).

Executive function deficits have consistently been found predicting AD conversion (Ritchie, Artero, & Touchon, 2001; Tabert *et al.*, 2006) although it remains unclear how executive function is impaired in aMCI (Bisiacchi, Borella, Bergamaschi, Carretti, & Mondini., 2008; Marshall *et al.*, 2011). Therefore, it is important to include executive function as one of the intervention outcomes in both aMCI and AD populations.

Nevertheless, the changes in executive function in MCI and early AD population could be so subtle that some of the widely used executive function tests may not be sensitive enough to detect the minimal changes (Espinosa *et al*., 2009; Pickens, Ostwald, Murphy-Pace, & Bergstrom, 2010). Moreover, the diversity of components under the umbrella of executive function (Miyake *et al*., 2000) may further complicate the difficulty in assessing executive function.

The approach to use multiple outcome measures, as that in the study by Kounti *et al.*(2011), may be helpful but care must be taken to balance the assessment burden on the participants (Pickens *et al*., 2010). Selection of outcome measures with appropriate sensitivity and specificity to the study population should be of primary concern in future studies (Karrasch, Sinerva, Gronholm, Rinne, & Laine, 2005; Parra, Ascencio, Urquina, Manes, & Ibanez, 2012).

2.5.3 Intervention Period

Suzuki *et al.* (2012) reported significant effects on general cognitive function and memory at 6 months which were not demonstrated at 12 months treatment end. The intervention period in the study of Suzuki *et al.* (2012) was the longest compared to that in other studies (3-5 months) with cognitively impaired participants. A previous meta-analysis has found negative association between the training duration and the cognitive intervention effect on persons with MCI and suggested that studies with longer sessions and longer duration of total sessions would produce smaller effect sizes (Li *et al*., 2011). As revealed by the study results in this review, an intervention period of three to six months has shown to be more favorable than a longer intervention period in populations with cognitive impairment. Nevertheless, the moderating effect of program duration may need to be examined systematically in future intervention studies.

2.5.4 Visual-spatial Component

Kounti *et al*. (2011) was the only study that used dual tasks with visual-spatial stimuli and assessed visuo-spatial ability. Visuospatial ability refers to the cognitive ability to orientate attention to visuospatial stimuli, manipulate and transform the visuospatial information to use in a goal-directed way (Sanchez, 2012). Studies have found that both MCI and AD patients show deficits in visual spatial function (Iachini, Iavarone, Senese, Ruotolo, & Ruggiero, 2009; Possin, 2010) which is also one of the predictors of conversion to dementia of persons with MCI (Amieva *et al*., 2004; Griffith *et al*., 2006). Indeed, visual spatial function is a very important cognition in everyday functioning, for instance, navigating a car safely in driving or searching the routes in a new environment. Subtle declines in this ability would impose a great impact on everyday livings in elderly populations (Alescio-Lautier *et al.*, 2007; Iachini *et al.*, 2009; Possin, 2010). Studies have found that visual spatial ability can be trained through practice (Jaeggi, Buschkuehl, Jonides, & Perrig, 2008; Wright, Thompson, Ganis, Newcombe, & Kosslyn, 2008). Therefore, including visual spatial components in interventions as well as in outcome measures are highly recommended in future studies.

2.5.5 Dual-task Component

The high quality RCT by Schwenk *et al*. (2010) found significant improvement in dual-task performance only under complex dual task conditions. The patients needed to be adequately challenged to reach the effects. It was reported that higher basic DTC were associated with a higher percentage of improvement in DTC. This highlights the importance of adjusting the level of the training tasks to meet individual capacity in intervention design, thus making optimal use of an individual's latent potential (Hertzog, Kramer, Wilson, & Lindenberger, 2009).

Although the findings from using dual- task intervention are encouraging, the results need to be interpreted with caution. It has been challenged that the similarity of the dual- tasks assigned in the interventions and the assessment tasks may produce a learning effect ultimately affecting the reliability of the outcome results (Pichierri, Wolf, Murer, & de Bruin, 2011). Therefore, selection of alternative dual-tasks should be considered in future studies using dual-task exercise.

2.5.6 Training Sequence in Combined Intervention

The sequence in delivering the cognitive training and exercise training sessions on combined training may have a potential impact on the intervention outcomes. Legault *et al.* (2011) found no intervention effects when the physical training was delivered after the cognitive training. Oswald *et al.* (2006) however found positive intervention effects with the physical training sessions delivered before the cognitive training for half of the intervention period.

Animal studies have found that exercise promote neurogenesis in the brain and improves learning (Farmer *et al.*, 2004; van Praag, Shubert, Zhao, & Gage, 2005). Neuroimaging studies in populations with cognitive impairment reported that compensatory recruitment of new brain area were observed during the performance of demanding task (Belleville *et al*., 2011; Reuter-Lorenz & Lustig, 2005). In a recent animal study on the effects of combined training with positive findings, the physical activity also preceded the cognitive training or the participants were re-exposed to cognitive training after physical training (Langdon & Corbett, 2012). It appears more favorable to have the exercise sessions before the cognitive training session, in order to better prepare the brain for the compensatory recruitment process in the cognitive training sessions. Nevertheless, more intervention studies are needed to clarify the potential impact of training sequence on training outcomes.

The combination of both cognitive and physical interventions has been consistently proposed in previous reviews to enhance the motor and cognitive functions in the older populations, and possibly to accomplish an optimal outcome over the interventions being used separately (Rebok, 2008; Thom & Clare, 2011; Yan & Zhou, 2009). However, only a limited number of studies in either cognitively healthy or impaired populations could be identified under this present review. A recent animal study has reported significant changes in cognitive ability using a paradigm involving moderate levels of physical activity plus cognitive activity (Langdon & Corbett, 2012). The researchers particularly suggested the potential benefit of adapting the paradigm in slowing the development of mild cognitive impairment and subsequent dementia in elderly people. More studies are still needed in this research area.

The limited number and the heterogeneity of the reviewed studies do not enable any firm conclusion to be drawn on the impact of combined cognitive and physical interventions on cognition of older adults. Nevertheless, specific study characteristics have been identified in this review that may help to promote intervention fidelity in future studies. Significant improvements were found in all included studies with cognitively impaired populations and in two out of the three studies with cognitively healthy populations.

2.6 Limitations

Limitations of this review should be noted. The search terms were limited to title, abstract and keywords to constrain the magnitude of the search yield to a manageable size and only citations published in English were included in this review. These restrictions may limit coverage of all potential studies under this topic. Moreover, initial study screening with title and abstract may lead to further limited cover of possible intervention identification although full text would be drawn for examination whenever a decision could not be judged by screening with title and abstract.

2.7 Conclusion

Two main types of combined cognitive and physical interventions were identified in this review. All studies with cognitively healthy population used combined sessions of single cognitive training and single exercise training. All of the studies among the cognitively impaired populations used dual-task training. One of these studies used visual spatial tasks in the dual-task exercise. Surprisingly, this review did not identify any studies with cognitively impaired participants using combined single cognitive training and single physical training sessions. Only three studies with cognitively healthy populations compared combined intervention with multiple comparison groups.

Results of the present review showed that studies with cognitively healthy populations revealed significant benefits of combined cognitive and exercise interventions on general cognitive functions, memory and functional status compared to active control groups. Studies with cognitively impaired populations also showed significant improvements in general cognitive functions, memory, executive functions, attention and functional status in persons with MCI and AD or dementia, but lack comparison with active control groups.

In conclusion, combined cognitive and exercise training can be effective for improving the cognitive functions and functional status of older adults with and without cognitive impairment. However, limited evidence can be found in populations with cognitive impairment when the evaluation includes an active control group comparison. More well-designed studies are required before one can draw any firm conclusion on the efficacy of the combined cognitive and exercise intervention in older adults.

In the absence of a cure for cognitive impairment or dementia, further research efforts are needed to explore the potential benefits of this new intervention paradigm to help delay, and possibly reverse the progression of cognitive impairment. In conclusion, this review found combined cognitive-exercise interventions showed moderate to large effects on cognitive functions in older adults.

Chapter 3

Systematic Review - Measures of Everyday Competence in Older Adults with Cognitive Impairment

This systematic review chapter was published in Age & Ageing. This journal was selected for the submission as it is an international journal publishing reviews on geriatric medicine and gerontology with an Impact Factor of 3.816 in year 2012**.**

Law L, Barnett F, Yau M, Gray MA (2012). Measures of everyday competence in older adults with cognitive impairment – A systematic review. *Age and Ageing,* 41(1), 9-16. doi: 10.1093/ageing/afr104.

3.1 Introduction

Cognitive impairment increases in occurrence with age with or without the presence of pathology (Stott, 2006). Research has consistently shown that cognitive impairment contributes to increased hospital use (Ferri *et al.*, 2005) and is a key risk factor for institutionalization of this population (Kelman & Thomas, 1990).

Studies have found that the elderly with cognitive impairment will have a high risk of functional decline during hospitalization affecting their level of independence at discharge (Pedone *et al*., 2005). Assessment to determine whether patients are still capable of meeting the cognitive challenges of everyday living at home are crucial for timely interventions and safe discharge planning. However, traditional psychometric measures of cognitive abilities may not adequately reflect older adults' functioning in a real everyday context whereby individuals have the opportunity to apply their experience and knowledge they have been accumulated over a lifetime (Marsiske & Willis, 1995). Functional assessments will only inform about the potential problems in specific functional areas. Nevertheless, these measures are still important and widely used as part of a team approach to discharge planning in clinical practice.

Studies can be found focusing on a single aspect of competence, such as driving or medication management (Barbas & Wilde, 2001). However, the corresponding result would have limited generalization on the overall competence which is multidimensional in context and requires the ability to function in multiple domains (Marsiske & Willis, 1995; Willis, 1996). We may find the involvement of an occupational therapist to assess the patient's function at home or a home trial in clinical practice to promote a safe discharge.

Everyday problem solving involves the application of multiple cognitive processes and is important for maintaining independent living in the community (Burton, Strauss, Hultsch, & Hunter, 2009). Measures of everyday cognition and everyday problem solving, examining the cognitive performance of older adults on tasks that are experienced in everyday situations, are considered to be more ecologically valid to adequately reflect older adults' everyday functioning in the real world (Brandt *et al*., 2009).

3.2 Objectives of Review

This review aims to identify the different instruments available for evaluating the everyday problem solving or everyday competence of the elderly with cognitive impairment. It will further critically review the measurement properties of the published instruments in order to give reference for researchers or clinicians to better assign priority for their outcome measure selection in clinical practice or research.

3.3 Methods

3.3.1 Search Strategies

A systematic computer-based search of Cinahl, Medline, PsycINFO, AARP Ageline, ProQuest databases and the Cochrane Library was conducted for the time period between January 1995 to December 2010.The following search terms: scale or assessment or measure* or test combined with dement* or Alzheimer* or cognitive impairment and everyday cognition*, everyday cognitive, functional cognition*, everyday problem solving, everyday functional competence, cognitive competence, everyday competence, everyday decision making.

The search was limited to publications in English. Additional searches of Medline, PsycINFO, AARP Ageline databases using the full name of the identified instruments was conducted to ensure maximum inclusion of potential articles. All reference lists in selected journal articles were screened for further potentially relevant articles.

3.3.2 Instrument Identification

Studies were firstly screened based on title and abstract for names and data of potential instruments. Articles were included in this review if they described development, validation or application of instruments assessing everyday competence or problem solving in elderly with cognitive impairment. Studies that described traditional neuropsychological assessments or only functional assessments were excluded due to their limited ecological validity as mentioned above. After screening, the name of potential instruments were identified from the included articles and further screened with selection criteria to be included in this review.

3.3.3 Instrument selection

Instruments were included if they measured everyday cognitive competence or everyday problem solving and were disease specific, i.e. developed and/ or validated for use in older adults with dementia or cognitive impairment. In addition, the instruments had to be structured and described in adequate detail with information published on their measurement properties to enable critical review of the instruments. Diagnostic instruments were excluded due to the predominant difference in focus from outcome measures. For example, the sensitivity to change or assessment of individual differences would be the key focus for an outcome measure but may not be the key focus for diagnostic tools. Instruments which focused on a single domain were excluded due to their limited generalisation. Further, self-reported or informant-based instruments were excluded as the aim of this review was to identify instruments that assess actual performance. Studies have shown that older adults tend to overestimate their ability or reported level of functioning (Ford *et al.*, 1988) and informant-based are potentially subject to various biases (Rubenstein, Schairer, Wieland, & Kane, 1984).

As recommended in the Cochrane Handbook of Systematic Review of Interventions, two reviewers (LL[4] and FB[5]) independently screened the titles and abstracts to identify relevant articles and potential instruments using the inclusion/exclusion criteria. Disagreements between the reviewers were resolved through discussion (Higgins & Green, 2006).

3.3.4 Quality Rating of Instruments

A limited number of articles exist demonstrating guidelines on outcome measure evaluation, particularly for tools measuring health-related quality of life (HRQOL) (Scientific Advisory Committee of the Medical Outcomes Trust, 2002). However, recent reviews on tools other than HRQOL using similar sets of instrument evaluation properties and criteria can be found (Noonan, Miller, & Noreau, 2009). The framework offered by Andresen (2000) provides a more structured and clearer definition of

[4] Lawla Law, Thesis Author
[5] Fiona Barnett, PhD Supervisor

instrument rating criteria and was further adapted by Terwee *et al*. (2007) in the review of HRQOL tools. A list of instrument properties with the corresponding rating criteria based on Terwee *et al.*'s work was adapted for use in this review (Table 3.1).

The clinimetric properties of the included instruments were evaluated on the following eight quality criteria: (1) Reliability, (2) Validity, (3) Interpretability, (4) Measurement model (floor/ceiling effect), (5) Item/instrument bias, (6) Responsiveness, (7) Respondent burden (time to complete), (8) Administrative burden (ease to administer, score and interpret). All instruments meeting the inclusion criteria outlined above were incorporated into the review. Instruments were evaluated and compared on relevant properties using the checklist by two independent reviewers (LL and FB).

Table 3.1 Instrument Rating Criteria

Characteristics	Description	Criteria for Rating
Reliability	The extent to which an instrument is consistent and free from measurement error. This includes test-test repeatability, internal consistency and comparison with proxy response.	**Test-retest / inter-rater repeatability:** (Intraclass Correlation Coefficient or Kappa κ) A ≧ .75 B ＞ .40 ＜ .75 C ≦ .40 **Internal consistency Coefficient α** A ≧ .80 B ＞ .70 ＜ .80 C ≦ .70 **Proxy response/ Inter-rater reliability (Intraclass Correlation Coefficient ICC)** A ≧ .75 B ＞ .40 ＜ .75 C ≦ .40
Validity	The extent to which an instrument measures what it purports to measure. This includes: factorial structure component analysis), convergent correlations (comparison with other measures) and discriminant (group difference)	**Construct Factorial Structure: (confirmatory/explanatory factor analysis or Rasch Analysis)** A = confirmed or result of Rasch Analysis is good B = factorial analysis has some problem C = weak or inadequate statistical analysis **Convergent Correlations** A ＞ .60 B ＞ .30 ＜ .60 C ≦ .30 **Discriminant (Group differences by mean or %)** A = strong, expected direction, supported by evidence B = moderate, conflicting evidence C = weak

Interpretability	The degree to which one can assign qualitative meaning to quantitative scores	Score interpretation A = Mean and SD scores presented for both general population and person with cognitive impairment **Plus** information on the relationship of scores to well-known functional measures or to clinical diagnosis was given/ interpretation of clinical meaning of score was given B = Mean and SD scores presented for general population and person with cognitive impairment/ interpretation of clinical meaning of score was given C = some high/ low interpretation
Measurement model **(floor/ceiling effect)**	Examines if there are problems with floor effects (lowest level of function) or ceiling effect (highest level of function	The instrument has measure/ scale 20% of clients with cognitive impairment grouped at scoring extremes A = no problem B = few or marginal problems C = substantial skewing of scale/measure
Instrument/Item bias	Assess if the instrument/any components are biased for people with cognitive impairment	A = content reviewed by experts/ disciplines working for people with cognitive impairment and people with cognitive impairment were included in the initial testing/ factorial analysis is good B = There is adequate face validity to support low bias C = bias is evident or tested
Responsiveness	Ability to measure or sensitivity to important changes	Patient-centered and/or clinical criteria for change are:: A = strong, expected direction, supported by evidence B = moderate, conflicting evidence C = weak

Respondent burden	Assesses the time to complete the measure	A = ≦ 15 min and no reported problem of acceptability B = either longer (but approximately so) or some reported problem of acceptability C = Both length and acceptability are problematic for people with cognitive impairment
Administrative burden	Assesses the ease of administration, scoring and interpretation of the measure	A = scoring by hand and no extra resources/ special equipment or test materials needed B = Extra resources/ special equipment or test materials needed / obscure interpretation of score C = costly and/ or complex equipment or test materials and/ or score interpretation

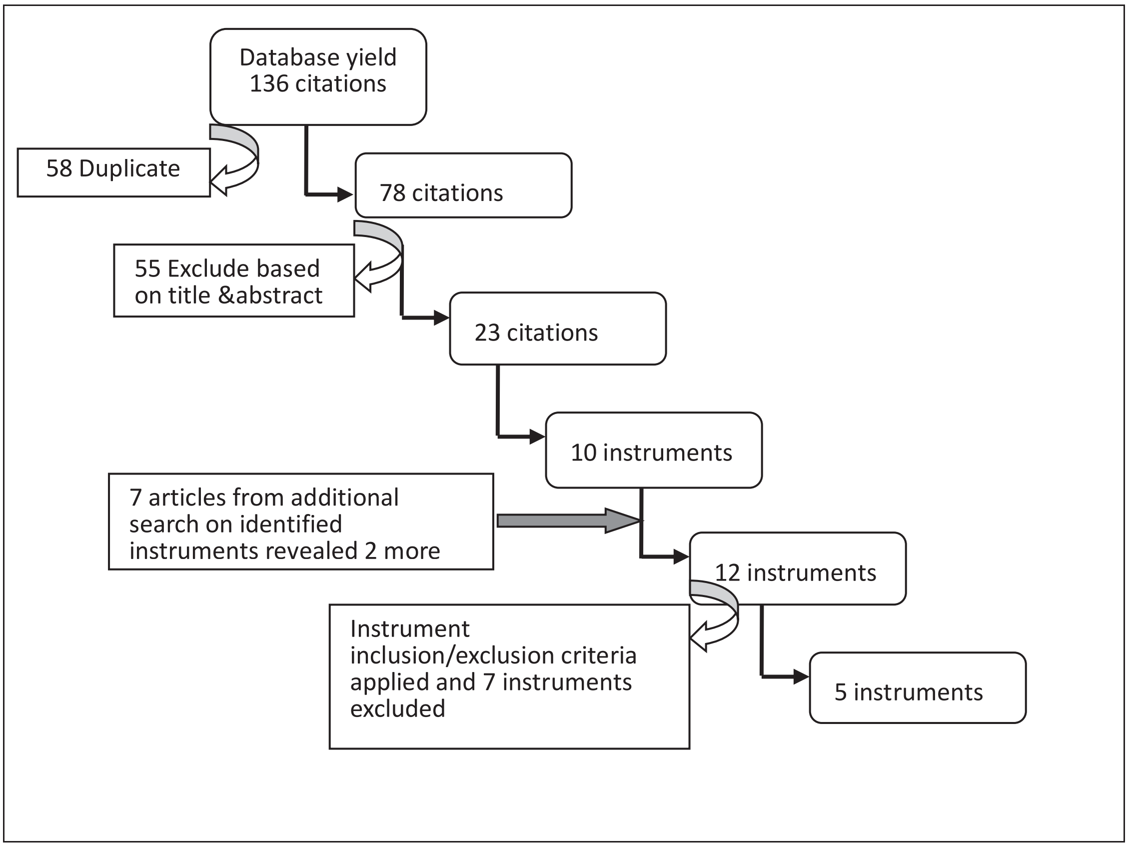
(Adapted: Caroline B. Terwee, Sandra D.M. Bot, et al. (2007). Quality criteria were proposed for measurement properties of health status questionnaires. Journal of Clinical Epidemiology (2007), 60: 34-42)

3.4 Results

The initial database search identified a total of 136 potentially relevant citations. After excluding duplicated articles, 78 citations were left. All titles and abstracts were screened according to the inclusion/exclusion criteria. Full texts of 23 articles were retrieved and carefully examined and ten instruments were identified. The additional search using the name of the included instruments disclosed seven more articles covering descriptions of two more potential instruments. Cross-referencing led to four more articles. After further screening of the potential instrument with the inclusion/ exclusion criteria, seven instruments were excluded. A summary of the selection process is illustrated in Figure 3.1.

Five instruments were included in this comprehensive review: Assessment of Capacity for Everyday Decision Making (ACED), Everyday Cognition Battery Memory Test (ECB), Everyday Problems Test (EPT), Everyday Cognitive Competence for Cognitive Challenged Elderly (EPCCE) and Problems in Everyday Living Test (PEDL).

Figure 3.1 Flow Diagram of Instrument Selection Process



3.4.1 Instrument Description

A summary of the characteristics of the instruments (Allaire, Gamaldo, Ayotte, Sims, & Whitfield, 2009; Allaire & Willis, 2006; Burton, Strauss, Hultsch, & Hunter, 2006; Lai *et al*., 2008; Leckey & Beatty, 2002) included in this review is presented in Table 3.2.

The ACED and EPCCE were developed specifically as a functional cognition assessment for the elderly with cognitive impairment The ECB and EPT were developed on a sample of elderly persons without dementia. The PEDL was developed on patients with multiple sclerosis but validated for use in population of Alzheimer's Disease (AD).

The ACED focuses on the capacity of decision making in solving everyday problems. The ACED interviewer needs to collect information on the participant's functional problem from an informant and tailor the interview content based on a structured format.

The ECB, EPT and EPCCE focus on Instrumental Activities of Daily Living (IADL) domains and encompass paper and pencil performance based problem solving measures using real world printed stimuli. Participants are asked to answer questions based on these stimuli. The EPCCP is a simplified version of EPT. The PEDL is a 14-items practical problem solving test. Examples from the ACED, ECB, EPCCP and PEDL as adapted from the corresponding publications are provided in Appendix 2.

Table 3.2 Description of Reviewed Instruments

Instrument	Study Population	Largest validation sample size	Study Setting	Goal	Domains	Mode of Administration	Time to complete	Scoring
ACED (Lai et al., 2008)	Very Mild to moderate cognitive impairment	39	Community-dwelling	Capacity to make decisions for solving everyday functional problems	4 Decision making abilities: problem understanding; problem appreciation; reasoning; expression of choice	Semi-structured interview to discuss the patient's problems in performing instrumental activities of daily living and the possible solutions to managing them.	15 – 20 min	Scoring criteria are available. Compute score by summing up individual question score.
ECB (Allaire et al., 2009)	Mild cognitive impairment	555	Community dwelling	Ability to solve memory related everyday problems	3 IADL domains: Medication use; financial management; nutrition and food preparation. Everyday cognitive competence: inductive reasoning, memory, and knowledge.	30 items Paper-pencil measure Presented with 2 real world printed materials (eg. medication labels) on each of the 3 IADL domains and removed before asking questions	> 12min	Compute score by summing up individual question score.
EPT (Burton et al., 2006)	Mild cognitive impairment	291	Community-dwelling	Measure competence in Problem solving related to daily living	7 IADL domains: medication use; meal preparation; telephone use; shopping; financial management; household management; transportation	Paper-pencil Performance-based measure To solve two problems pertaining to each of 21 printed stimulus (e.g., medication label). 42 items	No time limit	Compute score by summing up individual question score.
EPCCE (Allaire & Willis, 2006)	Mild to moderate cognitive impairment	773	Community-dwelling	measure of competence in problem solving with respect to cognitively	IADL domains: meal preparation, medication use, telephone use, shopping,	Performance- based measure To solve two problems pertaining to each of 16 printed stimulus (e.g., telephone bill)	No time limit	Compute score by summing up individual question score.

Note:
ACED, Assessment of Capacity for Everyday Decision Making; ECB, Everyday Cognition Battery Memory Test;
EPT, Everyday Problems Test; EPCCE, Everyday Cognitive Competence for Cognitive Challenged Elderly;
PEDL, Problems in Everyday Living Test; IADL, Instrumental Activities of Daily Living

				demanding daily living tasks (a shorter version of EPT)	financial management, household maintenance and transportation.	32 items		
PEDL (Leckey & Beatty, 2002)	Alzheimer’s disease	22	Community-dwelling	Measure ability to solve practical problems that occur in everyday life for predicting IADL performance.	Cognitive domain: Comprehension	Structured interview 14-item test of practical problem solving.	Not Reported	Compute score by summing up individual question score.

Note:
ACED, Assessment of Capacity for Everyday Decision Making; ECB, Everyday Cognition Battery Memory Test;
EPT, Everyday Problems Test; EPCCE, Everyday Cognitive Competence for Cognitive Challenged Elderly;
PEDL, Problems in Everyday Living Test; IADL, Instrumental Activities of Daily Living

3.4.2 Instrument Properties

3.4.2.1 *Validity*

The dimensional structures of two instruments (ECB and EPT) have been confirmed by factor analysis (Allaire & Marsiske, 1999; Whitfield, Baker-Thomas, Heyward, Gatto & Williams, 1999). The EPCCE followed the same factorial structure of the parent measure EPT (Allaire & Willis, 2006). The ACED has the dimensions adapted from a validated tool, the MacArthur Competency Assessment Tool for Treatment (MacCAT-T) (Lai *et al.*, 2008). The PEDL reported to have their structure based on WAIS-R Comprehension Test (Beatty *et al.*, 1998).

In all the studies that investigated validity of the reviewed instruments, hypotheses relating to the expected magnitude and direction of relationships with other instruments were presented. It was expected that correlation with basic cognitive abilities would be high. The ACED showed moderate to strong correlation with MMSE for all three decision making abilities ($0.48 \leq r_s \leq 0.60$) (Lai *et al*., 2008). However, only the reasoning and understanding subtests in ACED showed moderate associations with executive measures ($0.33 \leq r_s \leq 0.59$) (Lai *et al*., 2008). The correlations between basic ability tests and the ECB memory test were moderate to high (r =0 .47- 0.70, $p < .05$) (Allaire & Marsiske, 1999). The EPT had moderate correlations with cognitive tests (r = 0.32-0.59) and had the executive functions composite accounting for 11.4% of the variance (Burton et al., 2006). The EPCCE showed a moderate to high correlation with cognitive measures (r = 0.36-0.70). Results of a hierarchical regression analysis for variables showed performance on global cognitive measures and scores on executive abilities each accounting for a significant amount of unique variance (R^2 = .59, adjusted

R^2 = .57 and R^2 = .69, adjusted R^2 = .67 respectively) in EPCCE performance (Willis et al., 1998). The PEDL also showed a moderate correlation with MMSE (r = 0.52) (Leckey & Beatty, 2002).

Moreover, validations on specific functional domains of measure for individual instruments were found. Each ACED subtest showed moderate to strong correlations with its corresponding measure on the MacCAT-T, a validated measure for decision making capacity (r = 0.38-0.71) (Lai *et al.*, 2008). Three instruments (EPT, EPCCE and PEDL) have reported associations with IADL and/ Activities of Daily Living (ADL). The EPT showed a strong association with observed IADL (r = 0.67) (Burton *et al.*, 2006) but weak to moderate association with self/ informant reported IADL (r = 0.19 – 0.36) (Burton, Strauss, Bunce, Hunter & Hultsch, 2009). The EPCCE showed a weak association with caregiver reported IADL (r = 0.25) (Bertrand & Willis, 1999) but moderate association with self- reported IADL (r = 0.36) (Bertrand, Willis & Sayer, 2001). The PEDL had a strong association with IADL (r = 0.71) and moderate association with ADL (r = 0.58) (Leckey & Beatty, 2002).

Except for the verbal fluency subtest of ACED, all instruments demonstrated good discriminant group differences by mean. Nevertheless, the ACED showed a ceiling effect (Lai *et al.*, 2008) while the ECB reported a floor effect in pilot (Allaire & Marsiske, 1999). A possible floor effect was also reported in one of the studies on EPCCE (Allaire & Willis, 2006).

3.4.2.2 *Reliability*

With regard to internal consistency, a Cronbach's alpha was reported for all reviewed instruments, except PEDL, ranging from 0.84 to 0.92. Test-retest reliability was found for EPT (Burton *et al.*, 2006) and EPCCE (Allaire & Willis, 2006) using correlation coefficient r = 0.81-0.93. Inter-rater reliability was reported for ACED and PEDL. Inter-rater ICC was only reported for ACED ranging from 0.85-0.99 for subtests (Yu, Lui, Chiu, Karlawish, & Appelbaum, 2009). Percentage of agreement was reported for ACED subtest of choice (Lai *et al.*, 2008). Inter-rater reliability for PEDL was 0.944 (Beatty *et al.*, 1998).

3.4.2.3 *Responsiveness*

Change over time was addressed only in studies for EPCCE (Allaire & Willis, 2006; Bertrand *et al*., 2001). However, it was found that the correlation between the rate of change and initial status was not significant (r = 0.03) and the reliability of rate of change was low (r = 0.26) (Bertrand *et al*., 2001). No reported data on responsiveness were found for the other instruments from the articles under this review.

3.4.2.4 *Interpretability*

Information on score interpretation was found for all reviewed instruments. Mean and SD scores of control and study groups were presented for all instruments. Information on scores for different relevant subgroups was available for EPT (Burton *et al.*, 2009; Burton *et al*., 2006) and EPCCE (Willis *et al.*, 1998). One study showed that lower baseline scores on the EPCCE were a significant predictor of mortality (Allaire & Willis, 2006).

3.4.3 Overall Quality

An overview on the quality rating of included instruments is presented in Table 3.3, and the related data extracted from reviewed articles is listed in Table 3.4.

The EPCCE was the only instrument that reported on responsiveness although it was found that the rate of change in score was not significant (r = .03) (Bertrand *et al.*, 2001). The EPT received the best positive rating for its clinimetric properties (10 out of 12). ECB received the second highest rating at 9 out of 10 for its property rating in this review. Both ACED and PEDL received the best rating for administration (scoring by hand and no extra resources/ special equipment or test materials needed). The PEDL reported only on 5 out of 12 clinimetric properties.

