UNIVERSITI PUTRA MALAYSIA

EFFECTIVENESS OF A PREVENTATIVE MULTI-COMPONENT TRAINING PROGRAM FOR PROSPECTIVE MEMORY PERFORMANCE AMONG HEALTHY OLDER ADULTS

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By

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Thesis submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for the Degree of Doctor of Philosophy

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There is a number of people without whom this thesis might not have been written, and to whom I am greatly indebted.

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Doctor of Philosophy

EFFECTIVENESS OF A PREVENTATIVE MULTI-COMPONENT TRAINING PROGRAM FOR PROSPECTIVE MEMORY PERFORMANCE AMONG HEALTHY OLDER ADULTS

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May 2018

Chairman: Associate Professor Rahimah Ibrahim, PhD
Institute: Malaysian Research Institute on Ageing

Aging affects older adults' physical and psychological well-being. One of the most significant age-related changes could be found in cognitive functions. Hence, to promote healthy aging and longevity among older adults, a global interest regarding treating age-related cognitive declines emerged. Cognitive training seems to be more successful, compared with the pharmacological treatments, in improving cognitive functions among older adults. Cognitive training includes strategy- and process-based approaches. Both approaches showed some advantages and disadvantages individually. Therefore, the literature suggested to use a combination of these two approaches (i.e., multi-component approach) to benefit from their advantages and surpass their disadvantages. One of the cognitive functions which is affected by age is Prospective Memory (PM). PM is the memory for future intentions and is an essential part of everyday life, especially among older adults. It has significant impacts on levels of independence and well-being as significant elements of healthy aging and longevity. Nonetheless, only a few studies have focused on PM training and improving levels of independence and well-being among older adults and these studies showed inconsistent results. Past studies focused on clinical populations, did not have adequate training approaches and targets, lacked strong study designs, and they did not consider older adults' individualized characteristics and needs. Moreover, PM is closely associated with several other cognitive functions as well (e.g., episodic and working memories). As such, these functions can be adequately targeted by multi-component cognitive training programs to promote healthy aging among older adults. Consequently, this study developed a tailor-made, multi-component PM training program for healthy older adults. The current study aimed to evaluate the efficacy of the intervention on the levels of independence, negative mood and anxiety among healthy older adults. In addition, the current study was planned as a randomized controlled trial (RCT) within participants' crossover design. The sample consisted of 25 healthy older adults, aged between 55 and 75 years who are members of University of Third Age (U3A) Kuala Lumpur/Selangor, their family members or friends. The study included two conditions: treatment and control (waiting list). The intervention was conducted within a six-week period and lasted two hours per session. Implementation of intentions was

used as the strategy-based approach, whereas the process-based approach used a computer game called "virtual week." Two follow-ups were conducted one and three months post-intervention. The baseline measures included PM performance, independence, negative mood and anxiety measures. A significant increase in PM performance and the level of independence were found (e.g., PM: F (2, 11) = 58.15, p < 0.05, $\eta 2$ = 0.91; level of independence: F (1, 12) = 80.18, $\eta 2$ = 0.87, p < 0.05). Moreover, the results revealed a significant reduction in negative mood and anxiety levels (e.g., negative mood: F (4, 9) = 17.03, $\eta 2$ = 0.88, p < 0.05; anxiety: F (4, 9) = 44.43, $\eta 2$ = 0.95, p < 0.05). The training effects were also persistent after three months from the last intervention session.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

KEBERKESANAN PROGRAM LATIHAN PELBAGAI KOMPONEN BERBENTUK PENCEGAHAN UNTUK INGATAN PROSPEKTIF DALAM KALANGAN WARGA EMAS YANG SIHAT

Oleh

AZIN FARZIN

Mei 2018

Pengerusi: Professor Madya Rahimah Ibrahim, PhD
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Penuaan mempengaruhi kesejahteraan fizikal dan psikologi warga emas. Antara perubahan berkait umur yang signifikan adalah penurunan dalam fungsi kognitif. Justeru, demi mempromosikan penuaan sihat dan keumuran dalam kalangan warga emas, keprihatinan peringkat global tentang mencegah penurunan kognitif berkait umur telah muncul. Latihan kognitif dilihat lebih berjaya dalam meningkatkan fungsi kognitif dalam kalangan warga emas berbanding rawatan farmakologi. Latihan kognitif merangkumi pendekatan strategi dan proses. Kedua-dua pendekatan menunjukkan beberapa kebaikan dan keburukan tersendiri. Justeru, kajian lepas mencadangkan penggunaan kombinasi kedua-dua pendekatan (iaitu pendekatan pelbagai komponen) untuk memanfaatkan kebaikan dan menjangkaui keburukan. Salah satu fungsi kognitif yang dipengaruhi oleh penuaan adalah Ingatan Prospektif (IP). IP adalah ingatan untuk melakukan sesuatu pada masa hadapan yang penting dalam perancangan dan pelaksanaan tugas seharian, terutamanya dalam kalangan warga emas. Ianya mempunyai impak yang signifikan terhadap tahap berdikari dan kesejahteraan yang merupakan elemen penting untuk penuaan sihat dan keumuran. Walaupun begitu, kajian yang memfokuskan latihan IP dan meningkatkan tahap berdikari dan kesejahteraan warga emas masih terhad dan menunjukkan hasil kajian yang tidak konsisten. Kajian lepas menumpukan kepada populasi klinikal, tidak mempunyai pendekatan dan sasaran yang mencukupi, tidak mempunyai rekabentuk kajian yang kukuh, dan tidak mengambil kira ciri dan keperluan individu warga emas. Selain itu, IP juga adalah berkait rapat dengan fungsi kognitif yang lain (contohnya, ingatan episodik dan ingatan kerja). Oleh itu, fungsi tersebut boleh disasarkan dengan menggunakan program latihan kognitif pelbagai komponen untuk mempromosikan penuaan sihat dalam kalangan warga emas. Sehubungan itu, kajian ini telah membangunkan program latihan IP pelbagai komponen yang disesuaikan bagi warga tua yang sihat. Kajian ini bertujuan untuk menilai keberkesanan intervensi ke atas tahap berdikari, mood negatif dan kebimbangan dalam warga tua yang sihat. Seterusnya, kajian ini dirancang sebagai ujikaji terkawal secara rawak (UTR) dalam kalangan subjek kajian dengan reka bentuk silang. Sampel terdiri daripada 25 orang golongan tua yang sihat, yang berumur antara 55 hingga 75 tahun dan merupakan ahli Universiti Era Ketiga