Table 3.3 Instrument Rating

Instrument	Reliability--internal consistency α	Reliability:--test-retest repeatability ICC or κ	Reliability--Proxy response ICC	Validity—Factorial structure	Validity—Convergent correlation	Validity—Discriminant group differences	Interpretability	Measure-ment model (floor/ ceiling effect	Instrument/ Item bias	Responsive-ness	Respondent burden	Administrative burden
ACED	A	NR	A - B	C	A--B	B	B	C	NR	NR	B	B
ECB	A	NR	NR	A	A--C	A	B	B	A	NR	A--B	B
EPT	A	A	NR	A	A--C	A	B	A	A	NR	C	B
EPCCE	A	A	NR	B	A--B	A	B	C	A	C	C	B
PEDL	NR	NR	A	NR	A--B	A	B	NR	NR	NR	NR	A

NR: not reported

Please refer to Appendix 1 for details on rating system adapted from C B. Terwee, et al. (2007). Quality criteria were proposed for measurement properties of health status questionnaires. Journal of Clinical Epidemiology (2007), 60: 34-42

Table 3.4 Reliability and Validity of Instruments

	Reliability Internal Consistency Coefficient α	Test-retest repeatability: (Intraclass Correlation Coefficient or Kappa κ)	Proxy response/ Inter-rater reliability (Intraclass Correlation Coefficient ICC)	Validity Factorial Structure: (confirmatory/explanatory factor analysis or Rasch Analysis)	Convergent Correlations	Discriminant (Group differences by mean or %)	Instrument/Item bias	Measurement model (floor/ceiling effect)
ACED	Cronbach's α = 0.84-0.92 for subtests (Lai et al., 2008)	NR	Inter-rater reliability; ICC =.85-.99 for subtests (Yu et al., 2009) ICC = 0.65-0.72 for understanding, appreciation and reasoning subtests (Lai et al., 2008) Percentage agreement for choice = 93% (Lai et al., 2008)	Dimensions were adapted from MacCat-T (Lai et al., 2008)	Spearman's Correlation with corresponding measure on the MacCAT-T r = 0.38-0.71 (Lai et al., 2008) MMSE: $0.48 \leq r_s \leq 0.60$ with 3 decision making subtests. (Lai et al., 2008)	Except for verbal fluency, patients demonstrated lower performance on cognitive tasks relative to caregivers (Lai et al., 2008)	NR	23% obtained the highest score in understanding 97 % obtained the highest score in ability to express a choice (Lai et al., 2008)
ECB	Cronbach's α = 0.81 (Allaire & Marsiske, 1999)	NR	NR	Confirmatory factor analysis was done. Goodness of fit index = .92 Normal fit index = .89 Relative fit index = .85 (Allaire & Marsiske, 1999)	Correlations between the basic ability tests and CEB Memory subtests r = 0.47-0.70 (Allaire & Marsiske, 1999)	participants with MCI performed, on average, significantly worse than those without Participants with MCI, on average, performed 0.5 standard deviations below those without on all three subscales.	Factorial analysis is good (Allaire & Marsiske, 1999)	Floor effect reported in pilot (Allaire & Marsiske, 1999)

Note:
ACED, Assessment of Capacity for Everyday Decision Making; ECB, Everyday Cognition Battery Memory Test;
EPT, Everyday Problems Test; EPCCE, Everyday Cognitive Competence for Cognitive Challenged Elderly;
PEDL, Problems in Everyday Living Test
NR, Not Reported

						(Allaire et al., 2009)		
EPT	Cronbach's alpha = .88 (Burton et al., 2006) Cronbach's alpha = 0.89 (Whitfield et al., 1999)	1 year Test-retest reliability r = .93 (Burton et al., 2006)	NR	Structure was confirmed by a confirmatory factor analysis (Whitfield et al., 1999)	Observed IADL r = 0.67 (Burton et al., 2006) Lawton and Brody IADL Scale, Scales of Independent Behavior-Revised – SIB-R) (informant and self-reported) r = -0.19-0.36 (Burton et al., 2009) Inductive Reasoning r = 0.61 (Burton et al., 2006) cognitive tests r = 0.32-0.59 (Burton et al., 2006) Basic Skills Test (functional literacy) *r* = .87. (Burton et al., 2006)	For the young-old participants, the NCI group performed significantly better on the EPT than the other two groups (i.e., CIND and CIND2), which did not differ For the old-old participants, both the NCI and CIND groups obtained better scores than the CIND2 group (Burton et al., 2006; Burton et al., 2009)	Factorial analysis is good (Whitfield et al., 1999)	The distributions for EPT total scores and item variability indicated that there were no floor effects (Burton et al., 2006)
EPCCE	Cronbach's α = .90 split-half reliability of .87. (Willis et al., 1998)	6 months' Test-retest Reliability r = .81. (Willis et al., 1998) 2 months' test	NR	Same factorial structure as parent measure EPT MMSE was found to account for significant variance in	self-reported IADL r = .36 (Bertrand et al., 2001) Care giver IADL rating = .25 (Bertrand &	Non-impaired participants (*n* = 656) performed significantly ($p \leq .001$) higher on average than the	Factorial analysis is good from mother tool EPT	Possible floor effect was reported (Allaire & Willis, 2006)

Note:
ACED, Assessment of Capacity for Everyday Decision Making; ECB, Everyday Cognition Battery Memory Test;
EPT, Everyday Problems Test; EPCCE, Everyday Cognitive Competence for Cognitive Challenged Elderly;
PEDL, Problems in Everyday Living Test
NR, Not Reported

		retest reliability r = .93 (Allaire & Willis, 2006)		EPCCE total scores, F (1, 57) = 23.52, *p* < 0.001, R2 = 0.29. (Bertrand & Willis, 1999)	Willis, 1999) cognitive measures r = .36-.70 (Willis et al., 1998)	possible-impaired (*n* =72) and impaired groups (*n* = 45). (Allaire & Willis, 2006) Different mean score for Individuals with very mild cognitive impairments, mild cognitive impairments and moderate cognitive impairments (Willis et al., 1998)		
PEDL	NR	NR	Interrater reliability was 0.944. (Beatty et al., 1998)	Based on WAIS-R Comprehension Test (Beatty et al., 1998)	IADL r= .71 ADL r = .58 MMSE r =.52 (Lecky & Beatty, 2002) Problem focus coping strategies r = .46 abstraction r =.32 (Beatty et al., 1998)	AD patients demonstrated lower score than control group (Beatty et al., 1998)	NR	NR

(NR: Not Reported)

Note:
ACED, Assessment of Capacity for Everyday Decision Making; ECB, Everyday Cognition Battery Memory Test;
EPT, Everyday Problems Test; EPCCE, Everyday Cognitive Competence for Cognitive Challenged Elderly;
PEDL, Problems in Everyday Living Test
NR, Not Reported

3.5 Discussion

Only five instruments that assess the ability of everyday problem solving of the elderly with cognitive impairment were identified. All instruments attempted to adequately reflect older adults' everyday functioning in the real world. The ACED allows for specific assessment on patient's decisional abilities related to specific individual functional deficits. This information will be valuable in caring for persons with self-neglect. However, the presence of a knowledgeable informant is critical to obtain the participant's information prior to the administration of ACED. Therefore, ACED is not applicable for clients living alone or those without a knowledgeable informant.

The ECB is an instrument which focuses on memory-related problem solving. Participants are presented with real-world printed material which is removed before they are asked the questions. Clinician must be aware of the potential stress and degree of acceptance for clients with a memory problem.

The EPT requires participants to solve problems associated with seven IADL domains using real life stimuli. This provides a comprehensive assessment of everyday competence. However, it was reported that the mean item difficulty of EPT was -.646, suggesting the measure is a moderately difficult scale (Marsiske & Willis, 1995). The EPT may not be appropriate for individuals with higher level of cognitive impairment.

The EPCCP which was designed as a shorter version of the EPT would be more appropriate for populations with lower levels of cognitive function (Willis *et al*., 1998).However, a possible floor effect was reported for EPCCP (Bertrand *et al*., 2001). Additionally, both EPT and EPCCP are untimed based on the rationale that there should be no time limit in performing everyday tasks. A possible increase in the burden for the respondent and administrator need to be considered.

The PEDL is simple to administer. However, limited information on its psychometric properties was identified from this review.

All the instruments included in this review focused their framework on IADL domains. This focus is congruent with suggestions from other studies on the importance of IADL in determining an elderly individual’s capability to live independently in the community (Agüero-Torres, Thomas, Winblad, & Fratiglioni, 2002).

All the reviewed instruments allowed direct measures of everyday problem solving performance, which is more reliable than other indirect methods especially for use in populations with cognitive impairment. The measurement designs also allow the participants to apply their habitual experience and knowledge in the context of assessed everyday tasks without other constrains such as physical limitations.

With regard to providing information to promote the process of instrument selection, a critical review on the clinimetric properties was conducted with the key results listed in table 3.3 and table 3.4. For the selection of an outcome measure, responsiveness would be of particular importance. However, limited information on responsiveness was found, except for the EPCCE.

Ease of administration and interpretability should also be of great concern in tool selection. When using ACED, the interviewer must administer and rate the score according to a specific guidelines and rating criteria which is available from the developer. Similarly, prior to administration of ECB, EPT or EPCCP, copies of specific real-life stimuli are needed. The PEDL appears to be the simplest instrument. All instruments under review had good interpretability with mean and SD scores presented for the general population and for persons with cognitive impairment.

Different strengths and limitations were found with all of the reviewed instruments. No single measure, either by traditional neuropsychological psychometric measures or these everyday problem solving instruments, can unequivocally determine whether someone has the capacity to live independently. Input from multi-disciplinary healthcare team is needed for safe discharge planning. Previous studies have used these ecological test outcomes to compare performance between those with and without cognitive impairment or to associate ecological test outcomes with clinically meaningful outcomes (like risk of dementia or mortality). Further research is needed to compare assessment scores with real life outcomes on how the cognitively impaired older people manage after discharge from hospital to their own home or a supported care setting.

3.6 Conclusion

Few existing instruments that assess the ability of everyday problem solving of the elderly with cognitive impairment exist in the literature. Four out of the five instruments identified in this review (ECB, PET, EPCCE, PEDL) capture data by using hypothetical scenarios/ problems although they are more ecologically valid than traditional neurological tests. The ACED is able to more adequately reflect on the individuals' capacity in decision making related to everyday function in real life but it is not applicable for those living alone without a knowledgeable informant. Clinicians are more likely to determine that individuals with more severe cognitive impairment as ‘needing’ to be assessed than those with mild to moderate impairment. However, no available instrument for the moderate to severe impairment group was identified in this review.

Continuous studies are needed on the development and validation of simple screening tools aimed at accurately predicting everyday competence, especially for those with moderate to severe cognitive impairment. This will be of special importance if clinicians are expecting to provide better care of patients with cognitive impairment, in order to ensure their well-being and they can safely live in the community as long as possible.

This review provides information for clinicians or researchers on existing instruments to assess the ability of everyday problem solving of the elderly with cognitive impairment so as to facilitate the choice of an appropriate instrument. It is important to bear in mind that the selection process is a matrix of tactical decisions to meet the specific purposes for the specific application in the specific population under specific resources. Different measures provide valuable additional and objective information under certain circumstances, but will still need to be considered as one part of a team approach to discharge planning. These measures will still be considered as just one part of the assessment process, along with personalized functional assessment of IADL's and perhaps a home trial. Future research is suggested to involve trialing the tests in clinical practice as one part of a team approach to discharge and validating them against functional, real world outcomes.

Chapter 4

Development and Initial Testing of Functional Tasks Exercise on Older Adults with Cognitive Impairment at Risk of Alzheimer's Disease - FcTSim Program a Feasibility Study

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4.1 Introduction

The increasing prevalence of cognitive impairment is a growing concern, particularly due to the global phenomenon of population aging (Dodge, Shen, Pandav, DeKosky, & Ganguli, 2003; Ferri *et al*., 2005). A few studies have shown the protective effects of physical activity and exercise in older adults with cognitive impairment (Heyn, Abreu, & Ottenbacher, 2004; Larson *et al.*, 2006). However, discrepant findings can still be found in studies where there was no observed effect (Etnier, Nowell, Landers, & Sibley, 2006; Mayo Clinic, 2010).

Nevertheless, neurophysiological studies have suggested that combined mental and physical activities enhance synaptic connections between the brain cells and neuronal plasticity (Bennett, Diamond, Krech, & Rosenzweig, 1996; Spatz, 1996). Fabre *et al.* (2002) reported combined cognitive and physical training led to greater effects on memory performance compared to physical training or cognitive training alone. Studies have also found combined cognitive-exercise interventions are more promising than simply cognitive or motor training for improving cognitive functions (Curlik & Shors, 2013; Olazarán *et al.*, 2004; Oswald, Gunzelmann, Rupprech, & Hagen, 2006). Therefore, the combination of a cognitive and physical training programs appears to be of particular value for improving cognitive functions.

This chapter describes the development of a functional tasks exercise program, which consists of both cognitive and physical training components, and a pilot study which was conducted to examine the feasibility of application as well as the initial effects of the program in patients with mild cognitive impairment.

4.1.1 Potential Effects of Combined Cognitive-exercise Training

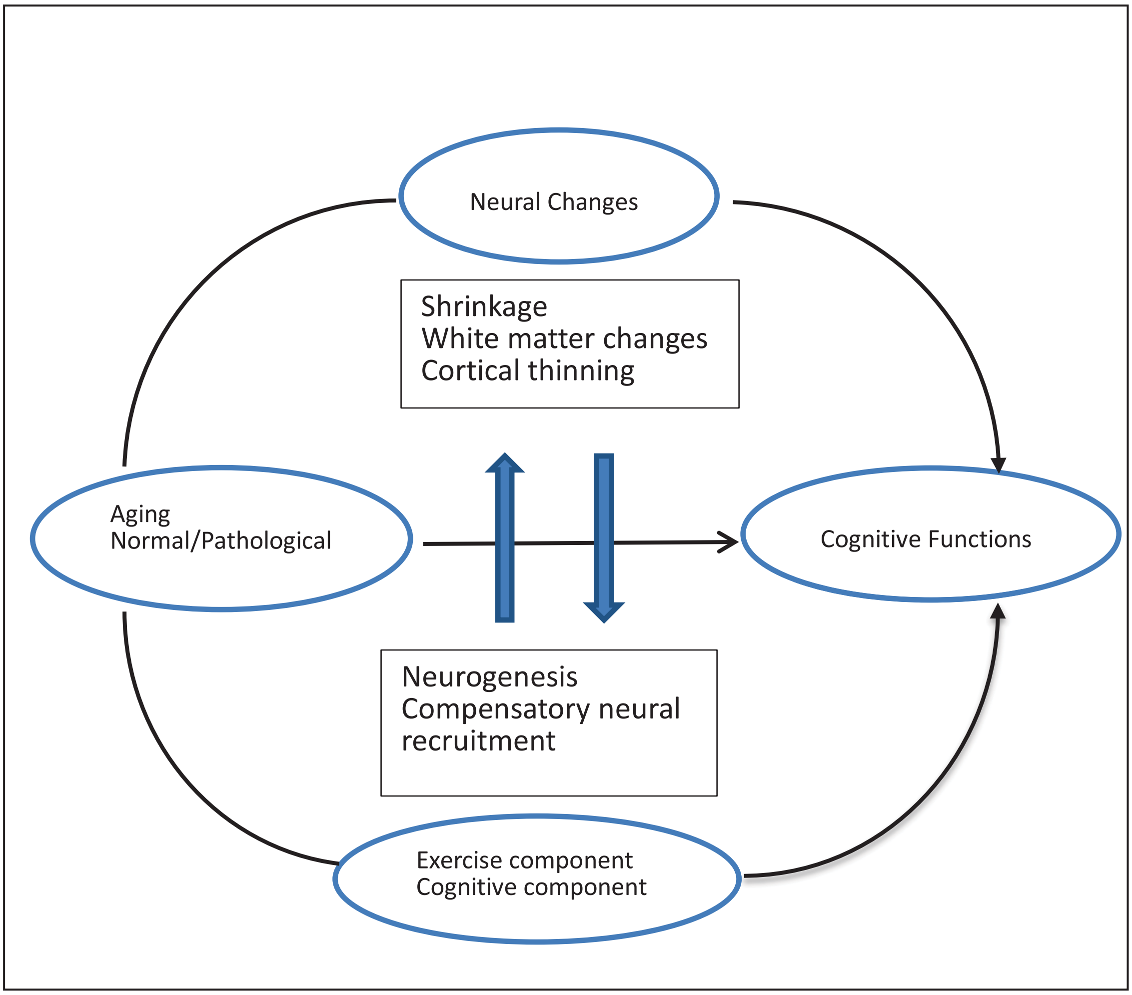
Studies in cognitively healthy populations have shown that combined cognitive-exercise intervention are more promising than simply cognitive or exercise training for improving cognitive functions (Fabre *et al.*, 2002; Olazarán *et al.*, 2004; Oswald *et al*., 2006). Animal studies also have shown that exercise can promote cerebral blood flow which enhancing neurogenesis and improve learning (Farmer *et al*., 2004; van Praag, Shubert, Zhao, & Gage, 2005). Bennett *et al*. (1996) has proposed that systematic physical training and a stimulating learning environment facilitates the development of new synaptic connections in the brain as well as promotes brain plasticity.

Recent neuroimaging studies in populations with cognitive impairment also reported that compensatory recruitment of new brain areas were observed during performance of demanding task (Belleville *et al*., 2011; Reuter-Lorenz & Lustig, 2005). It could be assumed that physical training or exercise promotes cerebral blood flow and improves the metabolic activity of the brain, whilst cognitively demanding activities provide an enriched environment resulting in more neurogenesis in the brain with synergic effect on cognitive function (Gomez-Pinilla, So, & Kesslak, 1998; Hertzog, Kramer, Wilson, & Lindenberger, 2009).

4.1.2 Functional Tasks Exercise

Daily functional tasks are innately cognitive-demanding (Alescio-Lautier *et al.*, 2007; Thornton & Dumke, 2005) and involve components of stretching, strengthening, balance and endurance as seen in a traditional exercise program (de Vreede *et al*., 2005). Particularly, visual spatial functional tasks, such as locating a key or finding the way through a familiar or new environment, demand complex cognitive processes and play an important role in everyday living (Possin, 2010). However, visual spatial cognitions are highly vulnerable to the aging process (Moffat, 2009). Studies have found that visual spatial ability can be trained through practice (Jaeggi, Buschkuehl, Jonides, & Perrig, 2008; Wright, Thompson, Ganis, Newcombe, & Kosslyn, 2008) and working memory, regarded as the hub of cognition, can be trained through visuospatial tasks (Duval, Coyette, & Seron, 2008; Jaeggi *et al*., 2008; Lopez *et al*, 2006). Based on these previous findings, it is hypothesized that functional tasks exercise can influence different cognitive domains leading to improvements in cognitive functions, whereby the functional tasks act as a cognitively demanding activity to provide an enriched environment to influence cognitive functions which is further enhanced by the exercise component. It is further hypothesized that using cognitively challenging functional tasks as a cognitive-exercise intervention will be more meaningful and more practical for individuals with cognitive impairment. Therefore, it will be more likely for the participants to adopt the learned ‘functional task exercise’ into their daily routine and better perpetuate the desirable cognitive intervention benefits. A conceptual frame for the influences of Functional Tasks Exercise on cognitive functions is illustrated in Figure 4.1.

Figure 4.1 Conceptual framework for influences of Functional Tasks Exercise on cognitive functions [Adapted and modified from Kraft (2012); Park and Reuter-Lorenz (2009)]



4.2 Functional Tasks Exercise Program

A structured functional tasks exercise program was newly developed to specifically facilitate the cognitive functions of working memory and executive function with the purpose of enhancing the daily functional status of older person with mild cognitive impairment. This program is named “FcTSim” in which simulated (Sim) functional tasks (FcT) are used as a mean of cognitive-exercise intervention. A summary of the content of the FcTSim Program and the training session plan were described in Appendix 3 and Appendix 4 respectively.

Studies have found that following the performance of a cognitively demanding task the cortical area involved in working memory is activated with cortex reorganization (Audoin *et al.*, 2003; Olesen, Westerberg, & Klingberg, 2004). The simulated functional tasks exercise demands encoding, retention, and reproduction of a specific sequence of targeted arm and hand movements following the pre-designed pattern. The movement patterns in the FcTSim program were developed based on research findings described as follows.

4.2.1 Program Development and Content

A person with MCI may have a decline in memory, language, executive function and working memory (Lopez *et al.*, 2006). Indeed, working memory has been described as “the hub of cognition” due to its important role in a wide range of cognitive operations central to everyday cognition, and it has recently attracted the attention of researchers (D'Esposito *et al.*, 1995). Working memory refers to the cognitive processes of temporary storage, transformation and manipulation of on-line information required for successful performance in all cognitively challenging everyday activities (Nee *et al*., 2012). The individual capacity of working memory is highly related to one's competence in problem solving, reasoning, language, comprehension, learning and intelligence (Jaeggi *et al*., 2008). Studies suggest that working memory can be trained through visuospatial tasks and the training effect can be generalized to non-trained tasks related to working memory and reasoning (Duval *et al*., 2008; Jaeggi *et al*., 2008).

Researchers have suggested that the transfer effect to a non-trained task primarily results from the involvement of attentional control, which is essential for most cognitive functions. Training procedures facilitate the ability to control attention as well as improve the attention span (Halford, Cowan & Andrews, 2007). Others propose that the improvement in working memory may serve as a domain-general cognitive resource that modulates the ability in a number of seemingly disparate areas of cognitive performance. Activation over the cerebral cortex during training may work as a common platform with increased cognitive resources for non-trained tasks performance (Kane *et al.*, 2004; Richmond, Morrison, Chein, & Olson, 2011). For example, the activity of the right parietal cortex contributes to tasks, including spatial working memory, task switching, selective attention, auditory and verbal working memory tasks, as well as simple mathematical reasoning (Behrmann, Geng, & Shomstein, 2004; Zurowski *et al.*, 2002).

The FcTSim program should be conducted by a trained therapist. Training is required to ensure standardization of procedures and quality to implement the program. The program involves sets of visuospatial functional tasks (object placing and collection) following specific movement patterns with increasing cognitive demands at different levels. A Brief description of the five levels of movement is illustrated in Table 4.1.

Table 4.1 Description of the FcTSim movements

Level 1	Simple Place/Collection. Cross midline reaching. Forward placing and backward collection
Level 2	Circular Place/Collection. Cross midline reaching. Clockwise placing and counterclockwise collection
Level 3	Alternate Place/Collection. Cross midline reaching. Place/collect with left/right hands alternatively.
Level 4	Repeated Place/Collection. Cross midline reaching. Place as previous level/ collect after 1 point of repeated placing
Level 5	Unilateral and Bimanual Alternate Place/Collection. Cross midline reaching. Unilateral forward placing Bilateral forward exchange movement Bilateral backward exchange movement Unilateral backward collection

4.2.2 Key Components of Functional Task Activities

In the FcTSim program, participants are required to place and collect two different sets of dining utensils (cups and bowls) following the rules and specific movement pattern with the following task components for each level. This activity is a form of adaptive training whereby task difficulty levels can be adjusted to meet individual capacity and thus make optimal use of individual's latent potential (Hertzog *et al.*, 2009).

4.2.2.1 *Forward and backward sequence task*

Forward placing and backward collection form the basic movement patterns of the FcTSim program. Participants place objects in a forward sequence and collect them in a backward sequence.

Imaging studies have shown that the brain is activated from the frontal to the parietal lobe during visuo-motor sequence learning and retrieval (Grafton, Hazeltine, & Ivry, 1995; Sakai *et al.*, 1998). A positive association has been found between performance and increased activity in the prefrontal cortices among older adults (Cabeza, Anderson, Locantore, & McIntosh, 2002; Erickson *et al.*, 2007). Both forward and backward span tasks demand central executive resources for successful performance (Gregoire & van der Linden, 1997). Sun *et al*. (2005) compared brain activation patterns across age groups and found that more regions, especially the frontal cortex, exhibited greater activation in the backward recall task than that in the forward recall task in older adults compared to young adults. It has been proposed that the visuospatial component for the backward recall task is more demanding on executive resources and hence is more sensitive to age-related decline in central executive processing (Miyake, Friedman, Rettinger, Shah, & Hegarty, 2001). Studies have suggested that forward span tasks involve automatic processing in working memory without the need to reorganize information and require minimal cognitive demand on central executive function. In contrast, backward span tasks require retrieval and manipulation of information while simultaneously storing information to maintain a memory of position in place and target a sequence of movement, thus exerting significantly higher cognitive demand on the central executive function (Li & Lewandowsky, 1995).

4.2.2.2 *Bimanual coordination task*

Participants are required to perform the task using the dominant hand only for lower level tasks but using both hands when moving up to higher level tasks. Bimanual alternating (left than right or right then left) and bimanual simultaneous anti-phase movements are incorporated into the placing and collection task at the higher levels. These coordinated movements demand attentional cost in the brain.

Neuroimaging studies showed activation over the prefrontal cortex and anterior cingulate cortex which suggested an increase in executive functions and attention requirement during bimanual coordination (Wenderoth, Debaere, Sunaert, & Swinnen, 2005). Increased cognitive resources are used to maintain consistent and accurate alternations of bimanual coordination. Studies have shown that the older adult has increased difficulty with temporally asynchronous discrete tasks, relying more on the executive process as well as requiring more attention load to perform inter-limb coordination of both discrete and continuous tasks especially in perceived high difficulty conditions (Lee, Wishart, & Murdoch, 2002). However, this cognitive demand will only happen at the early stage of motor learning. The stimulation will decrease once the movement becomes more automatic through practice (Leff *et al*., 2008). Nevertheless, the novelty of the motor practice in the FcTSim program is maintained with the specific visuospatial demands involved. Continuous attention and executive demands are required to maintain continuous visuomotor integration, correct response selection and adaptive response in visuospatial problem solving to monitor individual performance (Mayr & Kliegl, 1993).

4.2.2.3 *Switching task*

Participants are required to place two objects alternatively in the placing tasks and perform the collection tasks in a similar manner. They are also required to switch between tasks of different levels.

Task switching refers to the ability to shift rapidly from one task, object or mental set to another. Persons with MCI may have deficits in visuospatial attention. This group showed larger global switching cost (greater reaction time) compared to healthy participants in spatial condition, suggesting a deficit to the concurrent maintenance of two relevant spatial task sets in the working memory. This deficit affects the capacity to shift attention flexibly between task, location and object in space (Sinai, Phillips, Chertkow, & Kabani, 2010). However, the impairment in switching capacities in persons with MCI can be improved through practice (Gajewski & Falkenstein, 2012). A study using functional magnetic resonance imaging (fMRI) has revealed that there is activation over the prefrontal cortex, premotor cortex and other supplementary motor areas (SMA) and pre-SMA region during repeated task practice and additional activation in task switching (Dove, Pollmann, Schubert, Wiggins, & von Cramon, 2000). Higher working memory load for attention, inhibition and task management is required in task switching. The capacity to perform task switching has been identified as a primary marker of executive control. Recent studies have also found that practice on task-switching led to improvement in interference control, working memory, and fluid intelligence (Gajewski & Falkenstein, 2012).

4.2.2.4 *Body midline crossing task*

Participants are required to perform the tasks crossing body midline. Cross body midline movements are thought to promote brain stimulation and integration with the attentional and mnemonic processes, thus causing faster and better communication between the two hemispheres for more efficient processing skill for higher cortical functions. A recent study reported beneficial effects of using this principle movement on people with mild to severe dementia (Drabben-Thiemann *et al*., 2002). More recently, Yaguez, Shaw, Morris, and Matthews (2011) utilized the same movement-based intervention for people with Alzheimer's type dementia. These researchers found significant improvements in sustained attention, visual memory and a trend in working memory for the intervention group.

4.2.2.5 *Interference*

A chair rise movement is performed by participants between each table task movement to intensify the exercise demand as well as acting as an interference to facilitate the training effect. Studies have revealed that successful suppression of interference confers a positive benefit on working memory performance (Zanto & Gazzaley, 2009). Interference can be used as a form of intervening stimuli that is purposefully introduced to demand attention as an aspect of a secondary task (performing one task while holding something in mind). This stimulus requires a reallocation of cognitive resources, as well as processes involved in the intended task sequence performance, hence contributing to the improvement in working memory performance with practice (Sakai, Rowe, & Passingham, 2002). It has been suggested that distractibility is plastic and may be manipulated in a manner that beneficially impacts cognitive performance (Berry, Zanto, Rutman, Clapp, & Gazzaley, 2009).

The difference in cognitive demand within and between each level is achieved by increasing the complexity of movement to accomplish each task in terms of structure and repetition (Kemps, 2001). Encoding and maintenance of the movements, according to specific visuo-spatial pattern and sequence, exert attention-demand on the visuo-spatial working memory system (Kemps 2009, 2001). The cognitive demand is affected by the complexity of the pattern and sequence, which consumes different cognitive demand (Kemps 2009, 2001; Logie, Zucco, & Baddeley, 1990). Studies (Hulme, Roodenrys, Brown, & Mercer, 1995; Kemps 2009, 2001; Smirni, Villardita, & Zappala, 1983) have found that the complexity and hence the cognitive demand can be determined by: (1) number of elements in the patterns or movements; (2) repetition (length of the movement path); (3) structure (pattern of regularity is less demanding than pattern of variation). The number of pattern elements and movement elements are increased from level 1 to level 5 to increase the cognitive demand. For example, the sequential placing and collection task used two containers in level 1 will exert less cognitive demand than the task in levels 2 -5 used four containers. Moreover, variations in sequence were added from level 4 to level 5 to further increase the cognitive demand for task performance. For example, the sequence in level 4 with variation for collection (1 repeated placing at specific position added) is more complex and exerts more cognitive demand than the regular sequence in levels 1-3.

The aim of this study was to examine the feasibility of application and the effects of this newly designed functional tasks exercise program on cognitive functions of older adults with MCI.

4.3 Methods

4.3.1 Study Design

This study was a single group repeated measures design. All outcome measures were assessed at baseline, post-intervention and post-3-month follow-up after completion of intervention. Ethics approval for this study was obtained from the James Cook

University Human Research Ethics Committee and the Hospital Authority Research Ethics Committee. The study was conducted at the United Christian Hospital in Hong Kong. All the participants provided written informed consent.

4.3.2 Participants

Older adults (age 60+) living in the community were eligible for the study if they met the following inclusion criteria: (1) Subjective memory/cognitive complaint; (2) Objective cognitive impairment as revealed by neuropsychological assessment; but with (3) intact personal selfcare functions; (4) Absence of diagnosed dementia. The exclusion criteria were: (1) History of brain lesion/ psychoactive substance abuse/co-morbid medical condition associated with cognitive/ functional decline; (2) Clinically significant depression as screened by Geriatric Depression Scale-15; (3) Known psychiatric cause of cognitive dysfunction such as clinically significant anxiety disorders or psychosis; (4) Medical conditions rendering patients unable to engage in physical activity, such as severe cardiac failure; (5) Significant impairment of vision, hearing or communication that might affect testing or participation in the program.

Potential participants were recruited from the outpatient clinic of the Occupational Therapy department. Patients with subjective memory complaint or suspected cognitive impairment were referred by the out-patient clinic of Department of Medicine and Geriatric to Occupational Therapy Department for cognitive assessment and further management. Initial screening was conducted to rule out participants fitting the exclusion criteria and to check the inclusion criteria of subjective memory complaint and to complete an initial screen including cognition, depression, basic selfcare and fitness to exercise.

The Mini Mental State Examination (MMSE; Chiu *et al*., 1998) was used for initial cognitive screening with the education- adjusted MMSE cut-off scores validated for Hong Kong Chinese older adults. Those patients with Geriatric Depression Scale-15 (GDS-15) score of 7 or higher were excluded due to the presence of clinically significant depressive symptoms (Lee, Chiu, Kwok, & Leung., 1993). Basic selfcare functions were screened using Barthel Index (Collin, Wade, Davies, & Horne, 1988) as reported by the patients and family members. The Chinese version of MMSE (Chiu, Lee, Chung, & Kwong, 1994), GDS-15 (Lee *et al.*, 1993) and Barthel Index (Leung, Chan, & Shah, 2007) were used in this study. The Physical Activity Readiness Questionnaire (PAR-Q) was used to determine if the participants were safe to exercise (Thomas, Reading, & Shephard, 1992). Certificates of physical clearance to participate in the program from the participants' referring physicians were collected prior to the commencement of the program as indicated. Participants fulfilling the inclusion criteria received an invitation letter, information about the program and a consent form for participation of the study.

4.3.3 Interventions

Participants received a 10-week (3 sessions per week, 1 hour per session), center-initiated home based functional task exercise (FcTSim) program facilitated by an occupational therapist according to the training protocol. For the first 4 weeks, center-based sessions were scheduled twice weekly and supported by once weekly home practice. It was followed by once weekly center-based and twice weekly home practice session for the next 4 weeks; then once biweekly center-based sessions for the last 2 weeks. Exercise monitoring logbooks were used and regular phone calls with structured interview were made to monitor progress of home practice. All exercise sessions began with a 5-10 minute warm-up consisting of light stretching designed to increase flexibility, 30-40 minute core exercise and end with a 5-10 minute cool-down. The content of the functional tasks exercise program and a session plan are described in Appendix 3 and Appendix 4 respectively.

4.3.4 Outcome Measures

Assessments were undertaken at baseline, post-intervention at 3-month and follow-up at 6-month from baseline by an independent assessor. The primary goal of this pilot study was to determine the feasibility of implementing the Functional Task Exercise (FcTSim) Program and its effect on cognitive status of the participants. Feasibility was determined from information on participant drop-out, attendance, the occurrence of adverse events and retention rate during follow-up at 6-month.

The primary outcome measures for cognitive status were measures of general cognitive function assessed using Neurobehavioral Cognitive Status Examination (Kiernan, Muelle, Langston, & van Dyke, 1987) and specific cognitive function in executive function and memory using Verbal Fluency Test (Bryan & Luszcz, 2000) and Verbal Learning Test (Chang *et al.*, 2010) respectively. Secondary outcome measures were measures of functional status using Lawton Instrumental Activities of Daily Living Scale (Lawton & Brody, 1969) and everyday problem solving using Problems in Everyday Living Test (Leckey & Beatty, 2002).

4.3.4.1 *Primary outcome measures*

Neurobehavioral Cognitive Status Examination (NCSE)

The Neurobehavioral Cognitive Status Examination, now known as Cognistat, is a brief but comprehensive cognitive test. The test consists of 10 subtests: Orientation, Attention, Language (Comprehension, Repetition, and Naming), Constructions, Memory, Calculations, and Reasoning (Similarities and Judgment). A Cognistat Composite Score was used by adding all subtest scores (maximum 82) to reflect the overall performance (Drane *et al*., 2003; Nøkleby *et al*., 2008). The Chinese version of Cognistat was used in this study (Chan, Lee, Wong, Fong, & Lee, 1999).

Category Verbal fluency test- animal (CVFT)

The Verbal Fluency Test is a semantic task which has been suggested as a measure of executive function such as the speed and facility of verbal production and the ability to initiate a behavior in response to a novel task. The test measures language, speed of answering, mental organization, search strategies, and short- and long-term memory. Participants were asked to tell the examiner the names of as many different types of animal as possible within a 60-s period. Animal naming is the most commonly used category verbal fluency measure that effectively distinguishes between persons with and without mild AD (Oberg & Ramírez, 2006).

Chinese version verbal learning test (CVVLT)

The Verbal Learning Test is one of the neuropsychological tests used to evaluate memory registration, learning ability, recall, and recognition in patients with AD and other disorders. The CVVLT has been validated in Chinese populations and has good validity in discriminating AD participants (Chang *et al*., 2010). Immediate total free recall and 10-minute delayed free recall were examined in this study.

4.3.4.2 *Secondary outcome measures*

Lawton Instrumental Activities of Daily Living Scale (Lawton IADL)

The Lawton IADL is a widely accepted IADL assessment for older people measuring eight items of instrumental ADL abilities such as using a telephone, doing laundry, and handling finances (Lawton & Brody, 1969). Lawton IADL can be administered with a written questionnaire or by interview. The participant or a family member or caregiver may provide answers. A higher score indicates great independence. The validated Chinese version of Lawton IADL was used in this study (Tong & Man, 2002).

Chinese Version Problems in Everyday Living Test (C-PEDL)

The PEDL is a 14-item test of practical problem solving related to everyday life. A recent study has showed PEDL predicts IADL performance of patients with AD more accurately than the MMSE (Leckey & Beatty, 2002). Responses to the questions were recorded and scored on a 3-point scale (0–2) and the first verbal solution produced by the participant is scored. The Chinese prototype which is a translated version in the process of validation was used in this study.

4.3.5 Statistical Analysis

All analyses were performed using SPSS 19 (SPSS, Inc., Chicago, IL). Analyses were focused upon evaluating the effect of FcTSim program on cognitive functions and functional status. The effect of the FcTSim program was analyzed with Repeated Measures Analysis of Variance (ANOVA) with time as the within group factor for all outcome measures at baseline, post-intervention and 3-month follow-up. The statistical significant level was set at $p < 0.05$. Cohen's *d* effect size (Cohen, 1988) was calculated for each variable at post-intervention. Effect sizes were interpreted as small, $d = 0.20$; medium, $d = 0.50$; or large, $d = 0.80$ (Cohen, 1988).

4.4 Results

4.4.1 Study Population

Eleven participants (2 males, 9 females) aged 60 to 85 years (mean age = 71.8, SD = 8.5) were recruited. All of the participants were living with family in the community, with about half (45.5%) partaking in regular exercise. Baseline characteristics are tabulated in Table 4.2.

Table 4.2 Baseline demographics of functional tasks exercise participants

Characteristics	**Participants (N = 11)**
Age (years), [mean (SD)]	71.82 (8.54)
Gender, % (Female/male)	81.8/ 18.2
Education level, % (illiterate/primary /secondary /tertiary)	36.4/36.4/18.2/9.1
Living with family , %	100
Exercise per day, % (0 / < 30min/ > 30min)	54.5/36.4/9.1
Ambulatory level, % (Unaided/ with stick)	81.8/18.2
MMSE [mean (SD)]	24.64 (4.06)
NCSE [mean (SD)]	53.27 (11.71)
CVFT [mean (SD)]	9.91 (4.97)
CVVLT Total free recall [mean (SD)]	17.18 (6.01)
CVVLT 10-minute delayed recall [mean (SD)]	3.09 (2.77)
Lawton IADL [mean (SD)]	20.27 (4.36)
C-PEDL [mean (SD)]	17.82 (2.99)

Abbreviations: MMSE, Mini Mental State Examination; NCSE, Neurobehavioral Cognitive Status Examination; CVFT, Category Verbal Fluency Test; CVVLT, Chinese Version Verbal Learning Test; Lawton IADL, Lawton Instrumental Activities of Daily Living Scale; C-PEDL, Chinese version Problems in Everyday Living test

4.4.2 Process Evaluation

All the 11 participants performed the baseline assessment and completed the FcTSim program (100% compliance), the post-intervention evaluation, and the follow-up at 6-month from start of the program. The attendance was, on average, 94% ± 7.7% of the training sessions. Retention rate for follow-up at 6-month was 100%. No adverse events were reported.

4.4.3 Outcomes

Performance for all primary and secondary outcome measures along the three evaluation time and the effect size at post-intervention is illustrated in Table 4.3. Positive trends of improvement were demonstrated in scores of all outcome measures.

The results of Repeated-measures ANOVA revealed that the FcTSim group showed significant improvement over the course of the study in the NCSE composite score (F (2, 20)=13.71, $p < 0.001$); CVFT (F (2, 20) = 5.351, $p = 0.014$); CVVLT Total Free Recall (F (2, 20) = 16.32, $p < 0.001$); CVVLT 10-minute Delayed Free Recall (F (2, 20) = 6.26, $p = 0.008$); Lawton IALD (F (2, 20) = 4.48, $p = 0.025$) and C-PEDL (F (2, 20)= 15.31, $p < 0.001$).

4.4.4 Effect Size

The FcTSim group showed practical significant effects on all measures. In the performance of general cognitive functions, the FcTSim group had a medium to large effect size (Cohen’s $d = 0.79$) for NCSE. In the tests of memory and executive function, the FcTSim group also had a medium effect size (Cohen’s $d = 0.76$) for CVVLT Total

Free Recall, a small effect size (Cohen's *d* = 0.40) for CVVLT 10-minute Delayed Free Recall and a small effect size (Cohen's *d* = 0.45) in CVFT. In the functional status measures, the FcTSim group showed a medium effect size (Cohen's *d* = 0.60) for Lawton IADL and very large effect size (Cohen's *d* = 1.37) for C-PEDL. All the effects sustained during the follow-up at 6 months from start of the program.

Table 4.3 Outcomes at baseline, post-intervention, and 3- month follow-up

Measures	Baseline Mean ± SD	Post-intervention Mean ± SD	3-month follow-up Mean ± SD	P value (Time)	Effect size [a] (Cohen's d)
NCSE	53.27 ± 11.71	63.36 ± 13.85	59.18 ± 13.50	< 0.001	0.79
CVFT	9.91 ± 4.97	12.00 ± 4.31	12.18 ± 4.09	0.014	0.45
CVVLT Total Free Recall	17.18 ± 6.01	21.00 ± 3.87	22.64 ± 5.01	< 0.001	0.76
CVVLT Delayed recall	3.09 ± 2.77	4.27 ± 3.13	4.45 ± 3.83	0.008	0.40
Lawton IADL	20.27 ± 4.36	22.64 ± 3.56	21.45 ± 4.20	0.025	0.60
C-PEDL	17.82 ± 2.99	22.73 ± 4.10	20.00 ± 3.38	< 0.001	1.37

Note: a, standard effect size at post-intervention
Abbreviations: NCSE, Neurobehavioral Cognitive Status Examination; CVFT, Category Verbal Fluency Test ; CVVLT, Chinese Version Verbal Learning Test; Lawton IADL, Lawton Instrumental Activities of Daily Living Scale; C-PEDL, Chinese version Problems in Everyday Living Test

4.5 Discussion

The aim of this pilot study was to evaluate the feasibility of a new structured functional task exercise intervention, FcTSim program, its potential benefits on cognitive functions of older adults with mild cognitive impairment. The FcTSim program appears feasible and well accepted by this group of elderly participants with MCI as revealed by the high compliance (0% drop-out), high attendance (mean = 94%) and the high retention rate (100%) during follow-up at 6-month.

The participants were motivated intrinsically for attending the program when they experienced the improvements gradually in their own daily lives. For instance, one of the participants reported that she was able to remember 3-4 items on the shopping list after having the training as compared to only able to remember 1-2 items previously. The husband of another participant also reported that his wife was able to aware and press the correct lift button to reach the training center instead of being used to be disoriented and only follow him all the way before. The results of the current study showed that the FcTSim program had significant effects on general cognitive functions, memory, executive function, functional status and problem solving ability of older adult with MCI, and with a range of small to very large effect size.

Previous studies have reported persons with MCI exhibit subtle but significant deficits in Instrumental Activities of Daily Living (IADL) relative to their cognitively healthy peers (Kim *et al*., 2009; Perneczky *et al.*, 2006; Teng, Becker, Woo, Cummings, & Lu, 2010). Wadley *et al.* (2007) found that MCI groups showed faster rates of decline in everyday function relative to cognitively normal participants with no MCI. IADL impairment in MCI has consistently been found associated with increased rates of progression to dementia (Peres *et al.*, 2006; Rozzini *et al.*, 2007; Tabert *et al.*, 2002). It would be of critical importance to have functional improvement in IADL through interventions which are targeted to delay or even revert the progression of MCI to Alzheimer's or other dementia. The FcTSim group has shown significant improvement in Lawton IADL (p = 0.025, d = 0.60). Performance in IADL is closely related to competence in everyday problem solving (Bertrand & Willis, 1999; Law, Barnett, Yau & Gray, 2012). Problem solving ability is regarded as higher order execution cognition that has been found impaired in MCI compared to cognitively normal elderly (Sánchez-Benavides *et al.*, 2010).

Measures of everyday problem solving are considered to be ecologically valid to adequately reflect older adults' functioning in the real world (Law *et al*., 2012). Indeed, deficit in problem solving has been identified as a strong risk factor for the imminent development of dementia (Brandt *et al.*, 2009). The FcTSim group demonstrated significant improvement in everyday problem solving with a very high effect size (p < 0.001, d = 1.37). The initial findings of this study support previous results which showed combined cognitive-exercise training is promising for influencing different cognitive domains (Oswald, 2004; Oswald *et al.*, 2006).

Pillemer, Suitor, and Wethington (2003) emphasized the importance of practical applications of research knowledge and the critical need to use research findings systematically to guide the development of new intervention programs that would ultimately improve real-world practices. Performance of functional tasks involves a complex interplay of cognitive and motor functions (de Vreede *et al*., 2005). The FcTSim program is an innovative program based on previous research findings and uses daily functional tasks as a cognitive-exercise intervention media for older adults with mild cognitive impairment. The positive outcomes obtained in this study are reflective of the proposal of translational research guided by previous study findings.

To the authors' best knowledge, this is the first program that uses simple placing and collection tasks, which most people perform in their daily life, as a media of combined cognitive and exercise intervention for MCI. There are no sophisticated tools required and all the participants are able to continue to practice at home so as to build up and perpetuate the intervention effects as long as they can keep practicing. The program demonstrated the acceptability of cognitive-exercise programs for this group. The initial findings are clinically important in decrease the potential impacts of cognitive impairment and improves the cognitive performance in older adults with cognitive impairment.

4.6 Limitations

Although the study results are encouraging and are indicative of program feasibility, one needs to interpret these results with caution from a study with a small sample. The present findings will need to be further validated with findings from a randomized control trial with a larger population. The power calculation based on the results of a similar study, 34 participants in each group will be required for 80% power to detect a significant group difference of 5 points on direct recall of the auditory verbal learning test with a significance level of 0.05 (van Uffelen, Chinapaw, van Mechelen, & Hopman-Rock, 2008a). Taking into consideration a mean drop-out rate of 15% as suggested in a recent systematic review on similar studies (van Uffelen *et al*., 2008b), it follows that 40 participants will be needed in each group and a minimal total sample size of 80 participants for 2 groups. Besides, about half of the participants had regular exercise at baseline, the potential confounding effects should be controlled in future studies.

A further limitation of this study is the absence of a control group to understand fully the impact of the program. Moreover, we used C-PEDL to assess the functional status and higher order executive function, other measures of executive function in conjunction with the C-PEDL should be used in future studies to provide a more comprehensive evaluation.

4.7 Conclusion

In conclusion, this feasibility study showed that the newly designed functional tasks (FcTSim) program using simulated functional task as a mean of cognitive-motor intervention was feasible and demonstrated beneficial effects on cognitive functions and functional status of older person with mild cognitive impairment living in the community. Further study with an adequate sample size is needed to draw more definitive conclusions.

Chapter 5

Translation and Validation of Chinese Version of Problems in Everyday Living (PEDL) Test in Patients with Mild Cognitive Impairment

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5.1 Introduction

Cognitive decline is common among the elderly population and cognitive functions are strong predictors of functional disability (Blaum, Ofstedal, & Liang, 2002; Dodge *et al*., 2005). Because of the progressively disabling nature of cognitive decline, even subtle cognitive changes will place older adults at increased risk of functional declines, as well as the increased risks of injuries and hospitalization (Bennett *et al*., 1996; Sattin, 1992; Weiler, Lubben, & Chi, 1991).

Assessment to determine whether older persons are still capable of meeting the cognitive challenges of everyday living is crucial to ensure their safe and independent living in the community especially for those who are living alone (Tierney *et al.*, 2001). Further, everyday problem solving involves the interplay of multiple cognitive processes and is important for maintaining independent living in the community (Burton, Strauss, Hultsch, & Hunter, 2009). Measures of everyday problem solving, examining the cognitive performance of older adults on tasks that are experienced in everyday situations, are considered to be more ecologically valid to reflect their everyday cognitive performance in the real world (Brandt *et al.*, 2009).

In Hong Kong, the percentage of total population aged 65 or above will increase from 12% (822, 852) in 2006 to 26% (2 228, 252) in 2036. A recent epidemiological study in Hong Kong has shown that the prevalence of dementia will double for every five years' increase in age after the age of 60, from 1.2% among those aged 60 to 64 to 32.1% among those aged 85 and above (Lam *et al.*, 2008). The overall prevalence of dementia for persons aged 70 or above was 9.3%. About one in ten aged 70 or above and about one in three aged 85 or above among the community-dwelling elderly in Hong Kong had dementia (Ng & Chan, 2009). Assuming the prevalence of dementia remains unchanged, it has been projected that the number of people aged 60 and above with dementia will increase to more than double from 103,433 in 2009 to 332,688 in 2039 (Yu, *et al.*, 2012).

The systematic review, described in Chapter 3, identified five instruments that assess the ability of everyday problem solving of the elderly with cognitive impairment. Two instruments, Assessment of Capacity for Everyday Decision Making (ACED) and Problems in Everyday Living Test (PEDL) received the best rating for administration (scoring by hand and no extra resources/ special equipment or test materials required).

The ACED had been translated into Chinese version. However, only one (financial management) out of the three IADL components (meal preparation, medication management and financial management) in the ACED was validated with Chinese psychogeriatric patients (Yu, *et al*., 2009). Therefore, Chinese version of a complete instrument to assess everyday problem solving ability is still unavailable. Comparatively, the PEDL is simpler to administer (Law, Barnett, Yau & Gray, 2012). This is a 14-item test of practical problem solving related to everyday life. The participant's answers are recorded exactly word for word and scored on a 3-point scale (0–2). The scoring system is simple and easily to use following the rating guidelines. The assessor asks the questions verbally and the first verbal solution produced by the participant is scored. This eliminates the potential difficulties that may pose on those with inadequate literacy, which is common in elderly population (Parker, 2000). Furthermore, the PEDL had a stronger association with IADL (r = 0.71) compared to other similar tools (r = 0.19 – 0.36) and with a comparatively higher reported inter-rater reliability (r = 0.944; Law *et* *al*., 2012).

The PEDL has been validated for use in patients with Alzheimer's Disease. It has been shown to have a moderate correlation with problem focus coping strategies (r = 0.46) (Beatty *et al*., 1998), a strong association with Instrumental Activities of Daily Living (IADL; r = 0.71) and moderate association with Activities of Daily Living (ADL; r = 0.58; Leckey & Beatty, 2002). The brevity of its administration favors its use as a screening tool. The translation and validation of a Chinese version of the PEDL is important to promote both clinical and research developments of elderly care in Chinese populations.

The aims of this study were to translate the PEDL into Chinese version (C-PEDL) and to evaluate its reliability and validity. The specific objectives were:

1. To study the content validity and cultural relevance of the C-PEDL
2. To evaluate the test-retest and inter-rater reliability of the C-PEDL
3. To evaluate the concurrent validity of the C-PEDL using formal neuropsychological measures in older adults with mild cognitive impairment and cognitively healthy controls.

5.2 Methods

5.2.1 Translation and Cultural Adaptation of the PEDL

Approval was first obtained from the publisher to translate the PEDL and validate the translated Chinese version. The original version of the PEDL was translated from English to Chinese by the researcher and a professional independent translator to produce two initial drafts of C-PEDL. The two versions were collaboratively compared and discrepancies between the two versions were resolved through consensus to produce a single initial draft of C-PEDL. It was then back-translated by a second independent, qualified bilingual expert from the Chinese version C-PEDL to English version PEDL. The back-translated version was then reviewed by four native English speaking health professionals (1 General Practitioner, 1 Nurse and 2 Occupational therapists) to check for any conceptual discrepancies with the original English version of the PEDL (Questionnaire in Appendix A5.1). Since no discrepancies were found, the initial version of C-PEDL was adopted for the study.

A seven- member expert panel consisting of one Geriatrician, one Clinical psychologist, one Nursing specialist, two Occupational therapists, and two Bilingual older adults was recruited to review the cultural relevance, content validity and translation equivalence of the C-PEDL in Hong Kong. The Geriatrician and the clinical psychologist in the expert panel had more than 15 years' clinical experience. The nursing specialist and the two occupational therapists had more than 10 years' experience in the rehabilitation field for elderly patients. The two older adult panel members had tertiary qualifications and aged more than 75 years. A translation equivalence questionnaire (Appendix A5.2) was constructed for the panel members to identify and comment on the words, phrases of the Chinese version which did not reflect the semantic meaning of the English version. Subsequently, no modification of the translation was required. Another two questionnaires were designed for the panel members to comment on the cultural relevance (Appendix A5.3) and evaluate the content validity (Appendix A5.4) of the C-PEDL using a 4-point rating scale from 1 = totally irrelevant to 4 = relevant. A content validity index (CVI) was calculated based on the total items rated by the experts as either 3 or 4. A CVI score of 80% or higher was considered to have good content validity (Lynn, 1996).The test items were further modified according to the suggestions of the expert panel before the C-PEDL was administered to participants for the study of its reliability and validity.

Pilot testing was conducted before implementation of the performance testing. Eight elderly patients with healthy cognition were recruited in the pilot testing to comment on clarities of the wordings and problems encountered during the administration process. All the patients were able to complete the C-PEDL without any difficulties in understanding the questions in the C-PEDL and able to give appropriate verbal responses to the questions.

5.2.2 Performance Testing and Evaluation of Concurrent Validity and Reliability

5.2.2.1 *Participants*

Potential participants were recruited from the outpatient clinic of the Occupational Therapy department of a public hospital in Hong Kong. Patients with subjective memory complaint or suspected cognitive impairment were referred by the out-patient clinic of Department of Medicine and Geriatric. Older adults (age 60+) with mild cognitive decline living in the community were eligible for the study if they met the following inclusion criteria: (1) Subjective memory/cognitive complaint; (2) Objective cognitive impairment as screened using the Mini Mental State Examination (MMSE); but with (3) Reported intact personal selfcare functions; and (4) No confirmed diagnosis of Dementia.

The exclusion criteria were: (1) History of brain lesion/ psychoactive substance abuse/co-morbid medical condition associated with cognitive/ functional decline; (2) Clinically significant depression as screened with Geriatric Depression Scale-15 (GDS-15); (3) Known psychiatric cause of cognitive dysfunction such as clinically significant anxiety disorders or psychosis; (4) Medical conditions render patients unable to engage in physical activity, such as severe cardiac failure; and (5) Significant impairment of vision, hearing or communication that might affect testing.

The Chinese version MMSE (C-MMSE; Chiu, Lee, Chung, & Kwong, 1994) was used for initial cognitive screening and the education- adjusted C-MMSE cut-off scores validated for Hong Kong Chinese older adults was adopted. Those patients with GDS-15 score of 7 or higher were excluded due to the presence of clinically significant depressive symptoms (Lee *et al.*, 1993). Basic selfcare functions were screened using Barthel Index (Leung, Chan, & Shah, 2007).

Participants for the cognitively healthy control group were recruited from two social centers and a local church. The inclusion criteria were (1) No subjective memory/cognitive complaint; (2) No known history of cognitive impairment/ brain leision; and (3) Living independently in the community. Those with significant impairment of vision, hearing or communication that might affect testing were excluded. All the participants were screen with the Global Deterioration Scale (GDS) (Reisberg, Ferris, de Leon, & Crook, 1982). The GDS is a 7- stages scale that provides caregivers an overview of the stages of cognitive function for persons suffering from a primary degenerative dementia.

This study was a part of a main study assessing the effect of functional task exercise on older adults with cognitive impairment. Ethics approval for this study was obtained from the James Cook University Human Research Ethics Committee and the Hospital Authority Research Ethics Committee. All the participants provided written informed consent. The participants did not receive any financial reimbursement for their time spent on the assessments. Training was conducted for raters to ensure consistency in the administration and rating of the C-PEDL.

5.2.2.2 *Neuropsychological assessment*

All the participants were completed the C-PEDL by trained raters. To evaluate test-retest reliability, the C-PEDL was administered to all control subjects 2 weeks later by the same rater. All the participants attended the out-patient clinic performed the C-MMSE (Chiu, *et al*, 1994) and Category Verbal Fluency Test (Bryan & Luszcz, 2000). The C-MMSE was used as an index on level of general cognition. With the education- adjusted C-MMSE cut-off scores, the C-MMSE has good sensitivity (94.9%) and specificity (85.6%) in detecting dementia. The inter-rater reliability is also good with an intra-class correlation of 0.9 (Chiu *et al*, 1998).

Verbal Fluency has been identified as a predictor of competency in decision- making and everyday problem solving (Marson, Cody, Ingram & Harrell, 1995; Marson, Chatterjee, Ingram, & Harrell, 1996). Both category verbal fluency and letter fluency decline in MCI and at a faster rate compared to cognitively normal populations (Clark, Chen, McCleary, & Mack, 2009; Nutter-Upham *et al*., 2008). Tests of verbal fluency have been widely used in the elderly population, particularly for differentiating the demented elderly from those with healthy cognition (Bentham, Jones, & Hodges, 1997; Hänninen *et al.*, 1995; Solomon *et al.*, 1998; Troster, Salmon, McCullough, & Butters, 1989)

A recent meta-analysis has revealed that older adults with AD are more impaired on category fluency than on letter fluency (Laws, Duncan & Gale, 2010). Clark *et al.* (2009) also found that category fluency showed greater longitudinal decline compared to letter fluency among cognitively normal and AD populations. Animal naming is the most commonly used category verbal fluency measure that effectively detects possible MCI and distinguishes between persons with and without AD or dementia (Ardila, Ostrosky-Solis, & Bernal, 2006; Sagar, Hernann, La Rue, & Woodard, 2006; Woodard, Dorsett, Cooper, Hermann, & Sagar, 2005).

The Category Verbal Fluency Test requires subject to generate as many animal names as possible in 1 minute. This test is commonly used as an index of executive functions, language, speed of answer, mental organisation and search strategies (Roca *et al.*, 2012).

5.2.2.3 *Statistical Analysis*

Demographic data were compared between the patient group and the control group using Independent Samples t-test and Fisher's Exact Test as appropriate. Pearson and Spearman's correlation coefficients were used to examine the relationships between the C-PEDL and the demographic variables of age, gender and education. The internal consistency of the C-PEDL was estimated by calculating Cronbach's alpha. Both Pearson correlation coefficient (r) and the intra-class correlation coefficient (ICC) were used to estimate test-retest reliability and inter-rater reliability. The concurrent validity was assessed by using Pearson correlation test comparing the C-PEDL with the MMSE and the Verbal Fluency Test. One-way Analysis of Variance (ANOVA) was conducted to evaluate the discriminant validity of C-PEDL in the cognitive impaired patients and the cognitively healthy control group, using stratified analysis to control the confounding effects of age and education.

5.3 Results

5.3.1 Content Validity and Cultural Relevance

The content validity index CVIs were found to be 86% for item 3, 6, 7, 12, 13 and 100% for all the other items of the C-PEDL, indicating a high content validity of the C-PEDL as a tool to assess everyday problem solving ability. With regard to cultural relevance, the review panel concluded that the C-PEDL was culturally relevant for Chinese older adults in Hong Kong with modifications for the items as listed below:

1. Item 2: “coffee maker” was changed to “electric water kettle”
2. Item 4: “a bowl of cereal with milk, a glass of orange juice and a cup of coffee” was changed to “a bowl of oatmeal” and “you don’t have any milk” was changed to “you don’t have any water”
3. Item 5: “taking a college class for credit” was changed to “taking an interest class which you are keen on”
4. Item 7: “have $100 more” was changed to ”have $10,000 more”
5. Item 8A: “Friday evening” was changed to “Saturday evening” and “oven” was changed to” gas stove”
6. Item 13: “lost in the forest” was changed to “get lost during hiking”

No changes were made to the scoring system and rating criteria. The final versions of C-PEDL and rating criteria were presented in Appendix 6.

5.3.2 Participants and Relationship of C-PEDL to Demographic Variables

A total of eighty participants (40 patients and 40 controls) were recruited. The age of the participants in the control group ranged 55-85 years (mean age = 68.5 ± 9.2 years) and the age of the patients ranged 60-88 years (mean age = 74.1 ± 7.6). A comparison of the demographic characteristics is presented in Table 5.1. Significant association was found between the C-PEDL and education (r = 0.34, p = 0.002), indicating that better performance on the C-PEDL is associated with higher education level. No significant associations were found between the C-PEDL and age (r = -0.14, p = 0.22) or gender (r = 0.05, p = 0.67).

Table 5.1 Baseline demographics of cognitively impaired group and control group

Characteristics	**Cognitively Impaired Patients (n = 40)**	**Cognitively Healthy Controls (n = 40)**	***P*-value**
Age [a] (years),[mean ±SD)]	74.1 ± 7.6	68.5 ± 9.2	0.004
Gender [b], [Female/male]	23 (57.5)/ 17 (42.5)	25 (62.5)/ 15 (37.5)	0.820
Education level [b], [illiterate/primary /secondary /tertiary]	18 (45)/ 8 (20) /9 (22.5)/ 5 (12.5)	4 (10)/ 20 (50) /9 (22.5)/7 (17.5)	0.002
Global Deterioration Scale	3.05 ± 0.55	1	N/A

Notes: [a] Independent sample t- test, [b] Fisher's Exact Test
All data are shown as mean (SD) or n (%) as appropriate.
N/A = Not applicable.

5.3.3 Internal Consistency and Reliability

The Chronbach's Alpha for internal consistency of C-PEDL was acceptable ($\alpha = 0.69$ [raw]) ; $\alpha = 0.73$[standardised]). The Cronbach's α was not reported in the original PEDL. Test-retest was conducted in the community sites with two weeks apart. The test-retest reliability of C-PEDL was high ($r = 0.91$, $p < 0.001$) and the ICC was 0.95 (95% confidence interval 0.91 – 0.98). The inter-rater reliability was also high ($r = 0.98$, $p < 0.001$) and the ICC was 0.99 (95% confidence interval 0.98 – 0.99). The result on inter- rater reliability is comparable to that of the PEDL reported by Beatty *et al.* (1998) ($r = 0.94$). The test-retest reliability was not reported in the original version PEDL.

5.3.4 Concurrent Validity and Discriminant Validity

The C-PEDL showed moderate correlations with the MMSE ($r = 0.45$, $p = 0.004$) and the Category Verbal Fluency Test ($r = 0.40$, $p = 0.012$). The C-PEDL also had a moderate negative Spearman's correlation with the Global Deteriorating Scale ($r = -0.42$, $p = 0.007$).

Stratified analysis was conducted to control the confounding effects of education. The data were stratified with education level into subsets of illiterate (0-2 years education) and literate participants (> 2 years education; Cavaco *et al.*, 2013; Li, 2008). There were no significant differences between the cognitively impaired patient group and the control group in age, education level and gender after stratification. The demographic Characteristics after stratification were illustrated in Table 5.2.

Table 5.2 Baseline demographics of Cognitively Impaired group and control group stratified by education level

Characteristics	Cognitively Impaired Patients (n = 40)		Cognitively Healthy Controls (n = 40)		P-value	
	Illiterate (n = 18)	**Literate (n = 22)**	**Illiterate (n =4)**	**Literate (n = 36)**	**Illiterate**	**Literate**
Age [a] (years)	77.7 ± 7.0	71.1 ± 6.9	81.3 ± 4.9	67.1 ± 8.4	0.35	0.06
Gender [b], [Female/male]	13 (72.2) / 5 (27.8)	10 (45.5) /12 (54.5)	2 (50)/2 (50)	23 (63.9) / 13 (36.1)	0.57	0.19
Education level [b], [illiterate/ primary /secondary /tertiary]	18 (100)/ 0 / 0/ 0	0/ 8 (36.4) / 9 (40.9) / 5 (22.7)	4 (100)/ 0 / 0/ 0	0/ 20 (55.6) /9 (25) / 7 (19.4)	N/A	0.33

Notes: [a] Independent sample t- test, [b] Fisher's Exact Test

All data are shown as mean (SD) or n (%) as appropriate.

N/A = Not applicable.

Results of the One-way Analysis of Variance (ANOVA) revealed significant group difference on performance of the C-PEDL between the cognitively impaired group and the control group (F (1, 56) = 9.96, p = 0.003) in educated subset of the study populations. Bonferroni post-hoc comparison of the two groups indicated that the cognitively impaired group (M = 20.00, 95% CI [18.57, 21.43]) had significantly lower performance than the cognitively healthy group (M = 22.86, 95% CI [21.74, 23.98]), p = 0.003. There were no significant effects by education (F (2, 55) = 0.27, p = 0.76) or by age (p = 0.32). For the illiterate population, results of ANOVA also indicated significant difference in performance of C-PEDL between the cognitively impaired group and the control group (F (1, 20) = 10.43, p = 0.004). Bonferroni post-hoc comparison of the two groups identified that the cognitively impaired group (M = 16.67, 95% CI [14.79, 18.55]) had significantly lower performance than the cognitively healthy group (M = 23.50, 95% CI [19.51, 27.49]), p = 0.004. There was on significant effect by age (p = 0.54). Comparison of the C-PEDL performance between the cognitively impaired patients and the controls is illustrated in Table 5.3.