(U3A) Kuala Lumpur / Selangor termasuk ahli keluarga atau rakan mereka. Kajian ini merangkumi dua kumpulan: rawatan dan kawalan (senarai menunggu). Intervensi dilaksanakan dalam tempoh enam minggu dan selama dua jam setiap sesi. Pelaksanaan niat digunakan sebagai pendekatan berdasarkan strategi, manakala pendekatan berasaskan proses menggunakan permainan komputer yang disebut "aktiviti mingguan maya". Dua tindakan susulan tersebut dilaksanakan dalam tempoh satu dan tiga bulan selepas pemulihan. Pengukuran garis dasar merangkumi pengukuran prestasi IP, tahap berdikari, mood negatif dan kebimbangan. Terdapat perkaitan peningkatan dalam prestasi PM dan tahap berdikari (contohnya, PM: F (2, 11) = 58.15, $p < 0.05$, $\eta 2 = 0.91$; autonomi: F *(1, 12) = 80.18,* $\eta 2 = 0.87$, $p < 0.05$). Selain itu, hasil kajian juga menunjukkan pengurangan tahap mood negatif dan kebimbangan (contohnya, mood negatif: F (4, 9) = 17.03, $\eta 2 = 0.88$, $p < 0.05$; kebimbangan: F (4, 9) = 44.43, $\eta 2 = 0.95$, $p < 0.05$). Kesan latihan juga dikekalkan tiga bulan selepas fasa intervensi yang terakhir.

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I certify that a Thesis Examination Committee has met on 30 May 2018 to conduct the final examination of Azin Farzin on her thesis entitled "Effectiveness of a Preventative Multi-Component Training Program for Prospective Memory Performance among Healthy Older Adults" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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Declaration by graduate student

I hereby confirm that:

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Declaration by Members of Supervisory Committee

This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision;
- supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) are adhered to.

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Supervisory Committee: _____

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Supervisory Committee: _____

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LIST OF ABBREVIATIONS

AD	Alzheimer's Disease
CONSORT	Consolidated Standards of Reporting Trials
GAS	Geriatric Anxiety Scale
GDS	Geriatric Depression Scale
GLM	Generalized Linear Model
IADL	Instrumental Activities of Daily Living
MCI	Mild Cognitive Impairment
MMSE	Mini-Mental State Examination
PM	Prospective Memory
PM-Tasks	Prospective Memory-Tasks
PRMQ	Prospective and Retrospective Memory Questionnaire
RCT	Randomized Controlled Trial
RM	Retrospective Memory
TBI	Traumatic Brain Injury
U3A	The University of the Third Age
UPM	Universiti Putra Malaysia
VW	The Virtual Week Board Game

CHAPTER 1

INTRODUCTION

1.1 Introduction

The increasing longevity and the cognitive declines associated with aging encourage studies to develop new approaches to improve or maintain healthy aging, independent living and prevent cognitive declines among older adults (e.g., Ballesteros, Prieto, Mayes, Toril, Pita, et al., 2014; Klimova, 2016). Age-related cognitive declines could be found in various cognitive domains such as working memory, attention, processing speed, and executive functions. As aging and age-related declines among older adults were recognized and the importance of a healthy aging process was illustrated, the significance of interventions aimed to promote or maintain cognitive functions among older adults was demonstrated (Klimova, 2016). However, not all cognitive functions were included as focus points for cognitive training studies.

Prospective memory (PM) is one of the relatively neglected cognitive functions which might seem to be trivial, but it plays a significant role in our everyday lives (Einstein, McDaniel, Marsh, & West, 2008; Hering, Rendell, Rose, Schnitzspahn, & Kliegel, 2014). Einstein and McDaniel (1990) posited that PM plays a vital role in regard to having a successful and independent everyday life. PM is the memory for daily tasks such as cooking, grocery shopping, self-care, medication adherence, and keeping appointments. It can be a crucial cognitive function, especially among older adults (e.g., medication adherence) because a healthy functioning PM promotes independence, self-care and well-being (i.e., physical and psychological well-being) among older adults (Einstein et al., 2008; Giuli, Papa, Lattanzio, & Postacchini, 2016; McDaniel, & Bugg, 2012; Woods, Weinborn, Li, Hodgson, Ng, et al., 2015; Woods, Weinborn, Velnoweth, Rooney, & Bucks, 2012). Nonetheless, based on the literature, there are a few studies which aimed to assess or promote PM performance among older adults (e.g., Fleming, Shum, Strong, & Lightbody, 2005; Kinsella, Mullaly, Rand, Ong, Burton, et al., 2009), but there are fewer studies intended to improve PM functions among healthy older adults (e.g., Rose, Rendell, Hering, Kliegel, Bidelman, et al., 2015).

To promote healthy aging and longevity among older adults, PM could be one of the best training targets. Moreover, as PM is a multi-process cognitive function (i.e., PM has three sub-types and four functional stages) and it is closely associated with episodic and working memories, training PM could be largely beneficial for older adults (Einstein, & McDaniel, 1990; Einstein et al., 2008). Nonetheless, as PM is a multi-process cognitive function, there is a need for a cohesive and multi-component intervention which can target different and various underlying related factors of PM which are significant for a healthy functioning PM among older adults.

1.2 Problem Statement

Most countries face aging populations shortly. Malaysia is not an exception. Based on the statistics released by the United Nations, Department of Economic and Social Affairs (UNDESA), Population Division (2013), 8.5 percent of the Malaysian population aged 60 years and above in 2013. UNDESA, Population Division (2013) predicted this percentage would increase to 23.1 in 2050 and to 34.8 in 2100. So, Malaysia will have an aging population.