Table 5.3 Results on C-PEDL scores Comparison between Cognitively Impaired Patients and Controls

Measures	Sub-group	Cognitively Impaired Patients	Cognitively Healthy Controls	*P* value (group)	*P* value (education)	*P* value (age)
		Mean ± SD	Mean ± SD			
C-PEDL	Literate	20.0 ± 4.34	22.86 ± 2.58	0.003*	0.76	0.32
	Illiterate	16.67 ± 4.06	23.50 ± 2.08	0.004*	N/A	0.54

Note: * $P < 0.005$

N/A, not applicable

5.4 Discussion

This present study was the first attempt to translate the PEDL into Chinese and evaluate the validity and reliability of C-PEDL in assessing everyday problem solving ability of the Chinese elderly populations in Hong Kong. The C-PEDL has demonstrated good psychometric properties that further strengthening the psychometric quality of C-PEDL in clinical application.

In this present study, the finding of the association between C-PEDL and education is consistent with previous reports that problem solving performance is affected by the level of education (Diehl, Willis, & Schaie, 1995; Thornton & Dumke, 2005). No significant association between C-PEDL and age was found. However, this study found that there is no significant association between C-PEDL and age. Theories regarding the impact of age on everyday problem solving abilities have suggested that everyday problem solving processes are primarily compiled from cognitive abilities. However, accumulated experience and knowledge are also important in coping with the challenging demands in everyday life (Willis, 1996; Baltes, 1997). Age-related decline in cognitive functions, including memory, executive functions, processing speed and reasoning, have been reported from middle age onwards or even earlier (Der & Deary, 2006; Hidden & Gabrieli, 2004; Park & Reuter-Lorenz, 2009). With the advances in neuroimaging, studies have suggested a better understanding on the associations between the age-related cognitive declines and the underlying neural changes. Age-related brain volume reduction across different regions has also been identified in normal aging and persons with cognitive impairment, with the pre-frontal regions most severely affected (Raz, Gunning-Dixon, Head, Dupuis, & Acker, 1998; Raz, Lindenberge, Kennedy *et al.*, 2005; Raz & Rodrigue, 2006; Resnick, Pham, Kraut, Zonderman, & Davatzikos, 2003). The frontal lobe has been well-known as an important region mediating executive cognition, working memory, problem solving and conceptual abilities (Brandt *et al.*, 2009; Espinosa *et al*., 2009; Kramer *et al*., 2006; Roca *et al*., 2010; Shallice & Burgess, 1991).

Nevertheless, despite the underlying cognitive declines in normal aging, there are older adults who are still independent and well- adjusted in their everyday livings (Baltes, P. & Baltes, M., 1998; Mienaltowski, 2011; Westerhof, Dittman-Kohli & Thissen, 2001). It has been proposed that everyday problem solving is multidimensional (Baltes, P., 1987; Marsiske & Willis, 1995) which occurs in meaningful context and cannot be examined as an isolated act of pure cognition (Berg, Strough, Calderone, Sansone, & Weir, 1998; Willis, 1996). Advocates of the contextual and life span theories have emphasized the conceptions of pragmatic demands in real life problem solving that draw largely on an individual's accumulated knowledge and experience, in order to reach effective solutions and successful adaptation in everyday challenging environment (Berg, 2008; Berg, & Sternberg, 1985; Blanchard-Fields, & Mienaltowski, 2006). This pragmatic experience and knowledge continue to grow throughout the life span and increased with age. Age-related increase in everyday problem solving performance can still be found (Baltes P., 1993; Blanchard-Fields, Chen, & Norris, 1997; Cornelius & Caspi, 1987; Mienaltowski, 2011).

As reported by a previous meta-analysis review, the confounding effects of "age appropriate problem content" in everyday problem solving tests may cause the difference in findings (Thornton & Dumke, 2005). In addition, the performance in everyday problem solving is further complicated by the variation in domains and formats in the tests (Kimbler, 2013; Thornton & Dumke, 2005; Marsiske & Willis, 1995). Therefore, there are still no definitive conclusions regarding age related effects in everyday problem-solving performance.

The internal consistency of C-PEDL was acceptable and this was not reported before. The Cronbach's α for internal consistency is highly affected by the length (number of items) and the dimensionality (constructs) of the test (Cortina, 1993). Although the calculation of an α has become a common practice in research for easy comparison to other estimates (Chu, Chiu, Wong, Tang, & Lau, 2004; Tavakol & Dennick, 2011), it is suggested to be important to use and interpret Cronbach's alpha with caution and adequate understanding (Cortina, 1993; Schmitt, 1996). Everyday problem solving is a multidimensional construct that demands complex cognitive interplay to interact with everyday challenges in real world environment (Marsiske & Willis, 1995; Willis, 1996). As a tool to measure everyday problem solving ability, the items in the PEDL/ C-PEDL are probably measuring more than a single dimension. Together with its property of brevity, it is understandable to find the Cronbach's α of the C-PEDL was not very high. And this violation in the assumption of unidimensionality in the test items may lead to a major underestimate of reliability of the C-PEDL (Tavakol & Dennick, 2011).

The C-PEDL has shown good concurrent validity as revealed by the significant relationships with formal neuropsychological measures. The C-PEDL showed a moderate Pearson's correlation with C-MMSE. The strength of correlation identified in the present study is comparable to that of similar instruments reported in previous studies (Law *et al*, 2012).

Studies have shown that fluid intelligence is the strongest correlate of participants' everyday problem solving performance (Diehl *et al.*, 1995; Willis, Jay, Diehl, & Marsiske, 1992). It is also considered as a higher order executive function which involves working memory, reasoning, processing speed, and cognitive flexibility for a successful performance (Sánchez-Benavides *et al.*, 2010; Welsh, Satterlee-Cartmell, & Stine, 1999; Zook, Davalos, Delosh, & Davis, 2004). Verbal fluency test is widely used as a test of executive function and cognitive flexibility (Bryan & Luszcz, 2000; Gyurak *et al*., 2009; Troyer, Moscovitch & Winocur, 1997) and has been found closely related to processing speed (Elgamal, Roy, & Sharratt, 2011; McDowd *et al.*, 2011) as well as fluid intelligence (Roca *et al.*, 2012). The significant correlation of the C-PEDL with Verbal Fluency Test further confirms its validity in measuring performance of everyday problem solving. In addition, the high test-retest reliability found in this present study, which has not been reported before, further supports the reliability of the C-PEDL in clinical use. A previous study by Leckey and Beatty (2000) showed significant difference in the PEDL performance between patients with Alzheimer's Diseases and normal controls. The significant difference in the C-PEDL performance between the patients with mild cognitive impairment and the cognitively healthy controls found in the present study further enhances its clinical application in populations with cognitive impairment.

The C-PEDL has demonstrated good psychometric properties. Its ease of administration and simple scoring system further encourage the use of the C-PEDL as a screening tool in busy clinical settings where time or other assessment related resources are limited. It is also more favorable to use comparing to other paper-and pencil tools that may pose difficulty for illiterate assesse. Nevertheless, further studies are needed to clarify the specific constructs and dimensionality of the C-PEDL. Besides, sensitivity to measure changes over time, which is crucial and meaningful to clients, is also an important property of outcome measures (Law *et al*., 2012). More longitudinal studies to evaluate the sensitivity of the C-PEDL to measure changes over time are needed.

5.5 Limitations

One limitation of the current study was that only a global measure of general cognitive function and a single measure of fluid intelligent were used, more specific cognitive and functional measures should be included in future validation studies. A second limitation was the small sample size did not allow stratification of patients into more precise education sub-groups to identify the potential difference or interaction in C-PEDL performance. Due to the small sample size, one should interpret and generalize the present findings with caution. Further studies with larger sample sizes are still needed to validate and obtain more evidence on the psychometric properties of the C-PEDL. Moreover, the present study did not conduct a bilingual test-retest to validate the translation equivalence of the translated version and the original PEDL, and is suggested in future studies.

Furthermore, the present study population was limited to MCI, therefore further validation studies in populations with Alzheimer's diseases or other dementias are recommended to improve the clinical utility and local application of the C-PEDL. In addition, the practical limitation in the community settings did not allow detail baseline cognitive screening with neuropsychological measures in the cognitively healthy participants.

5.6 Conclusion

In conclusion, The C-PEDL is a valid and reliable test for assessing the everyday problem solving ability in Chinese older populations with mild cognitive impairment. In view of the limited number of tools, especially those being translated and validated for the Chinese population, available to assess everyday problem solving abilities, the results in this study could facilitate clinical decision makers in examining everyday problem solving performance of patients as well as encourage further validation studies related to everyday problem solving competence.

Chapter 6

Effects of Functional Tasks Exercise on Older Adults with Cognitive Impairment at Risk of Alzheimer Disease – A Randomized Controlled Trial

This systematic review chapter has been submitted to *Alzheimer's & Dementia* in May 2013. This journal was selected for the submission as it is the *Journal of the Alzheimer's Association* which bridges the knowledge gaps across a wide range of multidisciplinary investigations. This journal commits rapid communication of new findings and disseminates knowledge across diverse disciplines to promote early detection/diagnosis and/or interventions, with an Impact Factor of 14.483 in year 2012.

Law LL, Barnett F, Yau MK, Gray MA. Effects of Functional Tasks Exercise on Older Adults with Cognitive Impairment at Risk of Alzheimer's Disease – A randomized controlled trial. (Submitted to Alzheimer's & Dementia, under review)

6.1 Introduction

The increasing prevalence of cognitive impairment with age upsurges the potential impact of dementia upon global health and health care services (Ferri *et al*., 2005; World Health Organization and Alzheimer's Disease International, 2012). As described in Chapter 4, a structured functional tasks exercise program (FcTSim) was developed as a combined cognitive-exercise intervention to facilitate the cognitive functions of older persons with mild cognitive impairment.

Studies have found that following the performance of a cognitively demanding task the cortical area involved in working memory is activated with cortex reorganization (Audoin *et al*., 2003; Olesen, Westerberg, & Klingberg,, 2004). The FcTSim exercise demands encoding, retention, and reproduction of a specific sequence of targeted movements in the pre-designed visual spatial pattern. The movement pattern in the FcTSim program was developed based on research findings (Dove, Pollmann, Schubert, Wiggins, & von Cramon,, 2000; GrEGoire & Van der Linden, 1997; Wenderoth, Debaere, Sunaert, & Swinnen, 2005; Yaguez, Shaw, Morris, & Matthews, 2011) and involved five levels of functional task movement including unilateral movement, bimanual movement, task switching and body mid-line crossing.

The pilot study reported in Chapter 4 has shown that the newly designed functional tasks exercise (FcTSim) program using simulated functional task as a means of cognitive-exercise intervention is feasible. The early findings also demonstrated the beneficial effects on cognitive functions and functional status of older person with mild cognitive impairment.

The primary aim of the present study was to determine whether a functional tasks exercise program can improve the cognitive functions of older adults with mild cognitive impairment at risk of Alzheimer's disease (AD) comparing with an active control group. A further aim was to assess whether the use of meaningful functional tasks as an intervention would reduce functional decline and improve the everyday problem solving ability in older adults with cognitive impairment, using the validated Chinese version of Problems in Everyday Living Test (C-PEDL) detailed in Chapter 5.

6.2 Methods

6.2.1 Study Design

This study was a single-blind randomised controlled trial. All outcome measures were conducted by an assessor masked to the group status of the participants. After baseline assessment, participants were randomly allocated to the intervention group (functional tasks exercise) or the active control group (existing cognitive training) according to a list of computer-generated random numbers. The list was concealed until completion of baseline assessments. Ethics approval for this study was obtained from the James Cook University Human Research Ethics Committee and the Hospital Research Ethics Committee.

6.2.2 Participants

The study was conducted from December 2011 to April 2013 in Hong Kong. Potential participants were recruited from the outpatient clinic of the Occupational Therapy department. Patients with subjective memory complaint or suspected cognitive impairment were referred by the out-patient clinic of Department of Medicine and Geriatric. Older adults (age 60+) with mild cognitive decline living in the community were eligible for the study if they met the inclusion criteria for MCI (Albert *et al.*, 2011): (1) Memory/cognitive complaint as reported by the patients or the informants; (2) Objective cognitive impairment in 1 or more domains as revealed by neuropsychological assessment; but with (3) Intact personal selfcare functions; (4) No confirmed diagnosis of dementia.

The exclusion criteria were: (1) History of brain lesion/ psychoactive substance abuse/co-morbid medical condition associated with cognitive/ functional decline; (2) Clinically significant depression as screened by Geriatric Depression Scale-15; (3) Known psychiatric cause of cognitive dysfunction such as clinically significant anxiety disorders or psychosis; (4) Medical conditions which rendered patients unable to engage in physical activity, such as severe cardiac failure; (5) Undertaking medications with significant impacts on cognitive function such as anticholinergic drugs; (6) Significant impairment of vision, hearing or communication that might affect participation in the assessments or the program.

An initial screening was conducted to rule out participants with exclusion criteria and to check the inclusion criteria of subjective memory complain and cognitive screen. The Mini Mental State Examination (MMSE; Folstein M., Folstein S. & McHugh, 1975) was used for initial cognitive screening with the education- adjusted MMSE cut-off scores validated for Hong Kong Chinese older adults (Chiu *et al*, 1998). Those patients with Geriatric Depression Scale-15 (GDS-15) score of 7 or higher were excluded due to the presence of clinically significant depressive symptoms (Lee, Chiu, Kwok, & Leung, 1993). Basic selfcare functions were screened using Barthel Index (Collin, Wade, Davies, & Horne, 1988). The Chinese version of MMSE (Chiu, Lee, Chung, & Kwong, 1994), GDS-15 (Lee *et al*., 1993) and Barthel Index (Leung, Chan, & Shah, 2007) were used in this study.

The Physical Activity Readiness Questionnaire (PAR-Q) was used to screen if the participants were safe to exercise (Thomas, Reading, & Shephard, 1992). Certificates of physical clearance to participate in the program from the participants' referring physicians were collected prior to the commencement of the program as indicated.

Potentially eligible participants were invited to an in-person assessment to collect demographic data and check other inclusion criteria. Participants fulfilling the inclusion criteria received an invitation letter, information about the program and a consent form for participation in the study. All participants and caregivers were invited to the assessment site to complete the baseline assessments. All the participants provided written informed consent.

6.2.3 Sample Size

As subjective memory complaint is central to the diagnosis of mild cognitive impairment and plays a key predictive role for future dementia (Roberts, Clare, & Woods, 2009), memory is chosen as one of the key primary outcomes in this study. The power calculation of this study is based on the result of a previous similar study (van Uffelen, Chinapaw, van Mechelen, & Hopman-Rock, 2008a). It was found that to be able to detect a significant group difference of 5 points on direct recall of the auditory verbal learning test, 34 participants in each group were required for 80% power to detect this difference with a significance level of 0.05 in the proposed study. Taking into consideration of a drop-out rate of 15% as suggested in a recent systematic review (van Uffelen *et al*., 2008b) on similar studies, it follows that 40 participants were needed in each group, with a total sample size of 80 participants in two groups for this study.

6.2.4 Interventions

Functional tasks Exercise (FcTSim) Group

Participants randomised to the intervention group received a 10-week functional task exercise (FcTSim) program, in a group of 3-4 members, facilitated by an occupational therapist. For the first 4 weeks, participants had two center-based sessions (60 minutes/session) and one session of home practice per week. From week 5 to week 8, the center-based sessions were reduced to one session and supported by two home practice sessions per week. The center-based sessions were further reduced to once biweekly from week 9 to week 10.

Repetitions and activity speed were progressed based on the ability and comfort level of the individual participant. All exercise sessions began with a 5-10 minute warm-up consisting of light stretching to increase flexibility, 30-40 minute core exercise and ended with a 5-10 minute cool-down.

Active Control (AC) Group

Participants randomised into the AC group received an existing cognitive training program (1x 60 minute session) for a total of 10 weeks, once weekly for weeks 1-2 and once bi-weekly for weeks 3-10. Each session included 30 minutes computer-based cognitive training targeting on attention, memory and calculation as well as 30 minutes of cognitive strategies training. Each session was further supplemented with a paper and pencil home exercise. The cognitive training was conducted by an occupational therapist and an assistant in a group of 3-4 members. All the participants continued with their usual routine medical care.

6.2.5 Measurements

Assessments were undertaken at baseline, post-intervention at 11-12 weeks and during follow-up at 6 months from the start of the intervention. The primary outcome measures were assessments of general cognitive functions and specific cognitive functions including memory and executive functions. Secondary outcomes were assessments of functional status and everyday problem solving ability.

6.2.5.1 *Primary outcome measures*

Neurobehavioral Cognitive Status Examination (NCSE)

The Neurobehavioral Cognitive Status Examination ((Kiernan, Muelle, Langston, & van Dyke, 1987) was used to assess general cognitive function. The NCSE's sensitivity to dementia is 100% and specificity is 83%, when impairment is defined as a deficit on one or more component scales (van Gorp *et al*., 1999). To summarize the performance of general cognitive functions, a NCSE Composite Score (Drane, Yuspeh, Huthwaite, & Klingler, 2003) was calculated by adding all subtest scores (maximum 82) and a NCSE normal domains score (0-10) was calculated by adding up the number of domains scored normal (Osato, Yang, & La Rue, 1993). The Chinese version of NCSE was used in this study (Chan, Lee T, Wong, Fong, & Lee C, 1999).

The Chinese Version Verbal Learning Test (CVVLT)

The Chinese Version Verbal Learning Test (CVVLT) is a verbal learning and memory test validated in Chinese population (Chang *et al*., 2010). It consists of 9 two-character nouns presented over 4 learning trials with immediate recall, a 30-second delayed recall, a 10-minute delayed recall, and a delayed word recognition test. The scores measured in this study were the total immediate recall across the 4 trials, the 30-second and the 10-minute delayed recall. The scores in 30-second and 10-minute delayed recall were collapsed and analysed (Optale *et al.*, 2010; Smith *et al*., 2009)

Category Verbal Fluency Test (CVFT)

The Category Verbal Fluency Test (Carew, Lamar, Cloud, Grossman, & Libon, 1997) is commonly used as an index of executive functions (Troyer, Moscovitch, & Winocur, 1997). The participants were required to generate as many animal names as possible in one minute and the total number of words was recorded.

Trail making tests (TMT)

The Trail Making Test is widely used to assess, mental flexibility and executive functions (Reitan, 1959) and consists of Part A (TMT-A) and Part B (TMT-B). TMT-A involves rapidly connecting 25 numbered circular targets in sequential order. TMT-B involves connecting alternating numbers and letters in sequence. The time to complete each part is recorded as the score. The Chinese version of the TMT-B (Lu & Bigler, 2000), in which numerals in Chinese characters substitute for the letters of the standard version of Trails B, was used in this study.

6.2.5.2 *Secondary Outcome Measures*

Lawton Instrumental Activities of Daily Living Scale (Lawton IADL)

The validated Chinese version of Lawton IADL (Tong & Man, 2002) was used to measure the functional status reported by participant and/or a family member. A higher score indicates greater independence.

Problems in Everyday Living Test (PEDL)

The PEDL is a 14-item test of practical problem solving related to everyday life (Leckey & Beatty, 2002). Responses to the questions will be recorded and scored on a 3-point scale (0–2). The validated Chinese version of PEDL was used in this study (Law *et al*., 2013).

6.2.6 Statistical Analysis

All analyses were performed using SPSS 19 (SPSS, Inc., Chicago, IL). Group differences in demographics and all outcome measures at baseline were compared using Independent Samples t-test and Fisher's Exact Test when appropriate. Analysis of covariance (ANCOVA) were performed to evaluate the effects of intervention at each time point, with groups (intervention and active control) as the between subjects factor and baseline score, age, education and exercise pattern (time of regular exercise per day) as covariates. The baseline score was used as covariate to control for any statistically insignificant baseline group differences in outcome measures and to reduce error variance (Rausch, Maxwell, & Kelley, 2003) as well as to increase the power (Van Breukelen, 2006). Age, education and exercise pattern were used as covariates to control for confounding effects.

Post hoc Bonferroni analyses were performed for all measures when significant between-group differences were revealed. Repeated measures of Analysis of Variance (ANOVA) were performed to evaluate the intervention effect by time from baseline to post-training and from baseline to 6-month follow-up. Cohen's *d* was calculated to estimate the effect sizes between the intervention group and the active control group at post-intervention and at follow-up (Cohen, 1988). The data were analysed according to the intention- to- treat principle. The statistical significant level was set at $p < 0.05$ (two-tailed) for all analyses.

6.3 Results

6.3.1 Participant Characteristics

A total of 211 potential participants were screened for eligibility. Figure 6.1 shows the flow of participants from the time of screening through to the study completion at 6 months. Eighty- three patients met the inclusion criteria and were randomized into the intervention (FcTSim) group (n = 43) or the active control (AC) group (n = 40). There were 50 female and 33 male participants, aged 60 to 88 years (mean = 73.8, SD = 7.1). The average ages of the participants in the FcTSim group and AC group were 73.6 ± 6.8 and 74.1 ± 7.6 respectively. Over 95% of the participants were living with family in the community and about 25% of the participants were partaking in regular exercise. Baseline characteristics are tabulated in Table 6.1. No significant differences were found in demographic characteristics (range p = 0.659 - 0.873) or neuropsychological assessment results (range p = 0.203 – 0.910) between the two groups at baseline.

Figure 6.1 Study Flowchart

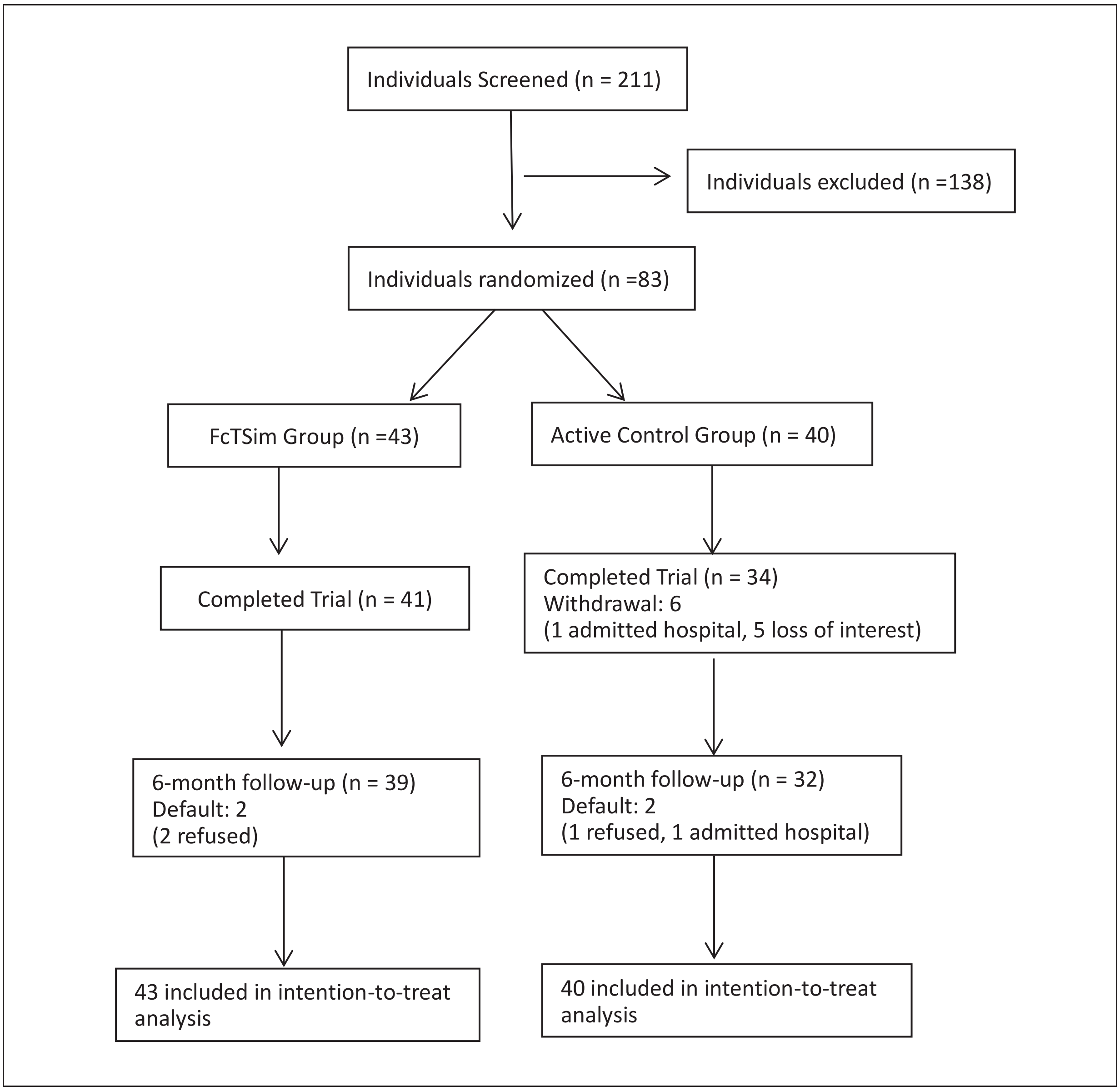

Table 6.1 Baseline Demographic and Neuropsychological Evaluation of Participants

Characteristics	FcTSim Group (N = 43)	Control Group (N = 40)	P-value
Age [a] , years,[mean (SD)]	73.68 (6.8)	74.1 (7.6)	0.756
Gender [b], N(%), [Female/male]	27 (62.8)/16 (37.2)	23 (57.5)/17 (42.5)	0.659
Education level [b], N(%), [illiterate/primary /secondary /tertiary]	17 (39.5)/ 13 (30.2)/ 9 (20.9)/ 4 (9.3)	18 (45.0)/ 8 (20.0)/ 9 (22.5)/ 5 (12.5)	0.755
Social Status [b], N(%) [Living with family/alone]	42 (97.7)/ 1 (2.3)	39(97.5)/ 1 (2.5)	0.735
Exercise per day [b], N(%), [0 / < 30min/ > 30min]	25 (58.1)/ 8 (18.6)/ 10 (23.3)	21 (52.5)/9 (22.5)/ 10 (25.0)	0.873
Ambulatory level [b], N(%), [Unaided/ with stick]	36 (83.7)/7 (16.3)	35 (87.5)/5 (12.5)	0.758
MMSE, score [a] [mean (SD)]	23.81 (3.45)	24.53 (3.12)	0.329
NCSE domain normal [a] [mean (SD)]	4.77 (1.86)	5.35 (2.30)	0.207
NCSE composite score [a] [mean (SD)]	50.65 (11.77)	53.95 (13.38)	0.236
CVVLT Total free recall [a] [mean (SD)]	15.49 (4.83)	16.35 (5.95)	0.470
CVVLT delayed recall [a] [mean (SD)]	5.00 (3.36)	5.26 (4.52)	0.766
CVFT [a], score [mean (SD)]	9.33 (3.67)	10.43 (4.13)	0.203
TMT – A [a] , seconds [mean (SD)]	136.28 (69.19)	134.31 (87.01)	0.910
TMT – B [a] , seconds [mean (SD)]	236.97 (85.75)	228.27 (87.45)	0.648
Lawton IADL [a] [mean (SD)]	20.67 (4.39)	19.73 (5.72)	0.402
PEDL [a] [mean (SD)]	18.12 (3.53)	18.50 (4.48)	0.665

Notes: [a] Independent sample t- test, [b] Fisher's Exact Test

Abbreviations: MMSE, Mini Mental State Examination; NCSE, Neurobehavioral Cognitive Status Examination; CVVLT, Chinese Version Verbal Learning Test; CVFT, Category Verbal Fluency Test; TMT-A, Trail Making Test–part A; TMT-B, Trail Making Test-part B; Lawton IADL, Lawton Instrumental Activities of Daily Living Scale; PEDL, Problems in Everyday Living test

6.3.2 Compliance

Of the 83 participants who completed the baseline assessment, 75 (90.4%) participants performed the post-intervention evaluation, and 70 (84.3%) participants attended the 6-month follow-up. Dropout rates did not vary significantly between the groups at post-intervention (χ^2 (1) = 2.54, p = 0.147) and during follow-up at 6-months (χ^2 (1) = 2.73, p = 0.134). In the FcTSim group, 2 participants dropped out before program completion and two more participants did not attend the follow-up at 6-months. In the AC group, six participants dropped out before completion and three more participants did not attend the follow-up at 6-months.

Completion rate for post-intervention evaluation were 95.3% in the FcTSim group and 85% in the AC group. Retention rate for follow-up at 6-months were 90.7% in the FcTSim group and 77.5% in the AC group. No adverse events were reported from either group.

6.3.3 Effects of Interventions

Performance of the two groups for all primary and secondary outcome measures along the three evaluation time periods and the between-group effect sizes at post-intervention and 6- month follow-up are illustrated in Table 6.2.

General Cognitive Functions

The ANCOVA of the NCSE composite score revealed a significant effect for group (F (1, 77) = 11.02, P = 0.001). The Bonferroni post-hoc comparison of the two groups indicated that the FcTSim group (M = 62.03, 95% CI [60.19, 63.85]) had a significantly higher performance score compared to the AC group (*M* = 57.59, 95% CI [55.69, 59.49]), $p = 0.001$. The ANCOVA of the NCSE normal domains also revealed significant effect of group (F (1, 77) = 14.64, $P < 0.001$). The Bonferroni post-hoc comparison of the two groups indicated that the FcTSim group (*M* = 6.99, 95% CI [6.59, 7.38]) had a significantly higher performance than the AC group (*M* = 5.88, 95% CI [5.47, 6.29]), $p < 0.001$.

Verbal Memory

The ANCOVA results also showed significant between-group differences in the CVVLT immediate recall (F (1, 76) = 5.05, $P = 0.028$) and the CVVLT delayed recall (F (1, 75) = 5.49, $P = 0.022$). The Bonferroni post-hoc comparison indicated that the FcTSim group (*M* = 19.84, 95% CI [18.65, 21.01]) had a significantly higher performance score compared to the AC group (*M* = 17.90, 95% CI [16.68, 19.12]) at $p = 0.028$ in immediate free recall. The comparison for delayed recall also showed the FcTSim group (*M* = 7.24, 95% CI [6.69, 7.79]) had a significantly higher performance score compared to the AC group (*M* = 6.29, 95% CI [5.72, 6.87]) at $p = 0.022$.

Executive Functions

The ANCOVA of the TMT results revealed no significant between- group difference in the TMT-A (F (1, 77) = 1.94, $P = 0.168$) but showed a significant between-group difference in the TMT-B (F (1, 77) = 4.13, $P = 0.045$). The Bonferroni post-hoc comparison on TMT-A scores found that the FcTSim group (*M* = 111.51, 95% CI [99.74, 123.29]) had a higher performance score compared to the AC group (*M* = 123.38, 95% CI [111.17, 135.59]) but the difference was not large enough to reach a statistically significant level. For post-hoc comparison on TMT-B, the FcTSim group (*M* = 189.90, 95% CI [173.98, 205.82]) had a significantly higher performance score compared to the AC group (M = 213.37, 95% CI [196.87, 229.88]) at $p = 0.045$.

The ANCOVA on the CVFT revealed a significant effect for group (F (1, 77) = 4.92, P = 0.029). The Bonferroni post-hoc comparison showed the FcTSim group (M = 12.62, 95% CI [11.73, 13.51]) also had a significantly higher performance score compared to the AC group (M = 11.19, 95% CI [10.27, 12.10]) at $p = 0.029$.