Aging causes several changes in different aspects of the individual's life. Age-related changes include lack of attention and concentration and decline in memory functions among others. Wimo, Winblad, Aguero-Torres, and von Strauss (2003) stated the number of individuals with Alzheimer's disease (AD) and other cognitive impairments increased rapidly. They stated by 2040 it will reach 81 million (as cited in Hamid, Krishnaswamy, Abdullah, & Abolfathi Momtaz, 2010, p. 533). Hamid et al. (2010) pointed out the number of individuals with cognitive impairments (e.g., dementia) in developing countries increases 3-4 times more than in developed countries due to different sociodemographic and health factors (e.g., the higher number of older adults, lower levels of education, occupational and marital statuses). This increase in the rate of older adults and cognitive impairments among them would cause more demands from healthcare services (e.g., economic and operational demands). Besides, in various countries, Alzheimer's Disease is listed among the top leading causes of death among older adults (e.g., Heron, 2015). In other words, nowadays, healthy aging and longevity are significant issues for older adults in numerous countries. Consequently, there is a global interest in keeping older adults healthy, active and independent. Also, Rose et al. (2015) pointed out that having successful PM performance would allow older adults to live; "*...independently, at home, without the need for assisted care*" (Rose et al., 2015, p. 2). Several studies focused on empowering and training older adults to decline age-related changes among them and these studies showed the importance of healthy aging and independence for older adults (e.g., Rebok, Ball, Guey, Jones, Kim, et al., 2014; Santos Golino, & Flores-Mendoza, 2016).

However, not all studies yielded positive results regarding declining age-related changes among older adults. There are many pharmacological treatments developed to decline or prevent cognitive impairments among older adults (e.g., Winbald, Gauthier, Scinto, Feldman, Wilcock, et al., 2008), but they failed to deliver desirable outcomes. Thus, there is a need for more research in the pharmacological field of study. Alternatively, using the concept of neural plasticity, cognitive training approaches emerged. As Barnes, Yaffe, Belfor, Jagust, DeCarli, et al. (2009) stated, the brain is capable of having neural plasticity, or in other words, neural plasticity claims developing new neurons and synaptic connections throughout the individual's entire life are feasible. In accordance with Barns et al. (2009), in a PM training program, Rose et al. (2015) measured their participants' event-related potentials (ERPs) regarding conducting PM tasks (i.e., laboratory-based and real-life PM tasks) before and after their training and showed their PM training program developed neural plasticity among older adults. Also, Hering et al. (2014) stated cognitive training (and PM training) can develop neural plasticity among older adults. Therefore, compared to pharmacological treatments, cognitive training programs showed to be more successful regarding preventing or declining age-related

changes among older adults. Subsequently, a growing global interest in cognitive training programs was developed among researchers and they aimed to improve cognitive functions and possibly, decline and delay the onset of cognitive impairments among older adults (Hering et al., 2014).

In general, there are two significant cognitive training approaches: i) strategy-based (e.g., using strategies such as the method of loci to train memory), and ii) process-based training approaches (e.g., using computer-based games such as Lumosity games to improve memory) (Hering et al., 2014). Strategy-based training approach aims to surpass issues (compensate) in the underlying cognitive processes (e.g., using alarms or external reminders to compensate for weak PM performance regarding medication adherence). Process-based training approach aims to enhance or maintain the underlying cognitive processes (e.g., playing a memory game to improve executive functions or working memory) (Reichman, Fiocco, & Rose, 2010). The research revealed both cognitive training approaches could decline cognitive impairments in older adults (e.g., Herrera, Chambon, Michel, Paban, & Alescio-Lautier, 2012; Rahe, Becker, Fink, Kessler, & Kukolja, 2015).

Nevertheless, as the literature demonstrated, both cognitive training approaches showed shortcomings as well (Hering et al., 2014). Based on Hering et al. (2014), usually, strategy-based approaches, as compensatory training approaches, do not develop persistent long-term training effects. And generally, process-based approaches use pure laboratory-based approaches which cannot develop near transfer effects (i.e., transferring the training effects to other everyday activities) because they are conducted in a laboratory, they usually do not show optimal results regarding real-life everyday living activities. Therefore, according to the literature, to gain all benefits and surpass disadvantages of both strategy- and process-based approaches, it is necessary to combine them (e.g., Blondelle et al., 2017; Hering et al., 2014).

One of the cognitive functions which is affected by age is PM (Einstein, & McDaniel, 1990). PM is the memory for performing an 'intended action' at a certain point in the future, and some of the primary tasks of PM include planning and learning (McDaniel, & Einstein, 2007). Some examples of PM functions are: remembering to send an email, taking medications on time, going for an appointment or calling a friend to invite them for dinner. PM is not the same cognitive function as retrospective memory (RM) which denotes the capability to recall information from the past (McDaniel, & Einstein, 2007). PM is an essential part of daily living activities, especially among older adults. Independence, self-care, medication adherence, and psychological well-being (especially mood and anxiety levels) are significantly associated with PM functions (Einstein et al., 2008; Woods et al., 2012; 2015).

As it was mentioned above, PM functions are affected by aging. Thus, as PM functions decline, older adults can lose their independence and even their physical (e.g., medication adherence) and psychological (e.g., levels of mood and anxiety) well-being might become endangered. Thus, training PM could improve all these mentioned areas and hence, it is significant for longevity and healthy aging (Einstein, & McDaniel, 1990; Einstein et al., 2008; Hering et al., 2014; Rose et al., 2015). Nevertheless, PM is relatively

a neglected area of research and previous studies showed mixed results regarding PM functions and PM training among older adults due to several reasons including; i) lack of a robust study design, ii) lack of a clear target cognitive function, iii) lack of follow-up sessions, and iv) inadequate training approaches (Einstein et al., 2008; Hering et al., 2014).

A number of studies showed the relationship between PM performance and self-care, medication adherence, psychological well-being (i.e., levels of mood and anxiety), and quality of life as important elements of everyday life among older adults (Giuli, et al., 2016; Kliegel & Jäger, 2006; Verhaeghen, Geraerts, & Marcoen, 2000; Woods, et al., 2015; Woods, et al., 2012; Yochim, Muellerb, & Segal, 2013), but there are a few studies focused on memory training and improving these areas among older adults (and there are hardly any studies for healthy older adults) (e.g., Giuli, et al., 2016; Takeuchi, Taki, Nouchi, Hashizume, Sekiguchi, et al., 2014). For example, few studies focused on PM training and improving independence and self-care (i.e., health tasks) (e.g., Insel, Einstein, Morrow, & Hepworth, 2013; Shelton, Lee, Scullin, Rose, Rendell, et al., 2016), but they did not consider all aspects of independence among their subjects (e.g., they just focused on one health task such as checking blood sugar) and they used clinical samples. Moreover, there are hardly any studies focused on PM training and improving psychological well-being (i.e., levels of mood and anxiety) among older adults (e.g., Giuli et al., 2016; Kliegel & Jäger, 2006; Woods et al., 2012; 2015) and they showed mixed results.

As it was mentioned before, levels of independence, mood, and anxiety are significantly associated with PM performance among older adults and they are significant elements of healthy aging so, they must be fully considered for a preventative PM training program to ensure healthy aging, longevity and having active older adults (Blondelle, Hainselin, Gounden, & Quaglino, 2017; Hering et al., 2014; Kliegel, & Jäger, 2006; Klimova, 2016; Yochim et al., 2013).

PM is considered to be a target memory for both strategy- and process-based interventions because it is a multi-process cognitive function (Hering, et al., 2014). So, conventional process-based training methods could be used to improve PM and its underlying components. According to the literature, exercising all types of PM with a method such as process-based method could provide a "learning environment" to reinforce the training effects, enhance training benefits, and sustain the effects from the training (Einstein et al., 2008). Also, the strategy-based approach could complete and improve the effects of the process-based approach by affecting other related cognitive and non-cognitive functions (Hering et al., 2014). However, there are a few studies which focused on empowering PM functions using strategy- or process-based approaches among healthy older adults (e.g., Blondelle et al., 2017; Hering et al., 2014; Jaeggi, Buschkuehl, Jonides, & Perrig, 2008; Carretti, Borella, Fostinelli, & Zavagnin, 2013a; Rose et al., 2015). These studies used either strategy- or process-based approaches and showed mixed results because of some limitations regarding their inadequate training approaches (Hering et al., 2014; Rose et al., 2015; Shelton et al., 2016). Consequently, it was suggested that one of the most potentially important and effective combinations of two training approaches regarding PM performance among older adults might include implementation intentions which can be convenient to reinforce planning and encoding

the intentions and a process-based computer game called Virtual Week which simulates real-life PM tasks to train PM performance (Hering et al., 2014; Rose et al., 2015; Shelton et al., 2016).

Moreover, as the previous studies suggested, to boost the training effects and develop a successful training program, the individual abilities and capacities should be considered before developing a training program for older adults. Based on the literature, a tailor-made training approach which could take into account all significant cognitive and metacognitive (i.e., personality characteristics, and capacities) elements involved in the training would be considered as the optimal training regime (e.g., Blondelle et al., 2017; Hering et al., 2014, Kliegel, Altgassen, Hering, & Rose, 2011; Kliegel, & Bürki, 2012). Blondelle et al. (2017) posited that one of the shortcomings of the previous PM training programs could be ignoring the metacognitive elements which can affect the training results.

From another perspective, many interventions suffer from a lack of rigor. Therefore, planning an intervention with a robust design is necessary (Hering et al., 2014). Based on Saturni, Bellini, Braido, Paggiaro, Sanduzzi, et al. (2014), the best method and design to evaluate the efficacy of a training program is Randomized Controlled Trial (RCT). RCT is considered to be the golden standard for assessing the effects of training programs. RCT is the design to test the training effects under an optimal setting without any confounding elements (e.g., personal characteristics, and preferences). So, RCT showed to have high internal validity. The PM-related literature indicated it is necessary to use such a rigorous design to report the efficacy of the interventions (Blondelle et al., 2017; Hering et al., 2014; Tardif, & Simard, 2011).

As Saturni et al. (2014) posited, RCT is the golden standard of experimental designs. Nonetheless, Hui, Zhukovsky, and Bruera (2015) stated that RCTs with parallel groups cannot address numerous 'interindividual' confounding factors especially regarding PM functions among older adults (Blondelle et al., 2017; Hering et al., 2014, Kliegel et al., 2012). Thus, Hui et al. (2015), suggested to report the accurate rate of effectiveness and any adverse effects of trainings, the within-participants crossover trials should be used. Based on Senn (2002) and Jones and Kenward (2014), compared to RCTs with parallel groups, within-participants crossover design has two significant advantages: i) the impact of confounding covariates is reduced, and ii) statistical power is higher than other designs and hence, the ideal sample size to indicate significant effects would be small. Thus, the present study is designed as an RCT (i.e., within-participants crossover trial) to evaluate the impacts of a multi-component PM training program (strategy- and process-based) among healthy older adults.

In a nutshell, most countries are facing aging populations in the near future and aging affects older adults physical and psychological well-being so, it is essential to keep older adults active and healthy. One of the most significant age-related changes could be found in cognitive functions. As age-related declines in cognitive functions became a major area of concern in numerous countries (i.e., Alzheimer's disease is one of the top leading causes of death among older adults in several countries), a global interest regarding treating age-related cognitive changes emerged. Pharmacological attempts to reduce or

eliminate age-related among older adults failed to deliver optimal results. However, cognitive training seems to be more successful regarding improving cognitive functions among older adults.