Functional Status

The ANCOVA of the Lawton IADL results revealed an effect approaching significance for group (F (1, 77) = 3.36, P = 0.071). When gender and ambulatory level were included as covariates to control for confounding effects, the ANCOVA revealed a significant effect for group (F (1, 75) = 3.99, P = 0.049). Bonferroni post-hoc comparisons showed that the FcTSim group (M = 21.73, 95% CI [20.69, 22.76]) had a significantly higher performance score compared to the AC group (M = 20.22, 95% CI [19.15, 21.29]) at p =0.049.

Everyday Problem Solving ability

The ANCOVA on the PEDL revealed a significant effect for group (F (1, 77) = 19.55, P < 0.001). The Bonferroni post-hoc comparison showed that the FcTSim group (M = 22.52, 95% CI [21.27, 23.77]) had a significantly higher performance score compared to the AC group (M = 18.52, 95% CI [17.22, 19.81]) at $p < 0.001$.

Table 6.2 Outcomes at baseline, post-intervention, and 3- month follow-up

Measures	Groups	Baseline	Post-intervention	Follow-up	Post-intervention			Follow-up		
	FcTSim (n = 43) AC (n=40)	Mean ± SE	Mean ± SE	Mean ± SE	P-value (Group)	P-value (Time)	Effect Size[a] (95% CI)	P-value (Group)	P-value (Time)	Effect Size[a] (95% CI)
NCSE Composite Scores	FcTSim	50.65 ± 1.79	62.23 ± 0.93	61.91 ± 1.17	0.001*	< 0.001	*d* = 0.81	0.025*	< 0.001	*d* = 0.51
	AC	53.95 ± 2.12	57.38 ± 0.96	58.03 ± 1.22			(0.36, 1.25)			(0.07, 0.95)
NCSE Normal Domains	FcTSim	4.77 ± 0.28	6.99 ± 0.20	6.95 ± 0.24	< 0.001	< 0.001	*d* = 0.84	0.034*	< 0.001	*d* = 0.48
	AC	5.35 ± 0.36	5.89 ± 0.21	6.20 ± 0.25			(0.39, 1.29)			(0.04, 0.92)
CVVLT Immediate Recall	FcTSim	15.49 ± 0.74	19.84 ± 0.59	20.44 ± 0.68	0.028*	< 0.001	*d* = 0.51	0.123	< 0.001	*d* = 0.35
	AC	16.35 ± 0.94	17.90 ± 0.61	18.9 ± 0.70			(0.07, 0.95)			(-0.08, 0.78)
CVVLT Delayed recall	FcTSim	5.00 ± 0.51	7.24 ± 0.28	7.43 ± 0.32	0.022*	< 0.001	*d* = 0.52	0.043*	< 0.001	*d* = 0.47
	AC	5.26 ± 0.71	6.29 ± 0.29	6.44 ± 0.34			(0.09, 0.96)			(0.04, 0.91)
TMT-A	FcTSim	136.28 ± 10.55	111.51 ± 5.91	93.63± 6.19	0.168	< 0.001	*d* = 0.31	0.011*	< 0.001	*d* = 0.58
	AC	134.31 ± 13.76	123.38 ± 6.13	116.97± 6.42			(-0.12, 0.74)			(0.14, 1.02)
TMT-B	FcTSim	236.97 ± 13.08	189.90 ± 7.99	202.75 ± 8.28	0.045*	< 0.001	*d* = 0.45	0.656	< 0.001	*d*= -0.10
	AC	228.27 ± 13.83	213.38 ± 8.29	197.41 ± 8.59			(0.02, 0.89)			(-0.53, 0.33)
CVFT	FcTSim	9.33 ± 0.56	12.62 ± 0.45	11.87 ± 0.42	0.029*	< 0.001	*d* = 0.49	0.19	< 0.001	*d* = 0.30
	AC	10.43 ± 0.65	11.19 ± 0.46	11.06 ± 0.44			(0.06, 0.93)			(-0.14, 0.73)
Lawton IADL	FcTSim	20.67 ± 0.67	21.73 ± 0.52	21.69 ± 0.62	0.049*	0.003*	*d* = 0.45	0.098	0.031*	*d* = 0.37
	AC	19.73 ± 0.90	20.22 ± 0.54	20.18 ± 0.65			(0.01, 0.88)			(-0.06, 0.81)
PEDL	FcTSim	18.12 ± 0.54	22.52 ± 0.63	22.19 ± 0.62	< 0.001	< 0.001	*d* = 0.98	0.008*	< 0.001	*d* = 0.61
	AC	18.50 ± 0.71	18.52 ± 0.65	19.75 ± 0.64			(0.53, 1.44)			(0.17, 1.05)

Note: *: P < 0.05; Mean = adjusted mean after Bonferroni correction
a: Effect size defined as Cohen's *d* of the intervention (FcTSim) group (FcTSim) compared with the active control (AC) group
Abbreviations: NCSE, Neurobehavioral Cognitive Status Examination; CVVLT, Chinese Version Verbal Learning Test; TMT-A, Trail Making Test –part A; TMT-B, Trail Making Test-part B; CVFT, Category Verbal Fluency Test ; Lawton IADL, Lawton Instrumental Activities of Daily Living Scale; PEDL, Problems in Everyday Living Test;
FcTSim = intervention group; AC = active control group; SE = Standard Error; CI = Confidence Interval

6.3.4 Sustainability of Effects

The ANCOVA on all outcomes at 6-month follow-up revealed significant effects for group, with Bonferroni correction performed, on general cognitive function by NCSE composite scores (F (1, 77) = 5.19, P = 0.025) and NCSE number of normal domains (F (1, 77) = 4.64, P = 0.034); verbal memory by CVVLT delayed recall (F (1, 75) = 4.24, P = 0.043); executive function by TMT-A (F (1, 77) = 6.82, P = 0.011) as well as in problem solving ability by PEDL (F (1, 77) = 7.45, P = 0.008). The ANCOVA of the Lawton IADL results revealed an effect approaching significance for group (F (1, 75) = 2.81, P = 0.098).

The between- group differences were non-significant in CVVLT immediate recall (F (1, 76) = 2.43, P = 0.123), TMT-B (F (1, 77) = 0.20, P = 0.656) and CVFT (F (1, 77) = 1.75, P = 0.19).

6.3.5 Intervention Effects across Time

The results of repeated-measures ANOVA on the effects of intervention by time at post-intervention revealed that the FcTSim group had statistical significant improvements in all outcomes including the NCSE normal domains (F (1, 42) =100.33, P<0.001, η_p^2 = 0.705); NCSE composite score (F (1, 42) = 134.83, P<0.001, η_p^2 = 0.762); TMT-A (F (1, 42) = 24.37, P<0.001, η_p^2 = 0.367); TMT-B (F (1, 42)= 33.88, P<0.001, η_p^2 = 0.446); CVFT (F (1, 42) = 45.17, P<0.001, partial η^2 = 0.518); CVVLT Immediate Recall (F (1, 42) = 35.96, P<0.001, η_p^2 = 0.461); CVVLT Delayed Recall (F (1, 42) = 46.86, P<0.001, η_p^2 = 0.527); Lawton IALD (F (1, 42) = 10.19, P = 0.003, η_p^2 = 0.195) and PEDL (F (1, 42) = 48.65, P<0.001, η_p^2 = 0.537).

For the effect of intervention during follow up at 6-month from baseline, the repeated-measures ANOVA revealed effects by time remained significant in all outcomes including the NCSE normal domains (F (1, 42) = 79.31, P<0.001, η_p^2 = 0.654); NCSE composite score (F (1, 42) = 90.27, P<0.001, η_p^2 = 0.682); TMT-A (F (1, 42) = 37.62, P<0.001, η_p^2 = 0.472); TMT-B (F (1, 42) = 14.41, P<0.001, η_p^2 = 0.255); CVFT (F (1, 42) = 33.86, P<0.001, η_p^2 = 0.446); CVVLT Immediate Recall (F (1, 42) = 34.81, P<0.001, η_p^2 = 0.453); CVVLT Delayed Recall (F (1, 42) = 53.13, P<0.001, η_p^2 = 0.559); Lawton IALD (F (1, 42) = 5.01, P = 0.031, η_p^2 = 0.107) and PEDL (F (1, 42)= 46.28, P<0.001, η_p^2 = 0.524).

6.4 Discussion

The aim of this study was to examine the potential benefits of a new functional tasks exercise, FcTSim program, on cognitive functions of older adults with mild cognitive impairment at risk of Alzheimer's diseases and to assess whether the use of functional tasks as a cognitive-exercise intervention would reduce the functional decline and improve the everyday problem solving ability of older adults with cognitive impairment.

The results of the present study showed that participants who received the FcTSim program had significantly higher improvements in general cognitive function, memory, executive function, functional status and problem solving ability, comparing to the active control group, at post-intervention and with a range of small to very large effect size (range d = 0.31- 0.98). The improvements within the FcTSim group across time from baseline to post-intervention were also significant in all outcomes.

The significant group effects on general cognitive functions, memory, executive function and everyday problem solving ability were sustained at 6-month follow-up. The improvement in functional status dropped slightly at 6-month follow-up but the performance of the FcTSim group remained significantly higher than the AC group as revealed by post hoc comparison. The within-group intervention effects across time were sustained and remained significant during follow-up at 6-month.

The findings support the hypothesis that functional tasks exercise can be used as a means of combined cognitive-exercise intervention and influence different cognitive domains leading to improvements in cognitive functions.

The relative high compliance of participants and high retention rate at follow-up in the FcTSim group further support the second hypothesis that using cognitively challenging functional tasks with exercise components is more meaningful and more practical for individuals with cognitive impairment and can better perpetuate the desirable cognitive intervention benefits.

The largest effect was observed on everyday problem solving ability. Previous studies have found everyday problem solving performance is closely related to fluid intelligence (Burton, Strauss, Hultsch, & Hunter, 2009; Marsiske & Willis, 1995), which is strongly related to working memory (Büehner, Krumm, Ziegler & Pluecken, 2006; Colom, Flores-Mendoza, & Rebollo, 2003; Kane *et al*., 2004) and can be improved through working memory training.

It is suggested that the improvement in everyday problem solving performance is associated with the working memory gained through the practice of functional tasks exercise (Duval, Coyette, & Seron, 2008; Lopez, *et al*, 2006). Problem solving ability has been found to be impaired in MCI (Sánchez-Benavides *et al.*, 2010) and is identified as a strong risk factor for the imminent development of dementia (Brandt, *et al.*, 2009). Nevertheless, the effect on this important cognitive function, which demonstrated in the present study, has not been reported in previous similar studies (Kounti *et al*., 2011; Suzuki *et al*., 2012) or other cognition-based interventions for older adults with MCI (Martin, Clare, Altgassen, Cameron, & Zehnder, 2011; Simon, Yokomizo, & Bottino, 2012).

The effects on general cognitive functions of the FcTSim group were also large and significantly higher than that of the AC group. This finding is consistent with results from previous studies that general cognitive functions were improved after combined cognitive and exercise training (Oswald, Gunzelmann, Rupprech, & Hagen, 2006; Kounti *et al.*, 2011). Importantly, this trial found that the numbers of cognitive domains scored normal, as revealed by the NCSE, of the participants increased in both groups but with significantly higher improvements in the FcTSim group.

Although cognitive status in persons with MCI may improve and sometimes revert to a normal (Koepsell & Monsell, 2012; Larrieu *et al*., 2002), prospective studies in MCI patients have found the reversion rate to normal state is low (Busse, Hensel, Gühne, Angermeyer, & Riedel-Heller, 2006; Fischer *et al.*, 2007). Those persons who reverted still remained at high risk of conversion back to MCI and to AD or dementia (Ganguli, Dodge, Shen, & DeKosky, 2004; Koepsell & Monsell, 2012). Therefore, it is important that combined cognitive - exercise intervention can improve the cognitive functions of individuals with MCI. The positive benefits of the intervention enhancing cognitive functions may ameliorate the progression of cognitive decline, which could potentially delay the conversion of pre-clinical stage to the clinical stages of AD or other dementias.

Participants in the FcTSim group also demonstrated significant improvements in memory and executive functions compared to the AC group. The simulated functional tasks of the FcTSim program involve performing tasks that demand encoding, retention, and reproduction of movements following specific sequence and pre-designed patterns. This activity may exert cognitive demands and attentional loads on central executive resources for successful performance (Gregoire & Van der Linden, 1997). Therefore, the performance of object location in the placing and collection tasks in the FcTSim program demands complex cognitive processes including memory, reasoning and executive function (Coventry, Venn, Smith, & Morley, 2003; Lövdén *et al*., 2012). Further, neuroimaging studies have found that the brain is activated from the frontal to the parietal lobe (brain areas for memory and executive functions) during visuo-motor sequence learning and retrieval, which are similar to the tasks performing in the FcTSim program (Grafton, Hazeltine, & Ivry, 1995; Sakai *et al*, 1998). This may explain the intervention effects of the FcTSim program on memory and executive functions.

The present findings support previous studies and show that training with cognitively demanding tasks may improve underlying neural substrates and induce neural compensation and cortical plasticity leading to improved cognitive performance (Ansado *et al.*, 2013; Erickson *et al.,* 2007; Lövdén *et al.*, 2012).

The intervention effect on functional status as showed by the results of the Lawton IADL is relatively small compared with effects on other outcomes even though the improvement of the FcTSim group had significantly higher performance scores compared to the AC group at post-intervention. This difference may be due to the fact that deficits in IADLs are subtle in persons with MCI (Peres *et al*., 2006; Teng, Becker, Woo, Cummings, & Lu, 2010).

Although assessment on everyday problem solving, which is closely related to performance in IADL, has been included in the present study, use of more sensitive or performance-based IADL assessments may help better gauge the intervention effects on IADL performance (Jak *et al*., 2009; Wadley, Okonkwo, Crowe, & Ross-Meadows, 2008). Nevertheless, the generalisation effects on everyday problem solving ability and IADLs found in the present study support results from previous studies that training effects through visuospatial tasks practice can be generalized to non-trained tasks related to working memory and reasoning (Duval *et al*., 2008; Jaeggi, Buschkuehl, Jonides, & Perrig, 2008).

Successful performance of the tasks in the FcTSim program, which involved encoding/retrieval of movement patterns, coordinated manual targeted movement and task switching, demands high attentional cost in the brain (Gajewski & Falkenstein, 2012; Mayr & Kliegl, 1993; Wenderoth, Debaere, Sunaert, & Swinnen, 2005). The training tasks can facilitate the ability to control attention as well as improve the attention span (Halford, Cowan & Andrews, 2007). Studies been proposed that the transfer effect to a non-trained task primarily results from the involvement of attentional control, which is essential for most cognitive functions. The cognitive gain may serve as a domain-general cognitive resource that modulates the ability in a number of seemingly disparate areas of cognitive performance and work as a common platform with increased cognitive resources for non-trained tasks performance (Kane *et al.*, 2004; Richmond, Morrison, Chein, & Olson, 2011; Zurowski *et al.*, 2002).

Overall, results from the present study support the findings of previous studies that combined cognitive and exercise training is effective for influencing different cognitive domains and improving cognitive functions (Langdon & Corbett, 2012; Oswald *et al.*, 2006). This present study differs to previous similar studies with cognitively impaired participants (Coelho *et al.*, 2012; Kounti *et al.*, 2011), which used combined cognitive and exercise training simultaneously, in that the intervention group was compared with an active control group.

To the authors' best knowledge, this is the first program that uses simulated functional tasks exercise as a combined cognitive-exercise intervention for MCI. No sophisticated tools are required and all the participants were able to continue to practice the learnt program at home so as to perpetuate the intervention effects as long as they can keep practicing. The FcTSim program has demonstrated the potential for cost-effectiveness and acceptability of cognitive-exercise programs for this group. The initial findings are clinically important in improving cognitive functions of older adults with MCI, as well as practically meaningful to older individuals with MCI in improving the functional status and everyday problem solving ability.

6.5 Limitations

One limitation of this study is the use of only the Lawton IADL to assess functional status. Including other measures of functional status could provide a more comprehensive evaluation on functional performance changes in response to interventions as well as the changes over time. A second limitation of this study is the absence of a no treatment control group and an exercise training group to understand fully the impact of the program. A further limitation is that no neuroimaging support was available to examine the actual effects on the activity in the brain.

6.6 Conclusion

In conclusion, findings from this randomised controlled trial show that a functional tasks exercise program using simulated functional tasks as cognitive-exercise intervention is feasible for improving general cognitive functions, memory, executive functions, functional status and everyday problem solving ability of older adults with mild cognitive impairment living in the community. Moreover, the improvements can be sustained over time after completion of training. The present study contributes to the efficacy of combined cognitive-exercise interventions in patients with cognitive impairment.

Chapter 7

Further Discussion and Conclusion

7.1 Further Discussion

The aim of this thesis was to determine whether functional tasks exercise as a means of combined cognitive-exercise intervention is effective for improving cognitive functions in older persons with mild cognitive impairment. It was hypothesized that functional tasks exercise can influence different cognitive domains leading to improvements in cognitive functions, whereby the functional tasks act as a cognitively demanding activity to provide an enriched environment to influence cognitive functions which is further enhanced by the exercise component. It was further hypothesized that using cognitively challenging functional tasks as a cognitive-exercise intervention would be more meaningful and more practical for individuals with cognitive impairment. Therefore, it would be more likely for the participants to adopt the learned ‘functional task exercise’ into their daily routine and better perpetuate the desirable cognitive intervention benefits.

7.1.1 Summary of Findings

This thesis demonstrated that a functional tasks exercise program using simulated functional tasks as a combined cognitive and exercise intervention is feasible for improving cognitive functions in older adults with mild cognitive impairment. Moreover, the effects can be generalized to everyday function including IADL and everyday problem solving ability. Furthermore, the improvements can be sustained over time following completion of training.

The systematic review described in Chapter 2 found that the studies on combined cognitive and exercise interventions in patients with cognitive impairment are still in their very early stage, with the identified studies only published in the past three years (2010-2012). With regard to the method of combined cognitive-exercise intervention, the results also found that the reviewed studies either using combined cognitive and exercise training sessions or using dual-task training, which involved concurrent motor tasks and cognitive tasks (e.g. calculation during walking) in addition to traditional exercise. The use of functional tasks exercise as a combined cognitive and exercise intervention described in this thesis may offer a cost-effective alternative in this intervention paradigm.

The systematic review reported in Chapter 3 identified five instruments for the evaluation of the everyday problem solving competence in older adults with cognitive impairment. However, a Chinese version of existing instrument to assess everyday problem solving ability of the target population, Chinese older adults in Hong Kong, was unavailable. Two instruments, Assessment of Capacity for Everyday Decision Making (ACED) and Problems in Everyday Living Test (PEDL) received the best rating for administration. The Problems in Everyday Living (PEDL) Test was selected, for its brevity, to translate and validate for use in this thesis.

The work described in Chapter 4 illustrated the development of a new functional tasks exercise program as well as a pilot study which examined the feasibility of application and potential effects across time in MCI patients. The initial findings from the pilot study supported that a functional tasks exercise program as a means of cognitive-exercise intervention is feasible and demonstrated positive benefits on cognitive functions in patients with MCI.

The study detailed in Chapter 5 revealed that the C-PEDL is a valid and reliable test for assessing the everyday problem solving ability in Chinese older populations with mild cognitive impairment. The results have shown that the C-PEDL has good psychometric properties which further strengthen the psychometric quality of C-PEDL in clinical applications.

The randomised controlled trial reported in Chapter 6 investigated the effects of the functional tasks exercise program compared with a cognitive training group in older adults with MCI. The findings further confirmed the positive effects of the functional tasks exercise program on general cognitive functions, memory, executive functions, functional status and everyday problem solving ability of older adults with MCI. The results also demonstrated significant higher improvements in the functional tasks exercise group compared to the cognitive training group, with small to very large effect sizes. Furthermore, the training effects were found to be sustained over time as revealed by the 6-month follow-up results.

An important investigation covered by this thesis is the use of cognitively demanding functional tasks as a media of cognitive-exercise intervention to explore the potential synergic effects as reported in previous studies (Fabre *et al*., 2002; Langdon & Corbett, 2012; Oswald, Gunzelmann, Rupprech, & Hagen, 2006). Although the functional tasks involved in the FcTSim program are simple placing and collection tasks that most people may do in their everyday life, complex cognitive interplays are required to enable us to see, reach and place the objects to the target positions throughout the course (Iachini, Iavarone, Senese, Ruotolo & Ruggiero, 2009; Possin, 2010). These goal-directed actions require integration and maintenance of information (e.g., object identity and spatial orientation) as well as simultaneous manipulation of the integrated information in the working memory, which demands intensive loads on the attentional and executive resources to facilitate the flow of the ongoing tasks (Chun, Golomb, &Turk-Browne, 2011; Jackson, Morgan, Shapiro, Mohr, & Linden, 2011; Pertzov, Dong, Peich, & Husain, 2012). Indeed, misplacing objects are commonly reported in MCI and AD (Hampstead, Stringer, Stilla, Amaraneni, & Sathian, 2011; Salloway & Correia, 2009). Studies have shown that persons with MCI have deficits in object location and visuospatial navigation imposing difficulties in their everyday life (Hampstead *et al*., 2011; Hort *et al.*, 2007; Iachini *et al*., 2009).

Simple daily tasks can be cognitively challenging to persons with cognitive impairment. The findings of the study reported in Chapter 6 supports the hypothesis that functional tasks exercise can influence different cognitive domains leading to improvements in cognitive functions, whereby the functional tasks act as a cognitively demanding activity to provide an enriched environment to influence cognitive functions which is further enhanced by the exercise component.

In addition, the relative high compliance of participants and high retention rate at follow-up of the FcTSim group in the studies, reported in chapter 4 and chapter 6, further support the second hypothesis that using cognitively challenging functional tasks with exercise components, as a means of intervention, is more meaningful and more practical for individuals with cognitive impairment and can better perpetuate the desirable cognitive intervention benefits.

7.1.2 Important Contributing Factors

Although the results of the studies investigating the effects of the functional tasks exercise program are promising, there are key contributing factors in program implementation needed to be highlighted.

7.1.2.1 *Partnership with families/carers*

Significant family members or caregivers play a vital role in the lives of person with cognitive impairment, influencing their level of activities and functional interaction in everyday environment. Studies have shown that involvement of caregivers in interventions promote better outcomes (Clare *et al.*, 2010; Martire *et al.*, 2003; Schoenmakers, Buntinx, & DeLepeleire, 2010). As mentioned in Chapter 1, the mode of intervention delivery used in this thesis was a center-initiated home-based program involving caregivers as exercise partners, with a specific purpose to promote active learning and better compliance of the program. The high compliance and retention rates of the intervention group in the studies reported in Chapter 4 and Chapter 6 further confirm the dyadic contributions of involving family members/carers in the intervention process as suggested in previous studies (McCurry *et al.*, 2010; Teri, Gibbons, McCurry *et al*., 2003; Teri, Logsdon, Whall *et al*., 1998).

7.1.2.2 *Motivation for participation*

It is important to firstly educate the participant as well as the carer about the rationale and the goals of practicing the exercise in order to initiate and facilitate their participation (Resnick & Spellbring, 2000; Resnick *et al.*, 2006). Once the participants experience the challenge in performing the functional tasks exercise, both the participants and the carer can understand better the difficulties the person with cognitive impairment encounters in everyday life. Through practising the simulated functional tasks in the FcTSim program and the guidance from the program therapist, both the participants and the carer are able to realize even simple daily tasks can be cognitively challenging to persons with cognitive impairment.

As discussed in the pilot study described Chapter 4, most of the participants were motivated intrinsically to participate in the program, particularly when they gradually experienced the improvements in their daily functions throughout the intervention period as reported by the participants. This motivation was further reflected by the high compliance of the FcTSim group and high retention rate at 6-month follow-up in both the pilot study and the randomised controlled trail reported in this thesis. Subjective improvements were reported by the participants at time well before the completion of the program. Further studies involving assessment of the gradual changes in everyday functions at time points throughout the program could provide a better understanding of the potential intervention effects.

7.1.2.3 *Importance of Task Demand*

The FcTSim program is designed to include 5 levels of functional tasks exercise so as to assure the task demand, which is adaptive to the individual ability of the participants, throughout the training. The program is also specifically structured in a simple format with the purpose that the participants can continue to practice the learnt exercise even after the completion of the training. However, the task demand must be maintained in order to facilitate neurogenesis **(**Curlik & Shors, 2013) or cortical reorganisation (Ansado *et al*., 2013). Moreover, studies have found that only successful performance is positively associated with the increased activity in the cortices and induces cortical reorganization among older adults (Cabeza, Anderson, Locantore, & McIntosh, 2002; Erickson, *et al,* 2007). It is crucial for the therapist conducting the program to monitor the performance of individual participant closely and adjust the task levels promptly to achieve the task demand meeting the individual's latent ability, as well as to ensure successful learning.

7.1.2.4 *Importance of Novelty*

The difference in cognitive demand within and between each level of the FcTSim program is achieved by increasing the complexity of movement to accomplish each task in terms of structure and repetition. However, the novelty of the practising task has to be maintained in order enhance synaptic plasticity and maintain an advantage for the intervention (Boyke, Driemeyer, Gaser, Büchel, & May, 2008; Duzel, Bunzeck, Guitart-Masip, & Duzel, 2010; Leff *et al*., 2008).

The cognitive demand of the learning task will only happen at the early stage of learning. The task or activity has to remain unfamiliar and demand repeated practice for challenging learning to occur (Buitenweg, Murre, & Ridderinkhof, 2012). Studies have found that stimulus repetition leads to a decrease in cortical activity as a result of more efficient neural processing and the stimulation will decrease once the task becomes more automatic through practice (Düzel *et al.*, 2010; Leff *et al.*, 2008; Ranganath & Rainer, 2003). Therefore, the cognitive processes can only be adequately challenged by including the important component of novelty (Buitenweg *et al.*, 2012; Ranganath & Rainer, 2003).

The novelty of the task practised in the FcTSim program is maintained with the changing visuospatial demands involved in the specific patterns and performing sequences. Novelty can be maintained in existing task by adding unfamiliar features, and therefore performance of the task will remain challenging and not become subject to automation (Buitenweg, Murre, & Ridderinkhof, 2012). Nevertheless, the trainer plays a significant role in monitoring the participant's individual performance so as to ensure continuous task demands and novelty throughout the intervention process. Therefore, as stated in Chapter 4, the FcTSim program should be conducted by a trained therapist. Training is required to ensure standardization of procedures and quality to implement the program.

Furthermore, although the results of the studies reported in Chapter 6 were encouraging and the training effects sustained over time, the training gains did drop slightly at 6-month follow-up. Previous studies have shown that booster training may help to maintain or even produce additional training gains (Aramaki & Yassuda, 2011; Willis, Tennstedt, Marsiske *et al.*, 2006). Including a monthly or bimonthly booster session in future studies may help maintaining the task demand and novelty, and thus further promote a longer term longitudinal training effects.

7.1.4 Clinical Implications of the Findings

In this thesis, the functional tasks exercise (FcTSim) program demonstrated significant positive benefits on cognitive functions and functional status in older adults with cognitive impairment compared to an active training group. The present findings support previous studies that combined cognitive and exercise interventions is effective in improving cognitive functions and functional status (Coelho *et al.*, 2012; Fabre *et al.*, 2012; Kounti *et al*., 2011; Oswald *et al*., 2006; Schwenk *et al*., 2010; Suzuki *et al*., 2012) and encourage further studies in this new research paradigm.

The FcTSim program is a simple and structured program that does not require any sophisticated equipment or tools for implementation, either in clinical or home-based settings. This may serve as a cost-effective adjunct in the combined cognitive and exercise arena.

The core of occupational therapy practice focuses on occupational performance. The findings of the current study further reinforce occupational therapy practitioner's understanding that "occupation" is a "means" and an "end" that involvement of the client in meaningful occupation as a means of intervention can promote cognitive functioning and performance of daily life occupations. The development of the FcTSim program is based on previous research findings as detailed in Chapter 4. The promising findings in this thesis may encourage future development of cognitive interventions in occupational therapy practice based on neuroscience research findings.

7.2 Limitations

Different studies may have different limitations as discussed in previous Chapters. There are further limitations in this thesis that warrant mention. First, the study samples in the studies were Chinese older adults in Hong Kong and this limits the generalization of the results in other populations. More studies in different countries are needed to further validate the efficacy of using this newly developed program in the research paradigm of combined cognitive-exercise intervention.

Second, the small sample size in the main study (Chapter 6) did not allow stratification of patients into more precise MCI sub-groups to examine and compare the potential intervention effects across the clinical subtypes which may demonstrate different responses to the same training exposure.

Further, the post-intervention follow-up period of the study in the present thesis was relatively short in view of the long preclinical period of Alzheimer's disease. Further larger scale studies with extended follow-up period are needed to validate the sustainability of the training gains, as well as to establish possible strategies to maintain or even promote additional training gains.

7.3 Conclusion

To conclude, findings from the studies reported in this thesis have shown that a functional tasks exercise program using simulated functional tasks as a cognitive-exercise intervention is feasible for improving general cognitive functions, memory, executive functions, functional status and everyday problem solving ability of older adults with mild cognitive impairment living in the community. Furthermore, the improvements can be sustained over time after completion of training. The present study contributes to the efficacy of combined cognitive-exercise interventions in patients with cognitive impairment.

Clinical Messages

- The systematic review reported in this thesis has found that combined cognitive and exercise interventions have moderate to large effects on cognitive functions in older adults.

- The studies reported in this thesis showed that a functional tasks exercise program using simulated functional tasks as a cognitive-exercise intervention is feasible and demonstrates significant positive benefits on cognitive functions and functional status in older adults with cognitive impairment compared to an active cognitive training group.
- The newly developed functional tasks exercise program may serve as a cost-effective adjunct in the combined cognitive and exercise arena.
- Further larger scale studies with extended follow-up period are needed to validate the sustainability of the training gains, as well as to establish possible strategies to maintain or even promote additional training gains.

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APPENDICES

Appendix 1: Chapter 2: Data Extraction Form

General Information

Date form completed *(dd/mm/yyyy)*	
Name/ID of person extracting data	
Reference citation	
Study author contact details	
Publication type *(e.g. full report, abstract, letter)*	
Notes:	

Study Eligibility

Study Characteristics	Eligibility criteria *(Insert inclusion criteria for each characteristic as defined in the Protocol)*	Eligibility criteria met? Yes	No	Unclear	Location in text or source *(pg &/fig/table/ other)*
Study Design	Randomised Controlled Trial	☐	☐	☐	
	Quasi-randomised Controlled Trial	☐	☐	☐	
Participants		☐	☐	☐	
Types of intervention		☐	☐	☐	
Types of comparison		☐	☐	☐	
Types of outcome measures		☐	☐	☐	
INCLUDE ☐		EXCLUDE ☐			
Reason for exclusion					

DO NOT PROCEED IF STUDY EXCLUDED FROM REVIEW

Characteristics of included studies

Methods

	Descriptions as stated in report/paper		Location in text or source *(pg & /fig/table/other)*
Aim of study *(e.g. efficacy, equivalence, pragmatic)*			
Design *(e.g. parallel, crossover, non-RCT)*			
Unit of allocation *(by individuals / groups)*			
Duration of participation *(from recruitment to last follow-up)*			
Ethical approval needed/ obtained for study	☐ Yes ☐ No ☐ Unclear		
Notes:			

Participants

	Description *Include comparative information for each intervention or comparison group if available*		Location in text or source *(pg & /fig/table/other)*
Population description *(from which study participants are drawn)*			
Setting *(including location and social context)*			
Method of recruitment of participants *(e.g. phone, mail, clinic patients)*			
Informed consent obtained	☐ Yes ☐ No ☐ Unclear		

Total no. randomized/recruited		
Number of participants in each group [intervention and control group(s)]		
Baseline imbalances		
Withdrawals and exclusions *(if not provided below by outcome)*		
Age		
Gender		
Race/Ethnicity		
Other relevant socio-demographics		
Notes:		

Intervention groups

Copy and paste table for each intervention and comparison group

Intervention Group 1

	Description as stated in report/paper	Location in text or source *(pg & /fig/table/other)*
Setting		
Group name		
No. randomized/ enrolled to group		
No. withdrawn/lost to follow-up		
No. included in analysis		
Description *(include sufficient detail for replication, e.g. content, dose, components)*		

Duration of treatment period		
Timing *(e.g. frequency, duration of each episode)*		
Delivery *(e.g. mechanism, medium, intensity, sequence)*		
Care Providers *(e.g. no., profession, training, ethnicity etc. if relevant)*		
Co-interventions *(if any)*		
Resource requirements *(e.g. staff numbers, equipment)*		
Adverse Events		
Notes:		

Outcomes

Copy and paste table for each outcome.