Cognitive training includes strategy- and process-based approaches. Both approaches showed some advantages and disadvantages. Therefore, to develop an ideal training program and use both approaches advantages and exceed their limitations, a combination of these two approaches should be used (i.e., multi-component). One of the cognitive functions which is affected by age is PM. PM is a multi-process cognitive function which is closely associated with several cognitive functions and well-being factors (i.e., levels of mood and anxiety). So, it is an adequate target for multi-component cognitive training programs for healthy older adults. Also, in accordance with the literature, there is a number of elements to be taken into account to create a successful PM training program such as; i) considering the participants' needs and resources (i.e., tailor-made approach), and ii) use a robust experimental design (i.e., RCTs). Consequently, this study developed a tailor-made, multi-component PM training program for healthy older adults using a within-participants crossover design to ensure the efficacy of the training effects.

This study was designed to answer the following research questions;

1. To what extent the multi-component training program is effective for PM performance among healthy older adults?

2. To what extent the multi-component training program is effective for healthy older adults' levels of independence?

3. To what extent the multi-component training program is effective for decreasing healthy older adults' levels of negative mood?

4. To what extent the multi-component training program is effective for decreasing healthy older adults' levels of anxiety?

1.3 Research Objectives

The main objective of the present study is to evaluate the effectiveness of a 12-hour, multi-component (strategy- and process-based) training program among healthy older adults.

The specific objectives of this training program are:

1. To evaluate the effectiveness of the multi-component training program on improving prospective memory (PM) functions among healthy older adults.

2. To evaluate the effectiveness of the multi-component training program on improving the levels of independence among healthy older adults.

3. To evaluate the effectiveness of the multi-component training program on decreasing the levels of negative mood among healthy older adults.

4. To evaluate the effectiveness of the multi-component training program on decreasing the levels of anxiety among healthy older adults.

1.4 Research Hypotheses

H1: The main hypothesis for this study is: there is a significant improvement in PM function among healthy older adults following a 12-hour multi-component (strategy- and process-based) PM intervention.

H2: There is a significant improvement in the level of independence among healthy older adults following a 12-hour multi-component (strategy- and process-based) PM intervention.

H3: There is a significant improvement in the level of mood among healthy older adults following a 12-hour multi-component (strategy- and process-based) PM intervention.

H4: There is a significant improvement in the level of anxiety among healthy older adults following a 12-hour multi-component (strategy- and process-based) PM intervention.

1.5 Significance of the Study

As mentioned before, dementia and other cognitive impairments can disable older adults even more than other aging-related changes among this population. Moreover, we face a growth regarding the aging population in many countries; thus it is necessary to keep older adults healthy, active and independent. In order to keep older adults active and healthy, there is an urgent need to decline age-related cognitive changes among older adults and improve their cognitive functions. Several approaches target cognitive declines resulted from aging. Pharmacological efforts failed to deliver an optimal result. Non-pharmacological approaches or cognitive training tried to target different cognitive functions among older adults.

An essential cognitive function associated with independence and well-being among older adults is PM. As PM is the memory responsible for future actions and is related to several significant aspects of life especially among older adults, training PM is a necessary action to be taken to keep the aging population healthy. So, PM should be a target for cognitive training. But, PM is still a relatively neglected research area, especially among healthy older adults (Einstein et al., 2008; Hering et al., 2014).

As a multi-process cognitive function, PM can be a suitable target for both strategy- and process-based training approaches. However, there are only a few studies focused on PM training, especially among healthy older adults (e.g., Blondelle et al., 2017; Hering et al., 2014). These studies used either strategy- or process-based approaches and the results from these studies were inconsistent for several reasons including i) sample populations (e.g., most previous studies used clinical populations), ii) lack of methodological consistency (e.g., some studies did not use strong intervention designs (i.e., RCTs), some others did not include follow-ups in their studies), iii) limited study targets (e.g., most PM training studies focused on health tasks solely), and iv) insufficient training approaches (e.g., some studies used strategy-based training approaches and failed to show long-term training effects and some used process-based training approaches and failed to show transfer effects to all everyday tasks) (Hering, et al., 2014). So, the literature showed a need for combined approaches (i.e., multi-component) which can exceed the limitations of the past approaches and combine their advantages in an individualized manner. It was highlighted in the literature that combined training approaches for PM should take metacognitive factors (e.g., personal characteristics of the participants) into account to show optimal results, as well (Blondelle et al., 2017).

To address the issues from previous studies and exceeding their limitations, the current study combined one of the most successful strategy-based techniques which is called "*implementation intentions*" and a very successful process-based technique which is a computer-based game called "*Virtual Week*" (Hering et al., 2014). Although these two techniques were used separately before, the current study is the first study which used a combination of both mentioned techniques in a tailor-made training program with a within-participants crossover design to improve PM performance among healthy older adults. This preventative multi-component PM training program will improve PM performance, levels of independence, mood, and anxiety (i.e., psychological well-being) among healthy older adults.

1.6 Definitions of Concepts

In accordance with the study aims and scope and based on their implication in the current study, the definitions of the study concepts were presented in the following order: i) conceptual, and ii) operational definitions.

1.6.1 Prospective memory (PM)

PM can be defined as the memory involved in remembering to perform an intention in the future (Einstein, & McDaniel, 1990). Based on the types of PM tasks, PM includes three sub-types: i) time-based PM, ii) event-based PM, and iii) activity-based PM (Einstein et al., 2008). PM can be conceptualized to function in four stages (Carey, Woods, Rippeth, Heaton, & Grant, 2006; Einstein & McDaniel, 1990): (1) Intention formation, (2) The delay maintenance interval, (3) Self-initiated cue recognition and intention retrieval. This stage is a defining feature of PM because the recall must be self-initiated, and (4) Intention execution.

This study measured PM subjectively and objectively. So, the subjective PM performance is the concept which can be measured with the Prospective and Retrospective Memory Questionnaire (PRMQ), and the objective PM performance is the concept which can be measured using a computer-based measurement which was Prospective Memory Tasks (PM Tasks) for the current study.

1.6.2 Independence

Independence can be defined differently depending on the context and the scope of the study. Based on the current study scope, the concept of independence was defined as Hofland (1990) asserted; the ability to take care of one's individual needs (i.e., physical and emotional needs) (as cited in Ball, Perkins, Whittington, Hollingsworth, King et al., 2004, p. 468) which is similar to McDaniel and Bugg (2012) definition of independence.

Based on the nature and aims of the current study, independence is defined as a concept which is measured with the Instrumental Activities of Daily Living scale (IADL).

1.6.3 Negative Mood

Based on the nature of this study, the negative mood is defined as; day-to-day and fluctuating negative emotional status which can be similar to the clinical mood disorders (i.e., depressive mood) (Kliegel, & Jäger, 2006). Negative mood, negative affect, negative emotions and depressive mood are used interchangeably in the PM-related literature (e.g., Kliegel, & Jäger, 2006; Yochim et al., 2013).

In the current study, the negative mood is the concept which is measured with the Geriatric Depression Scale (GDS).

1.6.4 Anxiety

Anxiety is considered as a negative emotion which encompasses several components including; i) physical symptoms (e.g., racing heart), ii) affective symptoms (e.g., feeling tensed up), and iii) cognitive symptoms (e.g., worrying) (Segal, Qualls, & Smyer, 2011).

In accordance with the current study nature, anxiety is defined as the concept which is measured with the Geriatric Anxiety Scale (GDS).

1.6.5 Healthy older adults

As the concept healthy older adults could include a wide range of definitions, it is necessary to define this concept in accordance with the nature and objectives of the study. Hence, based on the nature and scope of the current study, those older adults who meet all of the following criteria are considered to be healthy. These criteria include the absence of i) history of neurological impairments, ii) any major psychiatric disorders and learning disabilities, iii) history of general anesthesia, head traumas, or cerebrovascular disease, and iv) drug/alcohol abuse (Einstein et al., 2008).

There are different definitions for the concept of "older adult". In general, there is not a specific age range defined as older adults in the literature. Although in most countries (including Malaysia), older adults are defined as people with 60 years of age and above, different factors should be considered to define the concept of "older adults" in different regions of the world (World Health Organization, 2010). Based on World Health Organization (2010), the chronological age is not the only issue to consider to define older adults, but the context (i.e., training target), individuals' abilities, capacities, and resources should be considered to define older adults, as well. According to the nature of the current study (i.e., the primary training target was PM to keep older adults active and healthy), the World Health Organization (2010) definition of older adults was used for the current study. Based on this definition, older adults are defined in relation to age of retirement from a paid job and receive a pension (i.e., the age they were not active workwise) (World Health Organization, 2010). The retirement age for the study cohort was 55 years old consequently, the lower age limit for this study was 55 years and considering the Malaysian older adults' abilities and resources, the upper age limit was 75 years.

Thus, this study defined healthy older adults as individuals age between 55 to 75 years and meet all inclusion criteria of the current study.

1.7 Theoretical Framework of the Study

There are numerous changes along with aging. Aging has an impact on PM performance which also affects various aspects of the individual's life. As Kliegel and Jäger (2006) stated, the theoretical framework for PM training ought to be viewed as an amalgam of several developing theories, rather than a single theory developed by giants in the field such as Einstein and McDaniel. Kliegel et al. (2012) stated a successful PM training program needs to be a theory-based one. However, to develop a successful PM training for older adults to promote healthy aging and longevity among them, understanding the age-related changes on PM, as a concept and the underlying processes of PM is required. Thus, in the following sections, the theoretical perspectives regarding the age-related changes on the types, phases, and underlying processes of PM, and the theories regarding age-related changes in PM performance and their effects on older adults' day-to-day life are explained as the elements of the theoretical framework for the current study.

Craik's (1986) theory of aging posited that PM encompasses the retrieval of past information based on internal/external cues. He pointed out that PM is primarily dependent on internal cues (i.e., self-initiated). In regard to the age-related changes in PM, Craik (1986) stated aging affects primarily the self-initiated retrieval processes which are the fundamental processes of PM. Following Craik's (1986) guidelines, Einstein and McDaniel (1990) stated that as PM is the ability to remember to carry out an intended action in the future, it is a crucial element regarding daily living activities (i.e., independence), especially among older adults. They pointed out that an independent everyday life requires a successful PM performance. Einstein and McDaniel (1990) stated that aging affects all types of PM (i.e., time-, event-, and activity-based PM), but it interferes with time-based PM tasks more than other PM tasks because time-based PM tasks are more self-initiated than the other tasks (see also Henry, MacLeod, Phillips, & Crawford, 2004; Park, Hertzog, Kidder, Morrell, & Mayhorn, 1997). Einstein and McDaniel (1990) also posited that aging affects all phases of PM (i.e., intention formation, intention retention, intention initiation, and intention execution) (Einstein, & McDaniel, 1990; Kliegel, McDaniel, & Einstein, 2000). Specifically, aging might impair the intention formation phase which results in impairments in the intention execution phase. Accordingly, age-related declines in PM performance could endanger older adults' independence.

In regard to the underlying processes of PM, based on McDaniel and Einstein's (2000) "*Multi-Process Theory*" (see also Einstein, & McDaniel, 2005; Einstein, McDaniel, Thomas, Mayfield, Shank, et al., 2005), a combination of the "*Attentional Monitoring Theory*" (Smith, & Bayan, 2006) that assumes successful PM performance needs an attentional system to monitor the environment based on PM demands constantly and the "*spontaneous retrieval Theory*" (Einstein, & McDaniel, 1996) that suggests the occurrence of the cue initiates several processes which lead to automatic and spontaneous retrieval of the 'intended action' should be considered as a model to explain the underlying processes of PM. Based on this theory, it is not possible to assume all PM tasks are solely dependent on monitoring processes. On the other hand, not all PM tasks would be executed solely by the automatic retrieval processes and there is a need to monitor the environment for the target cues. So, attentional resources, monitoring, and retrieval processes should be considered the equally significant underlying processes of PM. Based on the Craik's (1986) and Einstein and McDaniel's (1990) theories, aging might interrupt the monitoring processes and it has a negative effect on the attentional resources and it affects the self-initiated retrieval processes as well.