Outcome 1

	Description as stated in report/paper	Location in text or source *(pg & /fig/table/other)*
Outcome name		
Time points measured *(specify whether from start or end of intervention)*		
Time points reported		
Person measuring/ reporting		
Is outcome/tool validated?	☐ Yes ☐ No ☐ Unclear	

Data and analysis

Copy and paste the appropriate table for each outcome, including additional tables for each time point and subgroup as required.

Dichotomous outcome

	Description as stated in report/paper		Location in text or source
Comparison			
Outcome			
Time point *(specify from start, end of intervention or follow-up)*			
Results *(e.g. odds ratio, risk ratio and confidence intervals, p-value)*	Intervention	Comparison	
	Total in group:	Total in group:	
Any other results reported *(e.g. odds ratio, risk difference, CI or P value)*			
No. missing participants			
Reasons missing			
Type of data analysis used *(e.g. ITT analysis, per protocol)*			

Continuous outcome

	Description as stated in report/paper	Location in text or source
Comparison		
Outcome		
Time point *(specify from start or end of intervention)*		
Post-intervention or change from baseline?		

Results	Intervention		Comparison		
	Mean	SD *(or other variance, specify)*	Mean	SD *(or other variance, specify)*	
Any other results reported *(e.g. mean difference, CI, P value)*					
No. missing participants					
Reasons missing					
Notes:					

Other information

	Description as stated in report/paper	Location in text or source *(pg & /fig/table/other)*
Key conclusions of study authors		
References to other relevant studies		
Correspondence required for further study information		
Notes:		

Appendix 2: Chapter 3: Examples of Instruments

A 2.1 Example of questions from the ACED

Medication Management

Understanding the Problem

Instructions for the Interviewer:
Prior to starting the interview, the interviewer must speak with a knowledgeable informant to obtain a specific problem experienced by the patient with respect to medication management as well as a potential consequence of that problem. The interviewer must then record this information in the appropriate boxes under Q2 in the "Understanding the Problem" section below. Afterwards, you may proceed with the interview.

Q2. Disclosure: "Ok, now I am going to talk about some problems people have in managing their medications and the consequences of these problems"
[Now, using the information below, make a statement about the problem and the potential consequences of that problem. For example, "Persons who frequently forget to take their medications may have a worse health condition and need to make more visits to the doctor."]

Problem Experienced by Patient	Potential Consequence to Problem

Inquire: "Please, tell me in your own words, what I just told you."

Q2- Understanding Problem Response	Score

(Reproduced from Assessment of Capacity for Everyday Decision-Making (ACED) developed by James Lai, MD and Jason Karlawish, MD with permission from the developer)

A 2.2 Example Stimuli and questions from the ECB

Study for one minute:

DATE OF PRESCRIPTION: 05-31-96	
Dr. Herbest, D.E.	**RX:** 081224
	REFILLS 1
	EXPIRES: 08-31-97
TAKE 1 TABLET EVERY 6 HOURS (TAKE AT EVEN INTERVALS AROUND THECLOCXK) CAPTOPRIL – 25MG 90 TABLES	

TAKE MEDICATION ON AN **EMPTY STOMACH** 1 HOUR BEFORE OR 2 TO 3 HOUR AFTER A MEAL UNLESS OTHERWISE DIRECTED BY YOUR DOCTOR

THIS DRUG MAY IMPAIRED YOUR ABILITY TO DRIVE OR OPERATE MACHINERY, **USE CARE** UNTIL YOU BACOME FAMILIAR WITH ITS EFFECTS

Turn the page and answer the questions:

1) How long should Mr. Jones wait to eat a meal after taking a dosage?
   a. he doesn't have to wait
   b. 6 hours
   c. 1 hour
   d. 2 hours
2) If Mr. Jones takes this medication, what might he be too impaired to do?
   a. write a letter
   b. drive a car
   c. talk on the phone
   d. walk

(Adapted from "Everyday Cognition: Age and Intellectual Ability Correlates," by J. C. Allaire and M. Marsiske, 1999, *Psychology and Aging*, *14*, p. 631 Copyright 1999 by the American Psychological Association.)

A2.3 <u>Examples of questions from the EPCCE</u>

Domain: Medications

Question: These are directions for taking cough medicine. What is the maximum number of teaspoons you should take in 24 hours?

Domains: Finances

Question: This is a book order form. To order 2 Irresistible Desserts Recipe Books and 1 Vegetable Recipe Book, how much money should be sent?

(Adapted from Sherry L. Willis, Rebecca Allen-Burge, Melissa M. Dolan (1998). Everyday Problem Solving Among Individuals with Alzheimer's disease. The Gerontologist 1998; 38: 5, P. 571)

A2.4 <u>Example of questions from the PEDL</u>

You receive your monthly bank statement on your checking account. When you try to reconcile your checkbook with the bank statement, you find that the bank says you have $100 more than your checkbook balance shows. What do you do?

(2) Recognize that it is possibly not your money and try to solve it immediately
- – Double check your math
- – Call the bank

(1) Recognize that it is possibly not your money and that you are not allowed to spend it.
- – Set it aside, don’t spend it

(0) No recognition of the problem and further consequences
- – Spend it

(Adapted from Everyday Living (PEDL) Test: A preliminary study. Journal of the International Neuropsychological Society 2002; 8, P.9)

Appendix 3: Functional Tasks Exercise Program Content

This is a 13-session 10-week (3 sessions per week, 1 hour per session), center-initiated home based functional task exercise program. For weeks1-4, center-based sessions will be scheduled twice weekly supported with once weekly home practice with caregiver, followed by once weekly center-based and twice weekly home practice sessions for weeks 5-8, then once biweekly center-based sessions for weeks 9-10.

At the first visit of the week, exercises will be first demonstrated by the occupational therapist, then practiced by the participant while the caregiver/ exercise buddy observes and assists. The occupational therapist will work together with the caregivers to ensure that exercises are being practiced safely and correctly by the participants. Caregivers are encouraged to ask questions and instructed in the use of the Physical Activity Log of practice. The caregiver and participant are required to maintain a Physical Activity Log of practice to detail the participant's motivation, total time in minutes exercise, number of repetitions, problems encountered and other comments.

During each exercise session, participants will perform 1-2 exercise task sets of 1-3 repetitions (depending on the participants' ability and condition) with 1-2 minutes' rest between each set.
All exercise sessions begin with a 5-10 minute warm-up consisting of light stretching designed to increase flexibility, 30 minutes core exercise and end with a 5-10 minutes cool-down similar to the warm-up to allow the body to readjust gradually from the demands of exercise back to baseline.

A 3.1 Warm up and Cool down

Warm up:

Neck stretch

Position: Sitting in chair, hands in lap.
Action: Turn head slowly–side-to-side. Repeat five times each side.
Bring ear to shoulder, keeping shoulders relaxed. Repeat five times each side.
Lower chin to chest. Repeat five times.

Shoulder stretch

Position: Sitting in chair.
Action: Reach up with one arm, then the other. Repeat five times.
Shrug your shoulders up toward your ears and then lower them back down.

Repeat five times.
Rotate shoulders forward and backward, leaving hands on hips. Repeat five times.

Arm Hand stretch
Position: Sitting in chair
Action: Reach both arms up high, then to the front. Hold elbow straight and make wrist circles. Repeat five times.

Leg Stretch
Position: Sitting in chair.
Action: Sitting upright with your back straight, smoothly raise one leg up so that your foot is at 2-5 inches clear from the floor, holding for 3 seconds prior to returning back to the ground and alternating your legs. Repeat five times.

Ankle stretch
Position: Sitting in chair.
Action: Extend one leg out and point and flex toes. Repeat five times.
Make circles with ankle in both directions. Repeat five times.
Repeat with other ankle.

Cool down:

Calf Stretch
Position: Standing
Action: Stand facing a wall and place your hands on the wall.
Use a chair if you need more support.
Keep your toes pointing straight ahead, step forward with one foot. Lean your hip towards the wall/ chair and keep your back leg straight with heel on the floor. Hold for 20 seconds. Repeat with the other leg. Repeat five times alternatively.

Upper body Stretch
Position: Sitting in Chair
Action: While seated, participant will do a lean forward, raise arms and then lean backward, lean sideways, and turn to each side. Repeat 5 times.

Knee Raise
Position: Sitting in chair

Action: Grasp one knee with both hand, gently pull up towards your chest until you feel a slight stretch. Hold this position for 10 second. Relax and lower the leg slowly down to the floor. Repeat with the other knee. Repeat 5 times with alternating sides.
Exhale during upward movement and inhale during downward movement.
Caution: Not for participants with a hip replacement.

Ankle stretch
Position: Sitting in chair.
Action: Extend one leg out and point and flex toes. Repeat five times.
Make circles with ankle in both directions. Repeat five times.
Repeat with other ankle.

A 3.2: Functional Tasks Exercise

Utensil Placing and Collection

Position: Sit to stand
Preparation: Table, chairs, plastic containers x 5 per set, cups x 4 per set, bowls x 4 per set, polar watch

Basic actions: Sitting in front of a table, rise from the chair with one hand supporting on the table. Lean forward with one arm stretch out to reach the containers for placing and collections. Return to sitting position after each placing or collection movement.
Repeat the chair-rise before each placing /collection movement.
Repeat the task (complete placing and collection) for 3 times = 1 cycle.
Complete 3 cycles = 1 task set

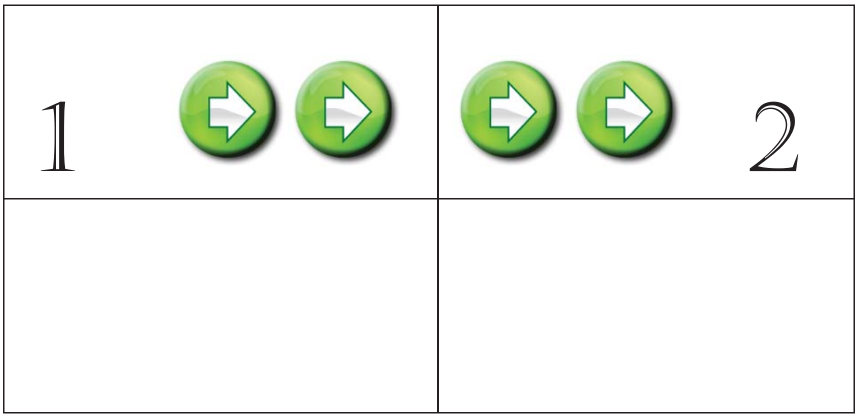
Remark: Precautions and modification should be done for back protection and participants with potential joint problems

Upgrading criteria: successful performance of 3 set consecutively without error

A 3.3: Basic Movement Patterns

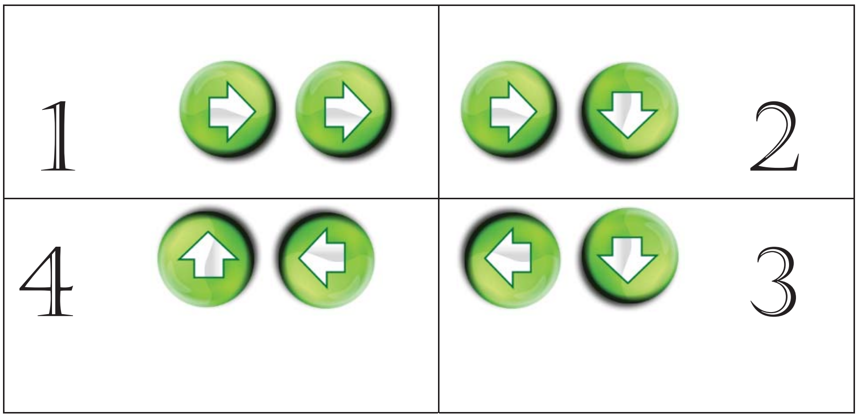
1. **Level 1:**

   Forward placing and backward collection in 2 containers



2. **Level 2 -5:**

   Forward placing and backward collection in 4 containers



3. **Level 4: sequence variation**

   Forward placing as in level 3

   Backward collection with 1 repeated place by placing each bowl/cup to position 4 before putting back to main container

4. **Level 5: sequence variation**

   2 forward placing, then 2 backward collection

A 3.4: Basic Setup and Examples of Task Illustrations

1. Setup of utensils for starting position

2. Level 1:
   Place 1 bowl, then 1 cup and repeat until all 4 sets of bowl and cup are placed as illustrated in picture 3

3. Positions of bowls and cups at completion of placing task for level 1

4. Level 2:
Place one bowl and one cup alternately in clockwise direction and repeat until all 4 sets of bowl and cup are placed as illustrated in picture 5.

5. Positions of bowls and cups at completion of placing task for level 2

Appendix 4: Functional Tasks Exercise Session Plan

Session 1

Introduction and rational for the program

Program overview

Schedule planning (2 non-consecutive days per week)

Introduction of keeping exercise log and explain importance of compliance

“Warm up” practice

Feedback time

Session 2

Brief overview

Warm up

Exercise program: functional task exercise level 1

Cool Down

Feedback time

Session 3

Review and follow up

Warm up

Exercise program: Functional task exercises level 1 or above
Continue practice as in session 2 and upgrade according to individual progress

Cool Down

Feedback time

Session 4

Review and follow up

Warm up

Exercise program: Functional task exercises level 1 or above
Continue practice as in session 3 and upgrade according to individual progress

Cool Down

Feedback time

Session 5

Review and follow up

Warm up

Exercise program: Functional task exercises level 1 or above
Continue practice as in session 4 and upgrade according to individual progress

Cool Down

Feedback time

Session 6

Review and follow up

Warm up

Exercise program: Functional task exercises level 1 or above
Continue practice as in session 5 and upgrade according to individual progress

Cool Down

Feedback time

Session 7

Review and follow up

Warm up

Exercise program: Functional task exercises level 1 or above
Continue practice as in session 6 and upgrade according to individual progress

Cool Down

Feedback time

Session 8

Review and follow up

Warm up

Exercise program: Functional task exercises level 1 or above
Continue practice as in session 7 and upgrade according to individual progress

Cool Down

Feedback time

Session 9

Review and follow up

Warm up

Exercise program: Functional task exercises level 1 or above
Continue practice as in session 8 and upgrade according to individual progress

Cool Down

Feedback time

Session 10

Review and follow up

Warm up

Exercise program: Functional task exercises level 1 or above
Continue practice as in session 9 and upgrade according to individual progress

Cool Down

Feedback time

Session 11

Review and follow up

Warm up

Exercise program: Functional task exercises level 1 or above
Continue practice as in session 10
Monitoring and maintaining skills
Reinforce safety

Cool Down

Feedback time

Session 12

Review and follow up

Warm up

Exercise program: Functional task exercises level 1 or above
Continue practice as in session 11
Monitoring and maintaining skills
Reinforce safety

Cool Down

Feedback time

Session 13

Review and follow up

Warm up

Exercise program: Functional task exercises level 1 or above
Continue practice as in session 12
Monitoring and maintaining skills
Reinforce safety

Cool Down

Feedback time

Program round up

Appendix 5 Chapter 5
Questionnaires for Translation Equivalence, Cultural Relevance and Content Validity

A 5.1 Translation Equivalence Questionnaire (Forward/Backward)

Translation Equivalence Questionnaire for Original English and Back-Translated English Versions of the Problem in Everyday Living Test (PEDL)

The following are the original English and the back-translated English versions of the PEDL. Conceptual rather than literal meaning is the goal of translation in this study. The forward translators have been asked to translate the PEDL into Chinese with the consideration of the meanings of the terms used in Hong Kong. Similarly, the back-translators have been asked to translate the Chinese PEDL into English with the consideration of the conceptual meanings of the terms.
Please share with me your opinions about the equivalence between these two versions.

Each of items is placed on a 4-point Likert scale as:
Equivalence:
1= totally different
2= the item needs major revision to be equivalent
3= the item needs minor revision to be equivalent
4= equivalent

Please check the number that best reflects the extent to which the translation equivalence is. Comments areas are provided. Please give your recommendations for revising the items with a rating less than 4

	Original English Version	Back-translated English Version	Rating of equivalence
Question	1. You notice your dog is limping. What do you do?	1. When noticing your dog is limping, what would you do?	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Get an idea of what could be done before starting further actions – Check the dog's paw – Observe the dog (1) Do something which leads to a solution without checking alternatives first.	(2) Understand the situation before taking further action - Examine the dog's paw - Observe the dog (1) Take action straight away in order to reach a solution without seeking any other ways to	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:

	– Call the veterinarian – Rush the dog to the veterinarian (0) Start actions, which do not refer to the problem, or even doing nothing. – Feed him – Ignore it	solve the problem first - Call the vet - Rush to the vet's clinic with the dog (0) Take action (unrelated to the problem), or even take no actions - Feed the dog - Ignore the dog	
Question	2. Last month, you purchased a new coffee maker. It worked well for about three weeks, but now the burner does not heat up. What do you do?	2. You bought a new coffee machine last month. But after about three weeks' perfect operation, the heating element stopped working. What would you do?	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Recognize the responsibility of the seller or producer – Return it to the place where it was purchased – Try to find the warranty card and follow instructions for sending it off for repair – Take apart and fix, with knowledge of electronics (1) Any actions which lead to a solution of the problem neglecting the producer's responsibility – Take it apart and see if you can fix it, without knowledge of electronics – Throw it out and buy a new one (0) Avoid a solution of the problem by adapting to the situation – Adapt yourself to a burned-out burner	(2) Understand the responsibility of the retailer or manufacturer - return the coffee machine to where you bought it - Try to find the warranty and follow its instruction to send the machine back for repair - According to your electronic knowledge, try to take the machine apart and fix it (1) Disregard the manufacturer's responsibility; take the corresponding action leading to a solution - Even though you have no knowledge of electronic, you try to take it apart and fix it - Throw it away and buy a new coffee machine (0) Adjust to the current situation to avoid solving the problem - Get used to using a coffee machine with broken heating element	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:

Question	3. You look at the calendar and realize a good friend's birthday was last week. You forgot to send her a card. What do you do?	3. When you check the calendar and realize that last week was your good friend's birthday. You forgot to send a birthday card to her. What would you do?	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Admit that you forgot and contact the friend – Call and apologize – Send a belated card (1) Contact the friend, but do not admit that you forgot – Pretend you sent one (0) Avoid any contact with the problem – Ignore it and hope she does not notice or will not care	(2) Admit that you forgot and contact your good friend - Call your friend to apologize - Send a belated birthday card (1) Contact your friend but do not admit that you forgot - Pretend that you have sent a card (0) Avoid any questions touching the issue - Ignore the issue and hope that she doesn't notice or doesn't mind	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Question	4. Your usual breakfast consists of: a bowl of cereal with milk, a glass of orange juice and a cup of coffee. One morning you go to make your breakfast and find out you don't have any milk. What do you do?	4. Normally your breakfast includes: a bowl of cereal with milk, a glass of orange juice and a cup of coffee. One morning you find that there is no milk left when you are preparing the breakfast, what would you do?	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Try alternatives – Have something else for breakfast (1) Get a solution without changing your habits - Borrow a cup of milk from the neighbor – Go out and buy milk (0) Have your usual breakfast without solution of the problem – Eat your cereal dry	(2) Try other alternative - choose other food as breakfast (1) Take a solution which is no need to change your habit - Borrow a glass of milk from your neighbor - Go out to buy some milk (0) Continue eating the normal breakfast without solving the problem - eat the dry cereal	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Question	5. You are taking a college class for credit. After	5. You are taking a university credit course. Three	1 ☐ 2 ☐ 3 ☐ 4 ☐

	three weeks, you have to miss a class session because of illness, but you are able to return after missing that one class. What do you do?	weeks later you were absent from one class because of sickness. But after missing the class you can make it up. What would you do?	Comment:
Scoring reference	(2) Recognize the need to get information about the missed class – Ask the instructor – Ask a classmate (1) Try to prepare on your own – Make sure you have read the text (0) Omit any effort to make up for the next lesson – Drop the course – Hope the information you missed will not be asked on the next test	(2) You know you need to collect the lecture notes and handouts of the missed class - Ask the lecturer - Ask your classmates (1) Try to prepare them yourself - Make sure you have read the relevant textbooks (0) Will not pay any effort to make up with the missed class - Withdraw from the course - Hope that the content of the missed class will not be asked in the next test	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Question	6. You find a letter in your mailbox that has been mis-delivered. It should have been placed in your next-door neighbor’s mailbox. What do you do?	6. You find in your letter box a letter delivered by mistake. That letter should have been delivered to your neighbour’s letter box. What would you do?	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Realize that it needs to be taken to your neighbor – Call them and let them know you have their mail – Go to neighbor’s house and give them the mail – Write “Delivered to wrong address” on the envelope (1) Recognize that it is another person’s property – Call the neighbor to have them come get the letter (0) Actions that don’t lead to an immediate solution	(2) Understand that the letter should be returned to your neighbour - Call your neighbour to inform him that you are safekeeping his letter - Take the letter to your neighbour - Mark on the envelope “Postal Error” and return the letter to the post office (1) Understand that the letter is other person’s property - Call the neighbor to inform him to come to collect his letter (0) Take action which doesn’t lead to immediately	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:

	– Open the letter – Throw it out	solve the problem - Open the letter - Throw it away	
Question	7. You receive your monthly bank statement on your checking account. When you try to reconcile your checkbook with the bank statement, you find that the bank says you have $100 more than your checkbook balance shows. What do you do?	7. You have received the bank statement from your cheque/current account. When you try to double-check the cheque book and the statement you find that the account balance is $100 more than that of the cheque book record. What would you do?	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Recognize that it is possibly not your money and try to solve it immediately – Double check your math – Call the bank (1) Recognize that it is possibly not your money and that you are not allowed to spend it. – Set it aside, don't spend it (0) No recognition of the problem and further consequences – Spend it	(2) Understand that this money may not belong to you and try to solve the problem immediately - double-check your calculation again - Call the bank (1) Understand that this money may not belong to you and you can't use it -Put it to one side and not use it (0) Don't understand what the problem is and the further consequence - Spend the money	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Question	8. A. It is Friday evening. You discover that your oven is not working. What do you do? B. It is Friday evening. You discover that your freezer has stopped working sometime within the past day or two. The freezer is full, and you have several hundred dollars worth of meat and other expensive items. What do you do?	8. A. Now is Friday evening and you find that the oven is not working. What would you do? B. Now is Friday evening and you find that the fridge has broken down some time a day or two ago. There are more than a few hundred dollars worth of meat and expensive things in the fridge. What would you do?	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Get a solution with a minimum amount of costs which could imply personal contact A - Wait until Monday; use the microwave A – Ask your neighbors if you can use their oven B – Try to move all the food and wait until	(2) Use minimal cost to reach a solution (contacting people is counted) A - Use microwave oven; and wait until Monday A - Ask your neighbours whether you can use their oven	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:

	Monday A or B – Fix them, with knowledge of appliance repair (1) Solution with no respect to the costs – Call an appliance repair service – Buy a new one (0) Adapt yourself to the situation without solving the problem – Live without it indefinitely	B – Try to remove all the food and wait until next Monday A or B – use your understanding on repairing electrical appliances to start repairing (1) Solution which does not count the cost - Call the electrical appliances repairing service - Buy a new one (0) Make yourself adjust to the situation without solving the problem - Continue your daily life even though the electrical appliance can't be used in future	
Question	9. You have a friend you speak to only every two months or so. One day you call her, and a machine answers. A recorded voice you do not recognize asks you to lease a message. What do you do?	9. You have a friend with whom you chat over telephone about every two months. One day when you try to call her but you can only reach the answering machine. A recorded message by a voice which you can't recognize asks you to leave a message. What would you do?	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Make an effort to confirm the number – Double check the number – Leave a qualified message (1) Realize that you might have the wrong number – Call a mutual friend – Write a letter to a friend (0) Do not recognize the possibility of a failure or give it up – Hang up and do not try again	(2) Try your best to confirm the telephone number - Double check the telephone number - Leave a clear message (1) Realize you might have the wrong telephone number - Call a mutual friend - Write to your friend (0) Don't realize that there might be a mistake or just give up - Hang up and would not try again	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Question	10. You are leaving the house with just enough time to arrive at an appointment on time. You glance down. Peeking from your pants are your socks – one is blue and the other is black.	10. You left home in a hurry and only just have enough time to arrive at a meeting on time. When you glimpse downward you find that you have worn a blue sock and a black one. What	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:

	What do you do?	would you do?	
Scoring reference	(2) Solve the problem immediately – Go back home and change your socks and call to inform people of potential tardiness (1) Try to manage the situation without solving the actual problem – Go to your appointment. Explain it. (0) Ignore the problem – Go to your appointment and hope nobody notices – Take them off (this alternative could be worth 2 points if the participant clearly indicates that the appointment is in a setting where casual dress is appropriate)	(2) Solve the problem immediately - Go home to change your socks and call to inform other people that you may be late (1) Try to deal with the situation without solving the practical problem - Go straight to the meeting and explain the situation (0) Ignore the problem - Go straight to the meeting and hope that nobody would notice it - Take off the socks (If the participant indicates clearly that causal wear suits the environment of the meeting, this method would be worth 2 marks)	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Question	11. What is the thing to do if you find an envelope in the street that is sealed, addressed, and has a new stamp?	11. If you find in the street a sealed envelope with address written and new stamp glued on it, what should you do?	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Recognition that the letter should be put into the mail immediately – Return it to the post office . . . Mail it . . . Drop it in the nearest box . . . Give it to the postman (1) Recognition that the letter is the property of someone else, but a poor idea as to the disposition of it – Give it to a policeman . . . Take it to the dead letter office . . . Try to find the owner (0) No idea of what to do with the letter or that the letter is the property of someone else – Leave it alone . . . Open it	(2) Understand that you should put the envelope into the post box immediately - Take it to the post office … Send it… Put it into a post box nearby … Give it to a postman (1) Understand that the letter belongs to other people; but the way you handle it is not appropriate - Hand it to a policeman … Take it to the Undeliverable Mail Office … Try to find the owner (0) Don't know how to deal with it or don't know it's other person's property - Disregard it …. Open the letter	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:

Question	12. What should you do if while in the movies you are the first person to see smoke and fire?	12. If you were the first person to notice smoke and fire in the middle of watching a movie, what should you do?	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Recognition that a person in authority on the scene, such as a manager or usher, should be notified – Report it to an usher . . . Report it to the manager . . . Tell the ticket taker (1) Recognition that action, though not so immediately effective, should be taken – Ring the fire alarm . . . Try to put the fire out or call the fire department. (0) Description of actions which would create a panic or would not avert disaster – Shout, "Fire!" . . . I'd try my best to get out . . . Stay calm (Q) . . . Warn the other people (Q) . . . Run out . . . Walk to the nearest exit . . . Go for water	(2) Understand that you should inform someone around whose is responsible for the venue, such as the manager or usher - Inform the usher… Inform the manager… Inform the conductor (1) Understand that you should take action (even though it is not immediately effective) - Set off the alarm … Try to put off the fire, or call the fire station (0) Description of some actions which would cause panic or can't avoid disasters - Shout "Fire!"… I will try hard to get out … Keep calm … (Q) …Warn other people (Q)… Run out … Walk to the closest exit … Try hard to get water	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Question	13. If you were lost in the forest in the daytime, how would you go about finding your way out?	13. If you got lost in a forest during daytime, how would you find your way out?	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Any explained use of natural phenomena in order to find a way out, or a systematic approach to the problem – Try to go in one direction by using the sun (stream, moss) . . . Get your direction from the sun . . . Use of a watch as a compass (explained fully) . . . Look for a stream or path and follow it to avoid circles (1) Mention of a haphazard means of getting out, or a partial 2-point response unexplained – By the sun (Q) . . . Moss (Q) . . . Follow a stream (Q) . . . Follow a path (Q) . . . Walk	(2) Any explanation in using natural phenomena to find the way out, or systematically dealing with the problem - Try to walk in one direction using the sun as a reference (or stream, or moss) … Using the sun to locate your direction … Use the watch as a compass (explain in detail) … find a stream or a track and follow them to avoid walking in circle. (1) Mention some disorganized getting out proposals, or part of the above (2 scores) responses but lacking of explanation - Rely on the sun (Q) … moss (Q) …	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:

	in the direction of the sun (Q) . . . Climb to the top of the tallest tree and try to locate a landmark . . . Look for landmarks for bearings (Q) (0) Use of unreliable or senseless phenomena, or reliance on people – Try to find a policeman to help you find your way out . . . Keep on walking . . . Try to find the way you got in . . . Wait for a forest ranger . . . I usually watch the way I go in and follow the moon . . . I would shout	Follow the stream (Q) … Follow the track (Q) … Follow the direction of the sun (Q) … Climb to the top of the tallest tree and try to find a landmark … Find a landmark to locate the coordinates (Q) (0) Use unreliable or irrational phenomena, or rely on other people - Try to find a policeman to help you to find the way out … Continue walking … Try to find the original way in which you came … Wait for the park rangers … I normally observe the way I came in, and follow the moon … I will shout loudly	

Remark: Items 11–13 are taken verbatim from the WAIS–R (Wechsler, 1981) by the developer.

A 5.2 Translation Equivalence Questionnaire (English/Chinese)

Translation Equivalence Questionnaire for Original English and Translated Chinese Versions of Problem in Everyday Living Test (PEDL)

The followings are the original English and the translated Chinese version of the PEDL.
Please share your opinions about the translation equivalence in content/ concept between these two versions.
The translators were asked to translate the PEDL test into Chinese with the consideration of the cultural issue and the meanings of the terms used in Hong Kong. Namely, conceptual rather than literal meaning is the goal of translation in this study. Please evaluate the translation equivalence with the goal of translation in this study in mind.

Each of the items is placed on a 4-point Likert scale as:
1= totally different
2= the item needs major revision to be equivalent
3= the item needs minor revision to be equivalent
4= equivalent
Please check the number that best reflects the extent of relevance to which the item is. Comments areas are provided. Please give your recommendations for revising the items with a rating less than 4.

	Original English Version	Translated Chinese Version	Rating of Translation Equivalence
Question	1. You notice your dog is limping. What do you do?	1. 當察覺你的犬隻行起來一瘸一拐的時候，你會怎麼辦？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Get an idea of what could be done before starting further actions – Check the dog’s paw – Observe the dog (1) Do something which leads to a solution without checking alternatives first. – Call the veterinarian	(2) 於採取進一步行動前，先瞭解情況 - 檢查犬隻的腳爪 - 觀察犬隻 (1) 直接採取行動以達到解決方案，而事先沒有尋求其他解決方法	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:

	– Rush the dog to the veterinarian (0) Start actions, which do not refer to the problem, or even doing nothing. – Feed him – Ignore it	- 致電予獸醫 - 忽忽帶犬隻前往獸醫診所 (0) 開始行動（與問題無關），或甚至不採取任何行動 - 餵它 - 不理會它	
Question	2. Last month, you purchased a new coffee maker. It worked well for about three weeks, but now the burner does not heat up. What do you do?	2. 你在上個月購買了一台新的咖啡機。但經過約三個星期的良好操作後，它的發熱器便熱不起來。你會怎麼辦？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Recognize the responsibility of the seller or producer – Return it to the place where it was purchased – Try to find the warranty card and follow instructions for sending it off for repair – Take apart and fix, with knowledge of electronics (1) Any actions which lead to a solution of the problem neglecting the producer's responsibility – Take it apart and see if you can fix it, without knowledge of electronics – Throw it out and buy a new one (0) Avoid a solution of the problem by adapting to the situation – Adapt yourself to a burned-out burner	(2) 清楚賣家或製造商的責任 - 退回購買咖啡機的地點 - 嘗試尋找保養證，按保養證上指示把咖啡機送回安排維修 - 根據自己對電子認識，嘗試拆開並進行維修 (1) 不理會製造廠的責任，作出任何能解決問題的行動 - 不管自己對電子毫無認識，嘗試把它拆開並進行維修 - 扔掉它並買一台新咖啡機 (0) 以適應當前形勢來避免解決問題 - 使自己適應使用一個燒壞了的發熱器 (咖啡機)	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Question	3. You look at the calendar and realize a good friend's birthday was last week. You forgot to send her a card. What do you do?	3. 你看日曆時發覺上星期為你好友的生日，而你忘了送一張賀卡給她。你會怎	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:

		麼辦？	
Scoring reference	(2) Admit that you forgot and contact the friend – Call and apologize – Send a belated card (1) Contact the friend, but do not admit that you forgot – Pretend you sent one (0) Avoid any contact with the problem – Ignore it and hope she does not notice or will not care	(2) 承認自己忘記了，並聯絡好友 - 致電好友道歉 - 送出遲來的賀咭 (1) 聯繫朋友，但不承認自己忘了 - 假裝已送出賀咭 (0) 避免任何觸及有關問題 - 不理會有關問題，並希望她沒有注意或不會在意	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Question	4. Your usual breakfast consists of: a bowl of cereal with milk, a glass of orange juice and a cup of coffee. One morning you go to make your breakfast and find out you don’t have any milk. What do you do?	4. 通常你的早餐包括：一碗牛奶麥片、一杯橙汁及一杯咖啡。一天早晨，當你正預備做早餐時發覺沒有牛奶，你會怎麼辦？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Try alternatives – Have something else for breakfast (1) Get a solution without changing your habits – Borrow a cup of milk from the neighbor – Go out and buy milk (0) Have your usual breakfast without solution of the problem – Eat your cereal dry	(2) 嘗試其他選擇 - 以其他食物作早餐 (1) 作出一個解決方案而無需改變您的習慣 - 向鄰居借一杯牛奶 - 外出購買牛奶 (0) 在沒有解決問題情況下，繼續吃慣常的早餐 - 乾吃麥片	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Question	5. You are taking a college class for credit. After three weeks, you have to miss a class session because of illness, but you are able to return after missing that one class. What do you do?	5. 你正在上一個大學學分課程。三星期後，你因病缺席一堂課，但錯過這堂後，你可補回該堂課程。你會怎麼辦？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:

Scoring reference	(2) Recognize the need to get information about the missed class – Ask the instructor – Ask a classmate (1) Try to prepare on your own – Make sure you have read the text (0) Omit any effort to make up for the next lesson – Drop the course – Hope the information you missed will not be asked on the next test	(2) 知道要取回缺課的資料 - 向講師查詢 - 向同學查詢 (1) 嘗試自己準備 - 確定自己已閱讀相關課本 (0) 不會作任何努力以彌補缺席課程 - 退選該課程 - 希望錯過的資料於下次測驗中不會問及	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Question	6. You find a letter in your mailbox that has been mis-delivered. It should have been placed in your next-door neighbor's mailbox. What do you do?	6. 你在信箱發現一封郵遞錯誤的信件，該信件應是投入你隔壁鄰居的信箱的。你會怎麼辦？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Realize that it needs to be taken to your neighbor – Call them and let them know you have their mail – Go to neighbor's house and give them the mail – Write "Delivered to wrong address" on the envelope (1) Recognize that it is another person's property – Call the neighbor to have them come get the letter (0) Actions that don't lead to an immediate solution – Open the letter – Throw it out	(2) 明白應把信件送回鄰居 - 致電給鄰居，通知他你管有他的信件 - 前往鄰居的家，把信件送回 - 於信封寫上"郵遞錯誤"並退回信件 (1) 理解信件為他人財物 - 致電給鄰居，通知他前來取回他的信件 (0) 作出沒有導致即時解決問題的行動 - 打開那信件 - 扔掉它	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Question	7. You receive your monthly bank statement on your checking account. When you try to	7. 你收到了支票帳戶的銀行月結單。當您嘗試把支票簿和月結單作複核時，你發	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:

	reconcile your checkbook with the bank statement, you find that the bank says you have $100 more than your checkbook balance shows. What do you do?	現支票戶口結餘比支票簿結餘記錄高出$100。你會怎麼辦？	
Scoring reference	(2) Recognize that it is possibly not your money and try to solve it immediately – Double check your math – Call the bank (1) Recognize that it is possibly not your money and that you are not allowed to spend it. – Set it aside, don't spend it (0) No recognition of the problem and further consequences – Spend it	(2) 明白這可能不是屬於你的錢,並設法立即解決問題 - 再次核對你的計算 - 致電給銀行 (1) 明白這可能不是屬於你的錢,你不能使用 - 放在一邊，不會使用 (0) 不明白問題所在及進一步後果 - 用掉它	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Question	8. A. It is Friday evening. You discover that your oven is not working. What do you do? B. It is Friday evening. You discover that your freezer has stopped working sometime within the past day or two. The freezer is full, and you have several hundred dollars worth of meat and other expensive items. What do you do?	8.A. 現在是星期五黃昏，你發現焗爐失靈。你會怎麼辦？ B. 現在是星期五黃昏,你發現電冰箱已於一兩天前的某時段失靈了。電冰箱內載滿數百元的肉類及昂貴物品。你會怎麼辦？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Get a solution with a minimum amount of costs which could imply personal contact A – Wait until Monday; use the microwave A – Ask your neighbors if you can use their oven B – Try to move all the food and wait until Monday A or B – Fix them, with knowledge of appliance repair (1) Solution with no respect to the costs – Call an appliance repair service	(2) 以最低的成本達到解決方法(與人接觸亦計算在內) A - 使用微波爐；等候到下星期一 A - 問你的鄰居可否使用他們的焗爐 B - 嘗試將所有食物移走,並等候到下星期一 A or B – 以修理家電的認識，進行修理 (1) 不計較成本的解決方法 - 電召家電維修服務	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:

	– Buy a new one (0) Adapt yourself to the situation without solving the problem – Live without it indefinitely	- 買一個新的 (0) 不去解決問題，使自己適應這種情況 - 繼續如常生活，縱使以後沒有該家電使用	

Question	9. You have a friend you speak to only every two months or so. One day you call her, and a machine answers. A recorded voice you do not recognize asks you to lease a message. What do you do?	9. 你有一位朋友，你和她只會每兩個月左右才談上一次話。有一天你致電給她，只得電話錄音回應。一把你不認識的錄音要求你留言。你會怎麼辦？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Make an effort to confirm the number – Double check the number – Leave a qualified message (1) Realize that you might have the wrong number – Call a mutual friend – Write a letter to a friend (0) Do not recognize the possibility of a failure or give it up – Hang up and do not try again	(2) 儘力確認電話號碼 - 再次核對電話號碼 - 留下明確的訊息 (1) 意識到你記錄的電話號碼可能錯誤 - 致電予一位共同認識的朋友 - 寫信給你的朋友 (0) 沒有意識到錯誤的可能性或是放棄算了 - 掛線及不再嘗試	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Question	10. You are leaving the house with just enough time to arrive at an appointment on time. You glance down. Peeking from your pants are your socks – one is blue and the other is black. What do you do?	10. 你匆匆離家並僅夠時間趕及一個約會。當你向身下一瞥，發覺穿上一隻藍色襪子，一隻黑色襪子。你會怎麼辦？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Solve the problem immediately – Go back home and change your socks and call to inform people of potential tardiness (1) Try to manage the situation without solving the actual problem	(2) 立即解決問題 - 回家替換你的襪子和致電通知他人有機會延誤 (1) 嘗試應付局面，但沒有解決實際問題	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:

	– Go to your appointment. Explain it. (0) Ignore the problem – Go to your appointment and hope nobody notices – Take them off (this alternative could be worth 2 points if the participant clearly indicates that the appointment is in a setting where casual dress is appropriate)	- 直接赴會；並解釋情況 (0) 置問題不理 - 直接赴會；並希望沒有人會注意到 - 脫掉襪子（如果參與者清楚地表明休閒服飾合符約會的環境，此方法可值 2 分）	
Question	11. What is the thing to do if you find an envelope in the street that is sealed, addressed, and has a new stamp?	11. 如果你在街上發現一個已封口、填上地址及貼上新郵票的信封，你該怎樣做？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Recognition that the letter should be put into the mail immediately – Return it to the post office . . . Mail it . . . Drop it in the nearest box . . . Give it to the postman (1) Recognition that the letter is the property of someone else, but a poor idea as to the disposition of it – Give it to a policeman . . . Take it to the dead letter office . . . Try to find the owner (0) No idea of what to do with the letter or that the letter is the property of someone else – Leave it alone . . . Open it	(2) 明白應立即把該信件放入郵箱 - 把它送回郵局・・・・寄出・・・・放入就近郵箱・・・・交給郵差 (1) 明白該信件為他人財物；但處理方法並不妥善 - 交給警察 . . . 送往無法郵遞信件辦事處 . . . 嘗試尋找物主 (0) 不懂如何處理或不知道該信件為他人財物 - 置諸不理. . . 打開信件	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:

Question	12. What should you do if while in the movies you are the first person to see smoke and fire?	12. 在電影播放途中，您如果是第一人發現有煙火，你該怎樣做？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:

Scoring reference	(2) Recognition that a person in authority on the scene, such as a manager or usher, should be notified – Report it to an usher . . . Report it to the manager . . . Tell the ticket taker (1) Recognition that action, though not so immediately effective, should be taken – Ring the fire alarm . . . Try to put the fire out or call the fire department. (0) Description of actions which would create a panic or would not avert disaster – Shout, “Fire!” . . . I’d try my best to get out . . . Stay calm (Q) . . . Warn the other people (Q) . . . Run out . . . Walk to the nearest exit . . . Go for water	(2) 明白應通知現場的負責人，如經理或帶位員 - 通知帶位員 . . . 通知經理 . . . 通知點票員 (1) 明白應採取行動（雖則非即時有效） - 打響火警鐘...嘗試把火撲滅，或致電消防處。 (0) 描述作出一些會引致恐慌，或不能避免災難的行動 - 喊叫，"著火啊！"... 我會盡力走出去 ... 保持冷靜 (Q)...警告其他人 (Q)...跑出去 ... 行到最近的出口...盡力取得水	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Question	13. If you were lost in the forest in the daytime, how would you go about finding your way out?	13. 如果你於白天在森林迷路，你將怎樣找到你的出路？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Any explained use of natural phenomena in order to find a way out, or a systematic approach to the problem – Try to go in one direction by using the sun (stream, moss) . . . Get your direction from the sun . . . Use of a watch as a compass (explained fully) . . . Look for a stream or path and follow it to avoid circles (1) Mention of a haphazard means of getting out, or a partial 2-point response unexplained – By the sun (Q) . . . Moss (Q) . . . Follow a stream (Q) . . . Follow a path (Q) . . . Walk in the	(2) 任何透過解釋以運用自然現象找到出路，或有系統地處理問題 - 利用太陽嘗試往一個方向走 （或溪流、或青苔）. . . 利用太陽取得你的方向 . . . 以手表用作指南針 (詳盡解釋) ...尋找溪流或小徑，沿著走以避免繞圈 (1) 提及一些雜亂無章的走出方案，或部分以上(2 分)的回應但缺少解釋 - 靠太陽 (Q)... 青苔(Q)...沿著溪流	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:

	direction of the sun (Q) . . . Climb to the top of the tallest tree and try to locate a landmark . . . Look for landmarks for bearings (Q) (0) Use of unreliable or senseless phenomena, or reliance on people – Try to find a policeman to help you find your way out . . . Keep on walking . . . Try to find the way you got in . . . Wait for a forest ranger . . . I usually watch the way I go in and follow the moon . . . I would shout	(Q)...沿著小徑 (Q)... 沿太陽的方向 (Q)...爬到最高的樹的頂部，並嘗試查找一個地標...尋找地標定方位 (Q) (0) 使用不可靠或無知的現象，或依賴他人 - 嘗試找一個警員來幫你找出路...繼續前行...嘗試尋找原先進來的路徑. . . 等候森林管理員..我通常察看我進來的路，並跟從月亮...我會喊叫	

Remark: Items 11–13 are taken verbatim from the WAIS–R (Wechsler, 1981) by the developer.

A 5.3 Cultural Relevance Questionnaire

Cultural Relevance Questionnaire for Original English and Translated Chinese Versions of Problem in Everyday Living Test (PEDL)

The followings are the original English and the translated Chinese version of the PEDL.
Please share your opinions about the cultural relevance of PEDL for Chinese elderly population in Hong Kong.

Each of the items is placed on a 4-point Likert scale as:
1= totally irrelevant
2= the item needs major revision to be relevant
3= the item needs minor revision to be relevant
4= relevant

Please check the number that best reflects the extent of cultural relevance to which the item is. Comments areas are provided. Please give your recommendations for revising the items with a rating less than 4.

	Original English Version	Translated Chinese Version	Rating of Cultural relevance
Question	1. You notice your dog is limping. What do you do?	1. 當察覺你的犬隻行起來一瘸一拐的時候，你會怎麼辦？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Get an idea of what could be done before starting further actions – Check the dog's paw – Observe the dog (1) Do something which leads to a solution without checking alternatives first. – Call the veterinarian – Rush the dog to the veterinarian (0) Start actions, which do not refer to the problem, or even doing nothing. – Feed him	(2) 於採取進一步行動前，先瞭解情況 - 檢查犬隻的腳爪 - 觀察犬隻 (1) 直接採取行動以達到解決方案，而事先沒有尋求其他解決方法 - 致電予獸醫 - 忽忽帶犬隻前往獸醫診所 (0) 開始行動（與問題無關），或甚至不採取任何行動	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:

	– Ignore it	- 餵它 - 不理會它	
Question	2. Last month, you purchased a new coffee maker. It worked well for about three weeks, but now the burner does not heat up. What do you do?	2. 你在上個月購買了一台新的咖啡機。但經過約三個星期的良好操作後，它的發熱器便熱不起來。你會怎麼辦？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Recognize the responsibility of the seller or producer – Return it to the place where it was purchased – Try to find the warranty card and follow instructions for sending it off for repair – Take apart and fix, with knowledge of electronics (1) Any actions which lead to a solution of the problem neglecting the producer's responsibility – Take it apart and see if you can fix it, without knowledge of electronics – Throw it out and buy a new one (0) Avoid a solution of the problem by adapting to the situation – Adapt yourself to a burned-out burner	(2) 清楚賣家或製造商的責任 - 退回購買咖啡機的地點 - 嘗試尋找保養證，按保養證上指示把咖啡機送回安排維修 - 根據自己對電子認識，嘗試拆開並進行維修 (1) 不理會製造廠的責任，作出任何能解決問題的行動 - 不管自己對電子毫無認識，嘗試把它拆開並進行維修 - 扔掉它並買一台新咖啡機 (0) 以適應當前形勢來避免解決問題 - 使自己適應使用一個燒壞了的發熱器 (咖啡機)	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Question	3. You look at the calendar and realize a good friend's birthday was last week. You forgot to send her a card. What do you do?	3. 你看日曆時發覺上星期為你好友的生日，而你忘了送一張賀卡給她。你會怎麼辦？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Admit that you forgot and contact the friend – Call and apologize – Send a belated card (1) Contact the friend, but do not admit that	(2) 承認自己忘記了，並聯絡好友 - 致電好友道歉 - 送出遲來的賀咭	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:

	you forgot – Pretend you sent one (0) Avoid any contact with the problem – Ignore it and hope she does not notice or will not care	(1) 聯繫朋友，但不承認自己忘了 - 假裝已送出賀咭 (0) 避免任何觸及有關問題 - 不理會有關問題，並希望她沒有注意或不會在意	
Question	4. Your usual breakfast consists of: a bowl of cereal with milk, a glass of orange juice and a cup of coffee. One morning you go to make your breakfast and find out you don’t have any milk. What do you do?	4. 通常你的早餐包括：一碗牛奶麥片、一杯橙汁及一杯咖啡。一天早晨，當你正預備做早餐時發覺沒有牛奶，你會怎麼辦？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Try alternatives – Have something else for breakfast (1) Get a solution without changing your habits – Borrow a cup of milk from the neighbor – Go out and buy milk (0) Have your usual breakfast without solution of the problem – Eat your cereal dry	(2) 嘗試其他選擇 - 以其他食物作早餐 (1) 作出一個解決方案而無需改變您的習慣 - 向鄰居借一杯牛奶 - 外出購買牛奶 (0) 在沒有解決問題情況下，繼續吃慣常的早餐 - 乾吃麥片	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Question	5. You are taking a college class for credit. After three weeks, you have to miss a class session because of illness, but you are able to return after missing that one class. What do you do?	5. 你正在上一個大學學分課程。三星期後，你因病缺席一堂課，但錯過這堂後，你可補回該堂課程。你會怎麼辦？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Recognize the need to get information about the missed class – Ask the instructor – Ask a classmate (1) Try to prepare on your own	(2) 知道要取回缺課的資料 - 向講師查詢 - 向同學查詢	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:

	– Make sure you have read the text (0) Omit any effort to make up for the next lesson – Drop the course – Hope the information you missed will not be asked on the next test	(1) 嘗試自己準備 - 確定自己已閱讀相關課本 (0) 不會作任何努力以彌補缺席課程 - 退選該課程 - 希望錯過的資料於下次測驗中不會問及	
Question	6. You find a letter in your mailbox that has been mis-delivered. It should have been placed in your next-door neighbor's mailbox. What do you do?	6. 你在信箱發現一封郵遞錯誤的信件，該信件應是投入你隔壁鄰居的信箱的。你會怎麼辦？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Realize that it needs to be taken to your neighbor – Call them and let them know you have their mail – Go to neighbor's house and give them the mail – Write "Delivered to wrong address" on the envelope (1) Recognize that it is another person's property – Call the neighbor to have them come get the letter (0) Actions that don't lead to an immediate solution – Open the letter – Throw it out	(2) 明白應把信件送回鄰居 - 致電給鄰居，通知他你管有他的信件 - 前往鄰居的家，把信件送回 - 於信封寫上"郵遞錯誤"並退回信件 (1) 理解信件為他人財物 - 致電給鄰居，通知他前來取回他的信件 (1) 作出沒有導致即時解決問題的行動 - 打開那信件 - 扔掉它	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Question	7. You receive your monthly bank statement on your checking account. When you try to reconcile your checkbook with the bank statement, you find that the bank says you have $100 more than your checkbook balance shows. What do you do?	7. 你收到了支票帳戶的銀行月結單。當您嘗試把支票簿和月結單作複核時，你發現支票戶口結餘比支票簿結餘記錄高出$100。你會怎麼辦？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:

Scoring reference	(2) Recognize that it is possibly not your money and try to solve it immediately – Double check your math – Call the bank (1) Recognize that it is possibly not your money and that you are not allowed to spend it. – Set it aside, don't spend it (0) No recognition of the problem and further consequences – Spend it	(2) 明白這可能不是屬於你的錢，並設法立即解決問題 - 再次核對你的計算 - 致電給銀行 (1) 明白這可能不是屬於你的錢，你不能使用 - 放在一邊，不會使用 (0) 不明白問題所在及進一步後果 - 用掉它	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Question	8. A. It is Friday evening. You discover that your oven is not working. What do you do? B. It is Friday evening. You discover that your freezer has stopped working sometime within the past day or two. The freezer is full, and you have several hundred dollars worth of meat and other expensive items. What do you do?	8.A. 現在是星期五黃昏，你發現焗爐失靈。你會怎麼辦？ B. 現在是星期五黃昏，你發現電冰箱已於一兩天前的某時段失靈了。電冰箱內載滿數百元的肉類及昂貴物品。你會怎麼辦？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Get a solution with a minimum amount of costs which could imply personal contact A – Wait until Monday; use the microwave A – Ask your neighbors if you can use their oven B – Try to move all the food and wait until Monday A or B – Fix them, with knowledge of appliance repair (1) Solution with no respect to the costs – Call an appliance repair service – Buy a new one (0) Adapt yourself to the situation without solving the problem – Live without it indefinitely	(2) 以最低的成本達到解決方法(與人接觸亦計算在內) A - 使用微波爐；等候到下星期一 A - 問你的鄰居可否使用他們的焗爐 B - 嘗試將所有食物移走，並等候到下星期一 A or B – 以修理家電的認識，進行修理 (1) 不計較成本的解決方法 - 電召家電維修服務 - 買一個新的 (0) 不去解決問題，使自己適應這種情況 - 繼續如常生活，縱使以後沒有該	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:

		家電使用	
Question	9. You have a friend you speak to only every two months or so. One day you call her, and a machine answers. A recorded voice you do not recognize asks you to lease a message. What do you do?	9. 你有一位朋友，你和她只會每兩個月左右才談上一次話。有一天你致電給她，只得電話錄音回應。一把你不認識的錄音要求你留言。你會怎麼辦？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Make an effort to confirm the number – Double check the number – Leave a qualified message (1) Realize that you might have the wrong number – Call a mutual friend – Write a letter to a friend (0) Do not recognize the possibility of a failure or give it up – Hang up and do not try again	(2) 儘力確認電話號碼 - 再次核對電話號碼 - 留下明確的訊息 (1) 意識到你記錄的電話號碼可能錯誤 - 致電予一位共同認識的朋友 - 寫信給你的朋友 (0) 沒有意識到錯誤的可能性或是放棄算了 - 掛線及不再嘗試	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Question	10. You are leaving the house with just enough time to arrive at an appointment on time. You glance down. Peeking from your pants are your socks – one is blue and the other is black. What do you do?	10. 你匆匆離家並僅夠時間趕及一個約會。當你向身下一瞥，發覺穿上一隻藍色襪子，一隻黑色襪子。你會怎麼辦？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Solve the problem immediately – Go back home and change your socks and call to inform people of potential tardiness (1) Try to manage the situation without solving the actual problem – Go to your appointment. Explain it. (0) Ignore the problem – Go to your appointment and hope nobody notices – Take them off (this alternative could be worth 2	(2) 立即解決問題 - 回家替換你的襪子和致電通知他人有機會延誤 (1) 嘗試應付局面，但沒有解決實際問題 - 直接赴會；並解釋情況 (0) 置問題不理 - 直接赴會；並希望沒有人會注意	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:

	points if the participant clearly indicates that the appointment is in a setting where casual dress is appropriate)	到 - 脫掉襪子（如果參與者清楚地表明休閒服飾合符約會的環境，此方法可值 2 分）	
Question	11. What is the thing to do if you find an envelope in the street that is sealed, addressed, and has a new stamp?	11. 如果你在街上發現一個已封口、填上地址及貼上新郵票的信封，你該怎樣做？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Recognition that the letter should be put into the mail immediately – Return it to the post office . . . Mail it . . . Drop it in the nearest box . . . Give it to the postman (1) Recognition that the letter is the property of someone else, but a poor idea as to the disposition of it – Give it to a policeman . . . Take it to the dead letter office . . . Try to find the owner (0) No idea of what to do with the letter or that the letter is the property of someone else – Leave it alone . . . Open it	(2) 明白應立即把該信件放入郵箱 - 把它送回郵局・・・・寄出・・・・放入就近郵箱・・・・交給郵差 (1) 明白該信件為他人財物；但處理方法並不妥善 - 交給警察 ... 送往無法郵遞信件辦事處 ... 嘗試尋找物主 (0) 不懂如何處理或不知道該信件為他人財物 - 置諸不理. . . 打開信件	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Question	12. What should you do if while in the movies you are the first person to see smoke and fire?	12. 在電影播放途中，您如果是第一人發現有煙火，你該怎樣做？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Recognition that a person in authority on the scene, such as a manager or usher, should be notified – Report it to an usher . . . Report it to the manager . . . Tell the ticket taker (1) Recognition that action, though not so	(2) 明白應通知現場的負責人，如經理或帶位員 - 通知帶位員 ... 通知經理 ... 通知點票員 (1) 明白應採取行動（雖則非即時有效）	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:

	immediately effective, should be taken – Ring the fire alarm . . . Try to put the fire out or call the fire department. (0) Description of actions which would create a panic or would not avert disaster – Shout, “Fire!” . . . I’d try my best to get out . . . Stay calm (Q) . . . Warn the other people (Q) . . . Run out . . . Walk to the nearest exit . . . Go for water	- 打響火警鐘...嘗試把火撲滅，或致電消防處。 (0) 描述作出一些會引致恐慌，或不能避免災難的行動 - 喊叫，"著火啊！"... 我會盡力走出去 ... 保持冷靜 (Q)...警告其他人 (Q)...跑出去 ... 行到最近的出口...盡力取得水	
Question	13. If you were lost in the forest in the daytime, how would you go about finding your way out?	13. 如果你於白天在森林迷路，你將怎樣找到你的出路？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Any explained use of natural phenomena in order to find a way out, or a systematic approach to the problem – Try to go in one direction by using the sun (stream, moss) . . . Get your direction from the sun . . . Use of a watch as a compass (explained fully) . . . Look for a stream or path and follow it to avoid circles (1) Mention of a haphazard means of getting out, or a partial 2-point response unexplained – By the sun (Q) . . . Moss (Q) . . . Follow a stream (Q) . . . Follow a path (Q) . . . Walk in the direction of the sun (Q) . . . Climb to the top of the tallest tree and try to locate a landmark . . . Look for landmarks for bearings (Q) (0) Use of unreliable or senseless phenomena, or reliance on people – Try to find a policeman to help you find your way out . . . Keep on walking . . . Try to find the	(2) 任何透過解釋以運用自然現象找到出路，或有系統地處理問題 - 利用太陽嘗試往一個方向走（或溪流、或青苔）. . . 利用太陽取得你的方向 . . . 以手表用作指南針(詳盡解釋) ...尋找溪流或小徑，沿著走以避免繞圈 (1) 提及一些雜亂無章的走出方案，或部分以上(2 分)的回應但缺少解釋 - 靠太陽 (Q)... 青苔 (Q)...沿著溪流 (Q)...沿著小徑 (Q)... 沿太陽的方向 (Q)...爬到最高的樹的頂部，並嘗試查找一個地標...尋找地標定方位 (Q) (0) 使用不可靠或無知的現象，或依賴他	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:

	way you got in . . . Wait for a forest ranger . . . I usually watch the way I go in and follow the moon . . . I would shout	人 - 嘗試找一個警員來幫你找出路...繼續前行...嘗試尋找原先進來的路徑. . . 等候森林管理員..我通常察看我進來的路，並跟從月亮...我會喊叫	

Remark: Items 11–13 are taken verbatim from the WAIS–R (Wechsler, 1981) by the developer.