Aging affects older adults' PM performance and the decline in PM performance would interfere with older adults' independence, physical (i.e., medication adherence) and psychological well-being (i.e., mood, and anxiety) among older adults (Einstein, & McDaniel, 1990). Einstein and McDaniel's (1990) theory showed the importance of PM performance in regard to the level of independence. Also, following Craik (1986), there are two theories which could explain the relationship between PM performance and levels of negative mood, and anxiety. These theories are: i) Ellis and Ashbrook's (1988) "*Resource Allocation Model*" that posited there is a relationship between age-related PM declines and the level of negative mood among older adults. So, as the attentional resources for a cognitive task decline, performing self-initiated tasks (i.e., PM tasks) could be more difficult for older adults and it might result in an increase in the level of negative mood and vice versa (i.e., increased levels of negative mood might cause more

PM performance errors), and ii) Eysenck and Calvo's (1992) "*Processing Efficiency Theory*" that explained the interaction between anxiety and cognitive tasks in a similar manner. Based on this theory, anxiety might affect the attentional resources. Thus, anxiety can disrupt attentional resources and monitoring processes regarding a cognitive task. On the other hand, stronger attentional resources might decline the level of anxiety among older adults. Consequently, as Einstein and McDaniel (1990) and Craik (1986) posited, older adults' psychological well-being (i.e., levels of negative mood and anxiety) have a significant relationship with their PM performance.

Not only does aging affect PM performance among older adults, but also it affects older adults' everyday activities, physical (i.e., medication adherence) and psychological well-being. Consequently, to keep older adults healthy and independent, there is a need to develop PM training programs for them. The current study developed a theoretical framework in accordance with the mentioned theoretical perspectives regarding age-related changes in PM performance. Based on this framework, all types, phases, and fundamental processes of PM should be targeted by the training program to promote PM performance and consequently, improve the levels of independence, negative mood, and anxiety among older adults. Therefore, to fully train all types, phases, and underlying processes of PM, a combination of both cognitive training approaches (i.e., strategy-based and process-based) should be used.

Strategy-based approaches generally try to improve a specific cognitive function in a compensatory manner, but they generally do not show transfer effects. Process-based approaches focus on training the underlying essential processes (and mechanisms) of a cognitive function and they show long-term training effects, yet they typically do not show transfer effects to real-life everyday tasks. To benefit from the advantages and circumvent the limitations of both approaches, this study utilized a multi-component training program (i.e. a combination of both approaches) and selected implementation intentions as the strategy-based training component to reinforce all PM phases, especially intention formation also the Virtual Week game was used as the process-based training component to improve all types and the underlying core processes of PM in a naturalistic manner. The theoretical framework for the current study is demonstrated in Figure 1.1.