A 5.4 Content Validity Questionnaire

Content Validity Questionnaire for Original English and Translated Chinese Versions of Problem in Everyday Living Test (PEDL)

The followings are the original English and the translated Chinese version of the PEDL.
Please share your opinions about the content validity of PEDL as a test to *measure the ability of solving practical problem*s that occur in everyday life for elderly population

Each of items is placed on a 4-point Likert scale as:
1= totally irrelevant
2= the item needs major revision to be relevant
3= the item needs minor revision to be relevant
4= relevant
Please check the number that best reflects the extent of relevance to which the item is. Comments areas are provided. Please give your recommendations for revising the items with a rating less than 4

	Original English Version	Translated Chinese Version	Rating of Content Validity
Question	1. You notice your dog is limping. What do you do?	1. 當察覺你的犬隻行起來一瘸一拐的時候，你會怎麼辦？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Get an idea of what could be done before starting further actions – Check the dog's paw – Observe the dog (1) Do something which leads to a solution without checking alternatives first. – Call the veterinarian – Rush the dog to the veterinarian (0) Start actions, which do not refer to the problem, or even doing nothing. – Feed him – Ignore it	(2) 於採取進一步行動前，先瞭解情況 - 檢查犬隻的腳爪 - 觀察犬隻 (1) 直接採取行動以達到解決方案，而事先沒有尋求其他解決方法 - 致電予獸醫 - 匆忽帶犬隻前往獸醫診所 (0) 開始行動（與問題無關），或甚至不採取任何行動 - 餵它	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:

		- 不理會它	
Question	2. Last month, you purchased a new coffee maker. It worked well for about three weeks, but now the burner does not heat up. What do you do?	2. 你在上個月購買了一台新的咖啡機。但經過約三個星期的良好操作後，它的發熱器便熱不起來。你會怎麼辦？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Recognize the responsibility of the seller or producer – Return it to the place where it was purchased – Try to find the warranty card and follow instructions for sending it off for repair – Take apart and fix, with knowledge of electronics (1) Any actions which lead to a solution of the problem neglecting the producer’s responsibility – Take it apart and see if you can fix it, without knowledge of electronics – Throw it out and buy a new one (0) Avoid a solution of the problem by adapting to the situation – Adapt yourself to a burned-out burner	(2) 清楚賣家或製造商的責任 - 退回購買咖啡機的地點 - 嘗試尋找保養證，按保養證上指示把咖啡機送回安排維修 - 根據自己對電子認識，嘗試拆開並進行維修 (1) 不理會製造廠的責任,作出任何能解決問題的行動 - 不管自己對電子毫無認識，嘗試把它拆開並進行維修 - 扔掉它並買一台新咖啡機 (0) 以適應當前形勢來避免解決問題 - 使自己適應使用一個燒壞了的發熱器 (咖啡機)	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Question	3. You look at the calendar and realize a good friend’s birthday was last week. You forgot to send her a card. What do you do?	3. 你看日曆時發覺上星期為你好友的生日，而你忘了送一張賀卡給她◦你會怎麼辦？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Admit that you forgot and contact the friend – Call and apologize – Send a belated card (1) Contact the friend, but do not admit that you forgot	(2) 承認自己忘記了，並聯絡好友 - 致電好友道歉 - 送出遲來的賀咭 (1) 聯繫朋友，但不承認自己忘了	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:

	– Pretend you sent one (0) Avoid any contact with the problem – Ignore it and hope she does not notice or will not care	- 假裝已送出賀咭 (0) 避免任何觸及有關問題 - 不理會有關問題，並希望她沒有注意或不會在意	
Question	4. Your usual breakfast consists of: a bowl of cereal with milk, a glass of orange juice and a cup of coffee. One morning you go to make your breakfast and find out you don’t have any milk. What do you do?	4. 通常你的早餐包括：一碗牛奶麥片、一杯橙汁及一杯咖啡。一天早晨， 當你正預備做早餐時發覺沒有牛奶，你會怎麼辦？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Try alternatives – Have something else for breakfast (1) Get a solution without changing your habits – Borrow a cup of milk from the neighbor – Go out and buy milk (0) Have your usual breakfast without solution of the problem – Eat your cereal dry	(2) 嘗試其他選擇 - 以其他食物作早餐 (1) 作出一個解決方案而無需改變您的習慣 - 向鄰居借一杯牛奶 - 外出購買牛奶 (0) 在沒有解決問題情況下，繼續吃慣常的早餐 - 乾吃麥片	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Question	5. You are taking a college class for credit. After three weeks, you have to miss a class session because of illness, but you are able to return after missing that one class. What do you do?	5. 你正在上一個大學學分課程。三星期後，你因病缺席一堂課，但錯過這堂後，你可補回該堂課程。你會怎麼辦？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Recognize the need to get information about the missed class – Ask the instructor – Ask a classmate (1) Try to prepare on your own – Make sure you have read the text	(2) 知道要取回缺課的資料 - 向講師查詢 - 向同學查詢 (1) 嘗試自己準備	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:

	(0) Omit any effort to make up for the next lesson – Drop the course – Hope the information you missed will not be asked on the next test	- 確定自己已閱讀相關課本 (0) 不會作任何努力以彌補缺席課程 - 退選該課程 - 希望錯過的資料於下次測驗中不會問及	
Question	6. You find a letter in your mailbox that has been mis-delivered. It should have been placed in your next-door neighbor's mailbox. What do you do?	6. 你在信箱發現一封郵遞錯誤的信件，該信件應是投入你隔壁鄰居的信箱的。你會怎麼辦？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Realize that it needs to be taken to your neighbor – Call them and let them know you have their mail – Go to neighbor's house and give them the mail – Write "Delivered to wrong address" on the envelope (1) Recognize that it is another person's property – Call the neighbor to have them come get the letter (0) Actions that don't lead to an immediate solution – Open the letter – Throw it out	(2) 明白應把信件送回鄰居 - 致電給鄰居，通知他你管有他的信件 - 前往鄰居的家，把信件送回 - 於信封寫上"郵遞錯誤"並退回信件 (1) 理解信件為他人財物 - 致電給鄰居，通知他前來取回他的信件 (2) 作出沒有導致即時解決問題的行動 - 打開那信件 - 扔掉它	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Question	7. You receive your monthly bank statement on your checking account. When you try to reconcile your checkbook with the bank statement, you find that the bank says you have $100 more than your checkbook balance shows. What do you do?	7. 你收到了支票帳戶的銀行月結單。當您嘗試把支票簿和月結單作複核時，你發現支票戶口結餘比支票簿結餘記錄高出$100。你會怎麼辦？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring	(2) Recognize that it is possibly not your	(2) 明白這可能不是屬於你的錢，並設法	1 ☐ 2 ☐ 3 ☐ 4 ☐

reference	money and try to solve it immediately – Double check your math – Call the bank (1) Recognize that it is possibly not your money and that you are not allowed to spend it. – Set it aside, don't spend it (0) No recognition of the problem and further consequences – Spend it	立即解決問題 - 再次核對你的計算 - 致電給銀行 (1) 明白這可能不是屬於你的錢，你不能使用 - 放在一邊，不會使用 (0) 不明白問題所在及進一步後果 - 用掉它	Comment:
Question	8. A. It is Friday evening. You discover that your oven is not working. What do you do? B. It is Friday evening. You discover that your freezer has stopped working sometime within the past day or two. The freezer is full, and you have several hundred dollars worth of meat and other expensive items. What do you do?	8.A. 現在是星期五黃昏，你發現焗爐失靈。你會怎麼辦？ B. 現在是星期五黃昏，你發現電冰箱已於一兩天前的某時段失靈了。電冰箱內載滿數百元的肉類及昂貴物品。你會怎麼辦？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Get a solution with a minimum amount of costs which could imply personal contact A – Wait until Monday; use the microwave A – Ask your neighbors if you can use their oven B – Try to move all the food and wait until Monday A or B – Fix them, with knowledge of appliance repair (1) Solution with no respect to the costs – Call an appliance repair service – Buy a new one (0) Adapt yourself to the situation without solving the problem – Live without it indefinitely	(2) 以最低的成本達到解決方法(與人接觸亦計算在內) A - 使用微波爐；等候到下星期一 A - 問你的鄰居可否使用他們的焗爐 B - 嘗試將所有食物移走，並等候到下星期一 A or B – 以修理家電的認識，進行修理 (1) 不計較成本的解決方法 - 電召家電維修服務 - 買一個新的 (0) 不去解決問題，使自己適應這種情況 - 繼續如常生活，縱使以後沒有該家電使用	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:

Question	9. You have a friend you speak to only every two months or so. One day you call her, and a machine answers. A recorded voice you do not recognize asks you to lease a message. What do you do?	9. 你有一位朋友，你和她只會每兩個月左右才談上一次話。有一天你致電給她，只得電話錄音回應。一把你不認識的錄音要求你留言。你會怎麼辦？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Make an effort to confirm the number – Double check the number – Leave a qualified message (1) Realize that you might have the wrong number – Call a mutual friend – Write a letter to a friend (0) Do not recognize the possibility of a failure or give it up – Hang up and do not try again	(2) 儘力確認電話號碼 - 再次核對電話號碼 - 留下明確的訊息 (1) 意識到你記錄的電話號碼可能錯誤 - 致電予一位共同認識的朋友 - 寫信給你的朋友 (0) 沒有意識到錯誤的可能性或是放棄算了 - 掛線及不再嘗試	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Question	10. You are leaving the house with just enough time to arrive at an appointment on time. You glance down. Peeking from your pants are your socks – one is blue and the other is black. What do you do?	10. 你匆匆離家並僅夠時間趕及一個約會。當你向身下一瞥，發覺穿上一隻藍色襪子，一隻黑色襪子。你會怎麼辦？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Solve the problem immediately – Go back home and change your socks and call to inform people of potential tardiness (1) Try to manage the situation without solving the actual problem – Go to your appointment. Explain it. (0) Ignore the problem – Go to your appointment and hope nobody notices – Take them off (this alternative could be worth 2 points if the participant clearly indicates that the	(2) 立即解決問題 - 回家替換你的襪子和致電通知他人有機會延誤 (1) 嘗試應付局面，但沒有解決實際問題 - 直接赴會；並解釋情況 (0) 置問題不理 - 直接赴會；並希望沒有人會注意到	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:

	appointment is in a setting where casual dress is appropriate)	- 脫掉襪子（如果參與者清楚地表明休閒服飾合符約會的環境，此方法可值 2 分）	
Question	11. What is the thing to do if you find an envelope in the street that is sealed, addressed, and has a new stamp?	11. 如果你在街上發現一個已封口、填上地址及貼上新郵票的信封，你該怎樣做？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Recognition that the letter should be put into the mail immediately – Return it to the post office . . . Mail it . . . Drop it in the nearest box . . . Give it to the postman (1) Recognition that the letter is the property of someone else, but a poor idea as to the disposition of it – Give it to a policeman . . . Take it to the dead letter office . . . Try to find the owner (0) No idea of what to do with the letter or that the letter is the property of someone else – Leave it alone . . . Open it	(2) 明白應立即把該信件放入郵箱 - 把它送回郵局・・・・寄出・・・・放入就近郵箱・・・・交給郵差 (1) 明白該信件為他人財物；但處理方法並不妥善 - 交給警察 ... 送往無法郵遞信件辦事處 ... 嘗試尋找物主 (0) 不懂如何處理或不知道該信件為他人財物 - 置諸不理. . . 打開信件	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Question	12. What should you do if while in the movies you are the first person to see smoke and fire?	12. 在電影播放途中，您如果是第一人發現有煙火，你該怎樣做？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Recognition that a person in authority on the scene, such as a manager or usher, should be notified – Report it to an usher . . . Report it to the manager . . . Tell the ticket taker (1) Recognition that action, though not so immediately effective, should be taken	(2) 明白應通知現場的負責人，如經理或帶位員 - 通知帶位員 ... 通知經理 ... 通知點票員 (1) 明白應採取行動（雖則非即時有效） - 打響火警鐘...嘗試把火撲滅，或致	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:

	– Ring the fire alarm . . . Try to put the fire out or call the fire department. (0) Description of actions which would create a panic or would not avert disaster – Shout, “Fire!” . . . I’d try my best to get out . . . Stay calm (Q) . . . Warn the other people (Q) . . . Run out . . . Walk to the nearest exit . . . Go for water	電消防處。 (0) 描述作出一些會引致恐慌，或不能避免災難的行動 - 喊叫，"著火啊！"… 我會盡力走出去 … 保持冷靜 (Q)...警告其他人 (Q)...跑出去 … 行到最近的出口...盡力取得水	
Question	13. If you were lost in the forest in the daytime, how would you go about finding your way out?	13. 如果你於白天在森林迷路，你將怎樣找到你的出路？	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:
Scoring reference	(2) Any explained use of natural phenomena in order to find a way out, or a systematic approach to the problem – Try to go in one direction by using the sun (stream, moss) . . . Get your direction from the sun . . . Use of a watch as a compass (explained fully) . . . Look for a stream or path and follow it to avoid circles (1) Mention of a haphazard means of getting out, or a partial 2-point response unexplained – By the sun (Q) . . . Moss (Q) . . . Follow a stream (Q) . . . Follow a path (Q) . . . Walk in the direction of the sun (Q) . . . Climb to the top of the tallest tree and try to locate a landmark . . . Look for landmarks for bearings (Q) (0) Use of unreliable or senseless phenomena, or reliance on people – Try to find a policeman to help you find your way out . . . Keep on walking . . . Try to find the way you got in . . . Wait for a forest ranger . . . I	(2) 任何透過解釋以運用自然現象找到出路，或有系統地處理問題 - 利用太陽嘗試往一個方向走 （或溪流、或青苔）. . . 利用太陽取得你的方向 . . . 以手表用作指南針(詳盡解釋) ...尋找溪流或小徑，沿著走以避免繞圈 (1) 提及一些雜亂無章的走出方案，或部分以上(2 分)的回應但缺少解釋 - 靠太陽 (Q)... 青苔 (Q)...沿著溪流 (Q)...沿著小徑 (Q)... 沿太陽的方向 (Q)...爬到最高的樹的頂部，並嘗試查找一個地標...尋找地標定方位 (Q) (0) 使用不可靠或無知的現象，或依賴他人	1 ☐ 2 ☐ 3 ☐ 4 ☐ Comment:

	usually watch the way I go in and follow the moon . . . I would shout	- 嘗試找一個警員來幫你找出路...繼續前行...嘗試尋找原先進來的路徑. . . 等候森林管理員..我通常察看我進來的路，並跟從月亮...我會喊叫	

Remark: Translated with permission from the publisher.

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Appendix 6　Chapter 5
Final versions of C-PEDL and rating criteria

C-PEDL and rating criteria

日常生活難題測試 (C-PEDL)

給參與者讀出問題，並將題目印刷於咭紙上以便參加者閱覽。
咭紙上僅會印上擬測試的問題，可能的答案及參加者所得分數只會列舉如下:

1. 當察覺你的犬隻行起來一瘸一拐的時候，你會怎麼辦？

(2) 於採取進一步行動前，先瞭解情況
- 檢查犬隻的腳爪
- 觀察犬隻

(1) 直接採取行動以達到解決方案，而事先沒有尋求其他解決方法
- 致電予獸醫
- 忽忽帶犬隻前往獸醫診所

(0) 開始行動（與問題無關），或甚至不採取任何行動
- 餵它
- 不理會它

2. 你在上個月購買了一個新的電熱水壺。但經過約三個星期的良好操作後，

它的發熱器便熱不起來。你會怎麼辦？

(2) 清楚賣家或製造商的責任
- 退回購買電熱水壺的地點
- 嘗試尋找保養證，按保養證上指示把電熱水壺送回安排維修
- 根據自己對電子認識，嘗試拆開並進行維修

(1) 不理會製造廠的責任，作出任何能解決問題的行動
- 不管自己對電子毫無認識，嘗試把它拆開並進行維修
- 扔掉它並買一台新電熱水壺

(0) 以適應當前形勢來避免解決問題
- 使自己適應使用一個燒壞了的電熱水壺

3. 你看日曆時發覺上星期為你好友的生日，而你忘了祝賀她 。
你會怎麼辦？

(2) 承認自己忘記了，並聯絡好友
- 致電好友道歉
- 送出遲來的祝賀

(1) 聯繫朋友，但不承認自己忘了

- 假裝已聯絡過好友

(0) 避免任何觸及有關問題

- 不理會有關問題，並希望她沒有注意或不會在意

4. **通常你的早餐會吃一碗麥皮 。一天早晨，當你正預備做早餐時發覺沒有水，你會怎麼辦？**

(2) 嘗試其他選擇

- 以其他食物作早餐

(1) 作出一個解決方案而無需改變您的習慣

- 向鄰居借一些水
- 外出購買一瓶水

(0) 在沒有解決問題情況下，繼續吃慣常的早餐

- 乾吃麥皮

5. **你正在上一個你非常喜歡的興趣班，但每一課是密切相關的，你需要出席每一堂課才能明白下一課。三星期後，你因病缺席一堂課◦你會怎麼辦？**

(2) 知道要取回缺課的資料

- 向講師查詢
- 向同學查詢

(1) 嘗試自己準備

- 確定自己已閱讀相關課本

(0) 不會作任何努力以彌補缺席課程

- 退選該課程
- 希望錯過的資料於下次測驗中不會需要

6. **你在信箱發現一封郵遞錯誤的信件，該信件應是投入你隔壁鄰居的信箱的。你會怎麼辦？**

(2) 明白應把信件送回鄰居

- 致電給鄰居，通知他你管有他的信件
- 前往鄰居的家，把信件送回
- 於信封寫上"郵遞錯誤" 並退回信件

(1) 理解信件為他人財物

- 致電給鄰居，通知他前來取回他的信件

(0) 作出沒有導致即時解決問題的行動

- 打開那信件
- 扔掉它

7. **當您查看您的銀行存摺，你發現你的銀行儲蓄帳戶多了 $10,000 元 。你會怎麼辦？**

(2) 明白這可能不是屬於你的錢，並設法立即解決問題

- 再次核對你的計算

- 致電給銀行

(1) 明白這可能不是屬於你的錢，你不能使用
- 放在一邊，不會使用

(0) 不明白問題所在及進一步後果
- 用掉它

8. A. **現在是星期六黃昏，你發現煤氣爐壞了，無法煮食。你會怎麼辦？**
B. **現在是星期六黃昏，你發現電冰箱已於一兩天前的某時段失靈了。電冰箱內載滿數百元的肉類及昂貴食品。你會怎麼辦？**

(2) 以最低的成本達到解決方法（與人接觸亦計算在內）
A - 暫時使用微波爐；等候到下星期一
A - 找你的鄰居或朋友幫忙
A - 暫時出外用膳
B - 嘗試將所有食物移走，並等候到下星期一
A or B – 以修理家電的認識，進行修理

(1) 不計較成本的解決方法
- 電召家電維修服務
- 買一個新的

(0) 不去解決問題，使自己適應這種情況
- 繼續如常生活，縱使以後沒有該家電使用

9. **你有一位好朋友，你和她只會每兩個月左右才談上一次話。有一天你致電給她，只得電話錄音回應要求你留言，但你知道這位朋友從來沒有電話錄音。你會怎麼辦？**

(2) 儘力確認電話號碼
- 再次核對電話號碼
- 留下明確的訊息，請您的朋友回電

(1) 意識到你記錄的電話號碼可能錯誤
- 致電予一位共同認識的朋友

(0) 沒有意識到錯誤的可能性或是放棄算了
- 掛線及不再嘗試

10. **你匆匆離家並僅夠時間趕及一個重要約會。當你向身下一看，發覺穿上一隻藍色襪子，一隻黑色襪子。你會怎麼辦？**

(2) 立即解決問題
- 回家替換你的襪子和致電通知他人有機會延誤

(1) 嘗試應付局面，但沒有解決實際問題
- 直接赴會；並解釋情況

(0) 置問題不理
- 直接赴會；並希望沒有人會注意到
- 脫掉襪子（如果參與者清楚地表明休閒服飾合符約會的環境，此

方法可值 2 分）

11. **如果你在街上發現一張別人遺下的證件，你該怎樣做？**

(2) 明白應立即把該證件送回失主

- 交給警察. . . 嘗試尋找物主

(1) 明白該信件為他人重要財物；但處理方法並不妥善
- 把它送回郵局・・・・放入就近郵箱・・・・交給郵差

(0) 不懂如何處理或不知道該信件為他人財物

- 置諸不理. . . 扔掉它

12. **在電影播放途中，您如果是第一人發現有少處煙火，你該怎樣做？**

(2) 明白應通知現場的負責人，如經理或帶位員
- 通知帶位員 . . . 通知經理 . . . 通知點票員

(1) 明白應採取行動（雖則非即時有效）
- 打響火警鐘...嘗試把火撲滅，或致電消防處。

(0) 描述作出一些會引致恐慌，或不能避免災難的行動
- 喊叫，"著火啊 ！"… 我會盡力走出去 … 保持冷靜 (Q)...警告 其 他人 (Q)...跑出去 … 行到最近的出口...盡力取得水

13. **如果你於白天在行山時迷路，你將怎樣找到你的出路？**

(2) 任何透過解釋以運用自然現象找到出路，或有系統地處理問題
- 利用太陽嘗試往一個方向走 （或溪流）. . . 利用太陽取得你的方向 . . . 以手表用作指南針(詳盡解釋) ...尋找溪流或小徑，沿著走以避免繞圈

(1) 提及一些雜亂無章的走出方案，或部分以上 (2 分) 的回應但缺少解釋

- 靠太陽 (Q)...沿著溪流 (Q)...沿著小徑 (Q)... 沿太陽方向 (Q)...爬到最高的樹的頂部，並嘗試查找一個地標...尋找地標定方位 (Q)

(0) 使用不可靠或不合理的的現象，或依賴他人
- 嘗試找一個警員來幫你找出路...繼續前行...嘗試尋找原先進來的路徑. . . 等候森林管理員..我通常察看我進來的路，並跟從月亮...我會喊叫

---- 完 ---

Appendix 7 Study Information Sheet

A 7.1 Information Sheet (English Version)

PROJECT TITLE: Effect of Functional Task Exercise Program on Older Adults with Cognitive Impairment at Risk of Alzheimers Disease – A randomized Control Trial

You are invited to take part in a research project about examining the Effect of a Functional Task Exercise Program on Older Adults with Cognitive Impairment at Risk of Alzheimers Disease. The study is being conducted by Lan Fong Law and will contribute to the Doctor of Philosophy in Rehabilitation Science at James Cook University.

About the Study
This study involves a 10-week (3 sessions per week, 1 hour per session) functional task exercise program conducted in your home by an occupational therapist/ trained researcher and your caregiver trained by a qualified therapist/ researchers. If you meet the eligibility criteria and agree to participate in the study, you will be invited to undergo tests before the study starts, and after 10 weeks and then again at 3 month follow up (called pre-tests, post-tests and follow-up tests). The tests, with your consent, should only take approximately 1 hour of your time and will be conducted at Launceston General Hospital.

After the pre -tests and if you remain willing and eligible to be in the study, you will be randomly assigned into either an exercise group or a non-exercise group.
If you are in the exercise group, you will be visited by therapists in your home. For the first 4 weeks, visiting sessions will be scheduled twice weekly, followed by weekly session for 4 weeks, then biweekly sessions for the last 2 weeks. At the first visit of the week, exercises will be first demonstrated by the exercise trainer, then practice by you while your caregiver/ exercise buddy observes and assists. The trainer will work together with your caregiver to ensure that exercises are being practiced safely and correctly by you. During the second visit of the week, your caregiver will model the teaching of the trainer with you in the presence of the trainer. On days when the researcher is not visiting, your caregiver will continue to encourage and assist you in performing the functional task exercises taught by the trainer. Your caregiver and you are required to maintain a Physical Activity Log of practice to detail the exercise progress, problems encountered and other comments.

If you are in the non-exercise group, you will be put on a waitlist and will continue with your usual routine medical care. After completing the exercise program and post- tests, the researcher will analyze and interpret the data and invite you to a presentation of the findings. Members of the non-exercise group will be given the opportunity to participate in the same exercise program after completion of the study.

Taking part in this study is completely voluntary and you can stop taking part in the study at any time without explanation or prejudice. You may also withdraw any unprocessed data from the study.

Your responses and contact details will be strictly confidential. The data from the study will be used in research publications and reports to Education Queensland. You will not be identified in any way in these publications.

If you have any questions about the study, please contact Lan Fong Law (Principal Investigator) **or** Samantha Leung (Occupational Therapist II) **or** Dr. Fiona Barnett (Supervisor)**.**

Principal Investigator:

Lan Fong Law
Occupational Therapy Discipline
School of Public Health, Tropical Medicine & Rehabilitation Sciences
James Cook University
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Email: lan.law@jcu.edu.au

Co-investigator:

Samantha Leung
Occupational Therapist II,
United Christian Hospital,
Hong Kong
Phone: 3513 4675

Supervisor:

Dr. Fiona Barnett
Senior Lecturer, Occupational Therapy Discipline
School of Public Health, Tropical Medicine & Rehabilitation Sciences
James Cook University
Phone: 07 4781 6678
Email: fiona.barnett@jcu.edu.au

A 7.2 Information Sheet (Chinese Version)

計劃介紹

主題: 功能作業運動對輕度認知功能障礙長者的成效之隨機對照試驗

閣下被邀請參加一個有關研究「功能作業運動對輕度認知功能障礙長者的成效」的項目。

這項研究是由「基督教聯合醫院職業治療部」與「澳洲昆士蘭詹姆斯庫克大學」合作。此研究項目將由職業治療師「羅蘭芳」姑娘負責進行及作為其在「澳洲昆士蘭詹姆斯庫克大學」康復科哲學博士的部份。

研究簡介

這項研究包括 10 週（每週 3 節，每節 1 小時）的「功能作業運動」。

如果您符合資格並同意參與研究，你將被邀請進行訓練前評估，相同的測試將重複於第 11 - 12 週及在訓練完成後三個月後的跟進覆診（所謂的預測試，後期測試和後續測試）。如果你同意，這些測試將會在「基督教聯合醫院職業治療部」進行，需時約 1 小時。

如你在預測試後仍然符合資格並同意參與研究，你會被隨機分配入「功能作業運動組」或現有的「認知訓練組」。
「功能作業運動組」，開始第 1 至 4 週，將安排每週兩次門診練習及每週一次在家裡繼續的照顧者支家居練習；接著第 5 至 8 週是每週一次的門診練習及每週兩次的家居練習；最後第 9 至 10 週是每兩週一次的門診練習及繼續家居練習，以達到保持每週三次的運動的目標。

在門診練習，治療師將首先示範及指導訓練，而你的照顧者同時觀察、學習和協助訓練，治療師會特別強調及訓練你的照顧者/運動訓練夥伴以確保練習實行時的安全和準確。。如果你是在非運動組，你將被安排一組認知訓練，並繼續原有標準的培訓。此訓練計劃完成後，研究人員將分析和解釋數據，並邀請您出席研討會介紹研究結果。

參加這項研究與否完全為自願性質，你可以在任何時候亦無需附上任何解釋下停止參與此項研究，您也可以撤回任何未處理的數據研究。

可能遇到的不適和風險

由於運動量的增加，您可能會感到輕微不適如肌肉酸痛或疲勞等。

如遇上任何不尋常的跡象或不適請立即停止運動並告知治療師與照顧者。所有的治療活動將施行於你的「舒適區」界限內，你應不會感到過度疲勞或超出你認為是安全的界限，**你可在任何時候自由終止任何活動**。

其他不排除的未知風險包括：肌肉扭傷或撕裂、關節扭傷、滑倒、跌倒、心臟病發作。因此為了減少這些可能性，在此項活動開始之前，我們需要你填報「體能活動適應能力問卷(PAR-Q) 」如有需要，我們會諮詢醫生的意見和要求收到確定你健康狀況適宜參與運動的「體檢合格證明」。此外治療師和你的照顧者都必須特別注意進行活動的地點安全，並按照安全指引執行運動訓練。

這項研究的數據將用於研究報告、醫療刊物和昆士蘭教育報告，你的資料將被嚴格保密，並絕對不會以任何方式在這些報告或刊物被透露。

閣下如對這項研究有任何問題，請聯繫:
職業治療師「羅蘭芳」姑娘
電話號碼： 35134680
電郵地址：lan.law@my.jcu.edu.au
或
基督教聯合醫院職業治療部二級職業治療師
職業治療師梁美玲姑娘
電話號碼：3513 4675
或
澳洲昆士蘭詹姆斯庫克大學教學導師：
菲奧娜・巴內特博士 (Dr. Fiona Barnett)
電話號碼：(61) 07 4781 6678
電郵地址：fiona.barnett@jcu.edu.au

若您對作為研究參與者所享有的權利有任何疑問，請聯絡九龍中/東聯網臨床研究倫理委員會 電話:2958 6623。

Appendix 8 Consent Form

A 8.1 Informed Consent Form (English version)

Project Title: Effect of Functional Task Exercise Program on Older Adults with Cognitive Impairment at Risk of Alzheimers Disease – A randomized Controlled Trial

Principal Investigator: Lan Fong Law

I understand the aim of this research study is to examining the *Effect of a Functional Task Exercise Program on Older Adults with Cognitive Impairment at Risk of Alzheimer's Disease.*

I consent to participate in this project, the details of which have been explained to me, and I have been provided with a written information sheet to keep.

I understand that my participation will involve a home-based 10–week functional task exercise program, pre-tests, post-tests and follow-up tests and I agree that the researcher may use the results as described in the information sheet.
I acknowledge that:

- any risks and possible effects of participating in the 10–week functional task exercise program, pre-tests, post-tests and follow-up tests have been explained to my satisfaction;
- taking part in this study is voluntary and I am aware that I can stop taking part in it at any time without explanation or prejudice and to withdraw any unprocessed data I have provided;
- that any information I give will be kept strictly confidential and that no names will be used to identify me with this study without my approval;

(Please tick to indicate consent)

I consent to participate in home-based 10-week functional task exercise program		**Yes**		**No**
I consent to participate in pre-tests conducted in Launceston General Hospital		**Yes**		**No**
I consent to participate in post-tests conducted in Launceston General Hospital		**Yes**		**No**
I consent to participate in follow-up tests conducted in Launceston General Hospital		**Yes**		**No**
I consent to provide Medical Clearance for participation in the study from my Doctor		**Yes**		**No**

Participant:

Name: *(printed)*	
Signature:	**Date:**

Caregiver:

Name: *(printed)*	
Signature:	**Date:**

A 8.2 Informed Consent Form (Chinese version)

參與研究活動同意書

研究主題: 功能作業運動對輕度認知功能障礙長者的成效之隨機對照試驗

合辦機構: 「基督教聯合醫院職業治療部」與「澳洲昆士蘭詹姆斯庫克大學」
研究員: 「羅蘭芳」姑娘

本人明白並了解此研究的目的是研究「功能作業運動對輕度認知功能障礙長者的成效」。
本人同意參與此研究項目，有關詳情已向我解釋清楚和提供了書面資料。
本人同意及明白我的參與將包括 10 個星期的「功能作業運動」配合由我的照顧者協助的家居練習環節及預測試、後期測試和後續的測試。
本人同意研究員可使用這些結果於研究報告、醫療刊物和昆士蘭教育報告。

本人確認：
1. 參與這項研究項目的相關風險及影響已向我解釋清楚
2. 參與這項研究是自願性質，我知道我可以在任何時候亦無需附上任何解釋下停止參與此項研究，也可以撤回任何未處理的數據研究
3. 我的資料將被嚴格保密，並絕對不會以任何方式在這些報告或刊物被透露

本人同意參與 10 個星期的「功能作業運動」配合由我的照顧者協助的家居練習環節		是		否
本人同意參與在基督教聯合醫院進行的預測試		是		否
本人同意參與在基督教聯合醫院進行的後期測試		是		否
本人同意參與在基督教聯合醫院進行的後續測試		是		否
本人同提供確定健康狀況適宜參與運動的「體檢合格證明」		是		否

參加者：

姓名:	
簽署：	日期：

照顧者：

姓名:	
簽署：	日期：

Appendix 9 Demographic Data Sheets and Assessment Summary Form

A 9.1 Demographic data sheet

Name: ___________________ **Date:** _________________ **Code:**_______________
D.O.B.: __________________ **Age:**__________________ **Sex:** □ Female □ Male

Education level: □ Illiterate □ Educated (Years of education): _________________

Marital status: □ Married □ Never married □ Widow/widower □ Separated
□ Divorced
Accommodation: □ Live with family □ Live with friend □ Live alone
Employment status: □ Retired □ Homemaker
Ambulatory level: □ Unaided walker □ Cane □ Frame

Initial screen cognitive status:
Global Deterioration Scale score: ______________
CMMSE Score:________________

Initial screen functional status:
ADL: BI__________________
IADL: Lawton IADL________________

GDS-15 score: _________________

Lifestyle History & other Medical Information:

Exercise Pattern: □ None □ Less than 30 minutes/day □ More than 30 minute /day
Smoking: □ Never □ Quit □ Current: ________________ pack/day
Alcohol: □ Never □ < 1 time/wk □ 1-2 times/wk □ > 3 times/wk
Height: ________________
Weight: ________________
Body Mass Index (BMI):_________________
Blood Pressure: _________________
Medication: □ None □ 1. _______________________ 2. ________________________
3. _______________________ 4.________________________
5. _______________________ 6.________________________
7. _______________________ 8.________________________
9. _______________________10.________________________

Disease Checklist

1. Stroke	**1. Y**	**2. N**	**3. NA**
2. Head Injury	**1. Y**	**2. N**	**3. NA**
3. Diabetes Mellitus	**1. Y**	**2. N**	**3. NA**
4. Heart Disease	**1. Y**	**2. N**	**3. NA**
5. Hypertension	**1. Y**	**2. N**	**3. NA**
6. COAD	**1. Y**	**2. N**	**3. NA**
7. Parkinsonism	**1. Y**	**2. N**	**3. NA**
8. Previous hip fractures	**1. Y**	**2. N**	**3. NA**
9. Previous hip fractures with hip replacement	**1. Y**	**2. N**	**3. NA**
10. Chronic Pain:	**1. Y**	**2. N**	**3. NA**
11. Knee Replacement	**1. Y**	**2. N**	**3. NA**
12. Others			

A 9.2 Assessment Summary

Name: ______________________________ **Code:** ____
DOB ______________________________ **PRE TEST: Date** ___________________________
Age _____________ **Sex** _____________ **POST TEST: Date** ___________________________
Assessor: ___________________________ **3-Month FU: Date** ___________________________

Physical Parameter	Baseline	Post-intervention	3-month FU
Height (cm)			
Weight (kg)			
BMI (kg/M^2)			
BP (diastolic/systolic)			

Assessment		Baseline	Post-intervention	3-month FU
1. NCSE	Domains scored Normal (0-10)			
	Composite Score (0-82)			
2. TMT (A)	Time (sec)			
	Error			
3. TMT (B)	Time (sec)			
	Error			
4. VFT-animal (/ 60 sec)				
5. CVVLT	Trial 1 correct			
	Trial 4 correct			
	Total free recall (trial 1-4)			
	Total Intrusions			
	Total trans-trial preservations			
	30 sec- delayed recall			
	10 min-delayed free recall			
	10 min-delayed cue recall			
	Recognition correct hits			
	Recognition false positives			
6. PEDL (0 -28)				
7. Lawton IADL (/ 27)				

Appendix 10 Physical Activity Log

A 10.1 <u>Physical Activity Log (English)</u>

Date: ______________ Name _____________________ Code ______________________

Exercise on 3 non-consecutive days per week

	Mon	**Tues**	**Wed**	**Thurs**	**Fri**	**Sat**	**Sun**
Warm Up *Check √*							
Functional Task 1 *Level* *Repetition* *Minute* *Perceived Exertion*							
Functional Task 2 *Level* *Repetition* *Minute* *Perceived Exertion*							
Cool Down *Check √*							
Complaint/ Pain	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹
Motivation	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹
Comment							

A 10.2 Physical Activity Log (Chinese)

運動日誌　　日期: ______________　姓名: _____________________　號碼: ____________________

每星期 3 個非連續日

	一	二	三	四	五	六	日
熱身 √							
功能運動 1 程度 重複 分鐘 費力度							
功能運動 2 程度 重複 分鐘 費力度							
緩和 √							
不適/疼痛	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹
參與程度	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹	☺ 😐 ☹
其他							