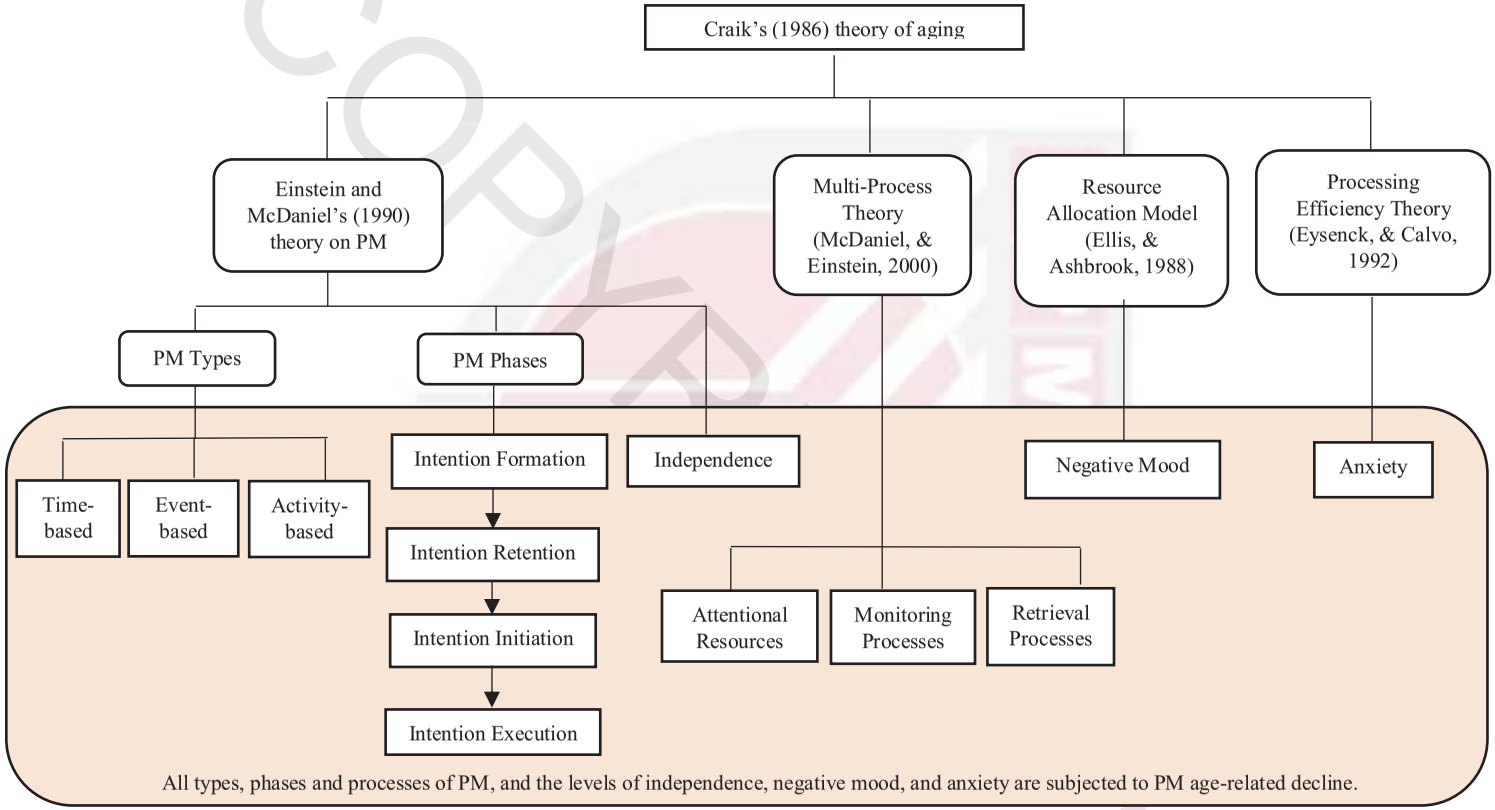

Figure 1.1: Theoretical Framework of the Study

1.8 Conceptual Framework of the Study

As it was mentioned before, keeping older adults healthy, active and independent is a significant goal for the countries which face aging populations in the near future. Numerous age-related changes could be found among older adults. Cognitive impairments are not only one of the most disabling issues, but also, they are listed among the leading causes of death among older adults. Thus, it is essential to keep older adults healthy and prevent any cognitive declines among them.

According to the theoretical perspectives, PM is a multi-process cognitive function related to several cognitive functions. Also, PM is associated with several aspects of everyday life which are critical for healthy aging among older adults. PM performance is closely related to the levels of independence, negative mood, and anxiety among older adults (Einstein et al., 2008; Hering et al., 2014; Woods et al., 2012; 2015). Accordingly, training PM among older adults could affect their PM performance and the levels of independence and well-being.

Based on the PM-related theories, the most important age-related change in PM performance among older adults is the decline in self-initiated retrieval processes. PM, by nature, is a self-initiated process and aging affects PM performance and consequently everyday life activities among older adults. Generally, PM training programs should compensate for age-related declines in PM and boost the underlying mechanisms associated with PM performance among older adults. Therefore, based on the PM theoretical framework, PM can be targeted by both compensatory (i.e., strategy-based) and restorative (i.e., process-based) training approaches to show the optimal training effects.

Strategy-based training approaches mostly focus on improving just one specific cognitive function in a compensatory way. As they do not target other near or far cognitive functions in regard to their main target, they frequently fail to show transfer effects to other cognitive functions. Process-based approaches mainly focus on exercising the underlying processes of their target cognitive function repetitively in an intensive manner and they show long-term training effects. However, these approaches mostly utilize either laboratory-based settings or training components. Therefore, they do not show transfer effects to real-life everyday activities. Accordingly, to fully benefit from a training program, a combination of both approaches is required.

The significance of a successful PM performance regarding having a healthy and independent life among older adults was explained theoretically. However, the literature showed there are a few studies focused on PM training among older adults and there are hardly ever any studies focused on training PM performance which resulted in improvements regarding the levels of independence (i.e., all major everyday life activities), negative mood and anxiety among healthy older adults. So, in accordance with the PM theories of aging and the related literature, this study developed a

preventative multi-component PM training program to improve PM performance and consequently the levels of independence, negative mood, and anxiety among older adults to promote healthy aging and longevity. The present study primarily used the age-related PM theories regarding the nature of PM and age-related changes in PM performance as the basis of the study framework. Some support was provided by incorporating different theories of aging regarding the relationship between age-related PM changes and levels of negative mood and anxiety (i.e., psychological well-being) into the framework. The conceptual framework is illustrated in figure 1.2.

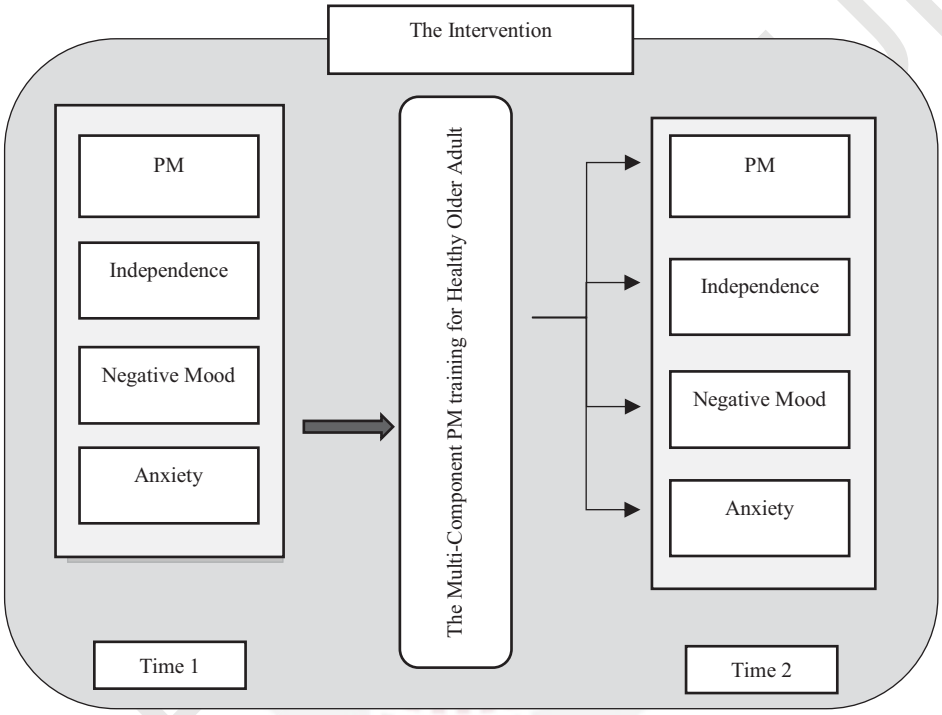

Figure 1.2: Conceptual Framework of the Study

1.9 Chapter Summary

In brief, this chapter provided a general perspective regarding the nature of PM functions and the impact of PM functions on the levels of independence and well-being among older adults. The theoretical perspective to understand PM and age-related changes in PM performance was presented. Also, the need for developing PM training programs for healthy older adults was described.

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